

Education Applications & Developments XI - Part II



Editor: Mafalda Carmo

Advances in Education and Educational Trends

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Edited by: Mafalda Carmo



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CONTENTS

Foreword	vii
Contributors	xxiii

Section 1: Projects and Trends

Chapter 1	
Generative AI in higher education: Impacts on teaching and learning	3
<i>Nora Gavira-Duron, Ana Lorena Jiménez Preciado, & Angelica Alonso-Rivera</i>	
Chapter 2	
Art therapy in the context of special education: A study of Bulgarian psychologists' attitudes	17
<i>Sabina Eftimova & Teodora Genova</i>	
Chapter 3	
AI transformation in economics and finance education: Innovations, challenges, and future directions	29
<i>Luis Enrique García Pérez & Muhammad Kashif</i>	
Chapter 4	
Precarious prosperity: Rethinking financial dependence on international students in Canadian higher education	41
<i>Adnaan Mallam-Hassam & Dale Kirby</i>	
Chapter 5	
Mastery, participation, and motivation in secondary school	52
<i>May Olaug Horverak, Gerd Martina Langeland, Emre Sari, & Tommy Haugen</i>	
Chapter 6	
Butterfly-Piano: A playful learning proposal for children with Autism Spectrum Disorder	67
<i>Priscila Gambary</i>	
Chapter 7	
Hackathons in the era of grand challenges: A tool fit for management education objectives?	81
<i>Sandrine Stervinou, Jennifer Goodman, Laurent Noël, Aline Polipowski, & Jean-Marc Charlot</i>	

Chapter 8	
Becoming a STEM focused school: Initial priorities for school transformation	93
<i>Wendy P. Ruchti & Cory A. Bennett</i>	
Chapter 9	
Navigating contradicting expectations: Study demands and resources in European games, animation and VFX education	106
<i>Silke Hassreiter, A. Treshi-Marie Perera, Tuki Clavero, Lindsey Bouwels, & Mata Haggis-Burridge</i>	
Chapter 10	
Future educators' perceptions of vicariance as a design tool in early childhood education services in the presence of visually impaired children	119
<i>Addolorata Amadoro, Umberto Veneruso, & Diana Carmela Di Gennaro</i>	
Chapter 11	
"You can bring yourself into your piece." Young women's agency in making	129
<i>Ken Rafanan, Nuria Jaumot-Pascual, Elise Levin-Güracar, & Teresa Lara-Meloy</i>	
Chapter 12	
Model of functional literacy for teachers concerning the application of 3D printing in secondary schools	147
<i>Tetjana Tomášková, Jan Krotký, & Jarmila Honzиковá</i>	
Chapter 13	
De-centering the human: Critical posthumanism and the refiguration of educational futures	161
<i>Valerija Vendramin</i>	
Chapter 14	
The importance of integrating engineering and science students in banking: Enhancing Innovation and Security	170
<i>Didier Mbela Kalengay, Kaarina Anna Paulus, Boniface Kerima, & Alex Banze Wa Mutombo</i>	
Chapter 15	
Artificial intelligence as a catalyst for fashion's digital future - Insights from university-company collaboration	179
<i>Xiaozhu Lin & Matteo Oreste Ingaramo</i>	
Chapter 16	
Use of AI agents and agentic AI to evaluate university curricula	189
<i>Deirdre Pratt & Pregalathan Reddy</i>	

Chapter 17	
Reframing subject advisors' professional roles as catalysts for sustainable life sciences education	204
<i>Nomzamo Xaba</i>	
Chapter 18	
The use of 3D printing as a didactic tool in technical drawing education with an emphasis on ecodesign	215
<i>Tetjana Tomášková, Jan Krotký, & Jarmila Honzík</i>	
Chapter 19	
Leadership of place to build anthropologies of presence: An alternative educational response to disinformation	225
<i>Victoria Konidari & Manolis Koutouzis</i>	
Chapter 20	
A relational framework for professional development in rural science education: Integrating Ubuntu, indigenous knowledge, & inquiry-based practice	238
<i>Nomzamo Xaba, Mayaba Brian, & Aviwe Sondlo</i>	
Chapter 21	
"Does it save time and make you smarter?" – Lessons learned from a workshop developing teachers' prompting competence with ChatGPT	251
<i>Björn Sjöden & Jeroen Lievens</i>	
Section 2: Organizational Issues	
Chapter 22	
Principals' leadership practices in a digitally evolving world: A human rights perspective	263
<i>Ngozi Blessing Enebe & June Monica Palmer</i>	
Chapter 23	
Knowledge management approach to remote care competence development	274
<i>Sonja Fröjd, Nina Helander, & Jussi Myllärniemi</i>	
Chapter 24	
Participatory design of a health-promoting university – The project mindful campus at Leibniz university Hannover	287
<i>Ariane Steuber & Natalie Banek</i>	
Chapter 25	
Development of the university research center and transfer of its results and new knowledge into teaching	295
<i>Tetjana Tomášková & Miloslav Kepka</i>	

Contents

Chapter 26	
The role of the local school in the rural community: A perspective of school multifunctionality	309
<i>Liga Paula & Anda Grinfelde</i>	
Chapter 27	
The impact of the extended curriculum programmes: The narratives from current and graduate students	319
<i>Jeanine N. Mwambakana-Mutombo</i>	
Chapter 28	
Tri-theory approach for mitigating the impacts of poly-violence exposure on learners in South African schools	330
<i>Oluwasola Babatunde Sasere & Martha Matashu</i>	
Chapter 29	
Enhancing social inclusion: The role of cognitive and emotional regulation in adolescents with specific needs	341
<i>Eva Vancu</i>	
Chapter 30	
Ethical leadership woven with integrity: Emerging pathways for school principals	352
<i>Edwin Darrell De Klerk & Sipiwe Mudadigwa</i>	
Author Index	361

FOREWORD

inScience Press is delighted to publish this book entitled *Education Applications & Developments XI* as part of the Advances in Education and Educational Trends books series. These series comprise the work of authors and editors to address global research in the Education area.

This 11th volume, presented in two parts, addresses some of the most relevant and pressing issues in contemporary educational research. Through the contributions of a dedicated group of authors, this volume explores diverse dimensions of Education, fostering the advancement of knowledge and encouraging innovation in the field. Progress in education depends on the active commitment of individuals who are willing to develop creative solutions and who believe in their capacity to bring about meaningful change. In this spirit, the present volume seeks to inspire broader public engagement and strengthen collaboration within and across communities. As part of our ongoing commitment to serving society, we underscore the importance of reinforcing research initiatives, promoting education and science, and encouraging interdisciplinary cooperation. We believe that connecting diverse perspectives and areas of expertise is essential for advancing educational practices that are both impactful and inclusive.

This 11th edition is organized around four major areas within the broad field of Education: “*Teachers and Students*”, “*Projects and Trends*”, “*Teaching and Learning*”, and “*Organizational Issues*”. Part I focuses on the areas: “*Teachers and Students*” and “*Teaching and Learning*”, while Part II addresses “*Projects and Trends*” and “*Organizational Issues*.” Each section comprises chapters that have emerged from extended and peer reviewed selected papers, originally published last year in the proceedings of the International Conference on Education and New Developments (END 2025) conference series (<http://end-educationconference.org/>). This meeting occurs annually with consistently successful outcomes. Selected original papers were expanded by their authors and underwent a renewed evaluation process. Following this, authors of the accepted chapters were invited to revise and improve their work based on the reviewers’ feedback. This process resulted in the publication of 27 high-quality chapters in Part I and 30 chapters in Part II. The following sections and chapter abstracts provide further insight into the content and scope of Part II of this volume.

Section 1, entitled “Projects and Trends”, presents chapters concerning, as the title indicates, education viewed as the center for innovation, technology and projects, concerning new learning and teaching models.

Chapter 1: *Generative AI in higher education: Impacts on teaching and learning*; by Nora Gavira-Duron, Ana Lorena Jiménez Preciado, & Angelica Alonso-Rivera. The rapid advancement of artificial intelligence (AI) technologies, particularly generative AI and Natural Language Processing (NLP) tools is transforming higher education. This study investigates the integration of AI in tertiary educational settings, focusing on its impact on teaching practices and learning outcomes. Our corpus analysis highlights the prominence of AI in education, with frequent references to AI applications such as ChatGPT and large language models. These technologies offer innovative solutions for personalized learning, intelligent tutoring systems, and enhanced pedagogical methods. The analysis reveals a significant focus on practical implementations of AI, emphasizing the transformation of traditional teaching methodologies. The study also addresses critical issues such as the technological infrastructure required for AI integration and the ethical considerations of AI use in education. The findings suggest that while AI holds promise for revolutionizing education, there is a need for a balanced approach that includes developing critical thinking skills and addressing ethical implications. This research contributes to the growing body of literature on AI in education by providing a detailed exploration of current trends, challenges, and future directions in the field.

Chapter 2: *Art therapy in the context of special education: A study of Bulgarian psychologists' attitudes*; by Sabina Eftimova & Teodora Genova. This book chapter examines the application of art therapy as a supportive approach when working with children with special educational needs (SEN). As part of the study, a survey was conducted with psychologists working with children with SEN in various educational and therapeutic institutions. The aim of the study is to analyze the attitudes, professional experience and perceptions of specialists regarding the benefits and challenges associated with the use of art therapy in this context. The results show a positive attitude towards art therapy as an effective tool for emotional, cognitive and social support of children, but also highlight a number of practical difficulties related to the lack of resources, specialized training and systemic support. Possibilities for a wider introduction of art therapy practices in the field of special education are discussed.

Chapter 3: *AI transformation in economics and finance education: Innovations, challenges, and future directions*; by Luis Enrique García Pérez & Muhammad Kashif. The integration of Artificial Intelligence (AI) into economics and finance teaching represents a transformative shift in pedagogical strategies, offering opportunities to enhance learning outcomes and institutional efficiency. This study explores the applications of AI tools, such as generative models and big data analytics, and personalized learning. By synthesizing empirical findings from multiple case studies and qualitative analyses, this research identifies key

innovations, including automated content generation, adaptive learning platforms, and AI-driven assessment systems. However, the adoption of AI also presents significant challenges, such as algorithmic biases, data privacy concerns, and the risk of overreliance on technology diminishing human interaction. The research employs a mixed-methods approach, combining literature reviews, surveys of educators, and practical implementations of AI tools in classroom settings. Results indicate an increase in AI adoption among educators when supported by structured training programs, alongside improved student engagement in complex topics like financial modeling and economic policy analysis. In conclusion, AI serves as a complementary force in education, enhancing, not replacing, the role of educators. Strategic implementation, grounded in ethical considerations and pedagogical goals, can bridge gaps in traditional teaching methods and prepare students for a digitized economy.

Chapter 4: *Precarious prosperity: Rethinking financial dependence on international students in Canadian higher education*; by Adnaan Mallam-Hassam & Dale Kirby. This paper examines the growing financial dependence of Canadian universities on international student tuition and the risks associated with this funding model. Applying Resource Dependence Theory, the study explores how institutional reliance on unregulated international tuition revenue has made universities vulnerable to external shocks, including recent federal policy changes limiting study permits. The analysis highlights three core issues: financial instability, ethical concerns around the commodification of education, and reputational risks in global academic markets. It also underscores the consequences of decentralized governance and declining public investment in higher education. Drawing on international comparisons, the paper outlines a range of policy and institutional strategies to promote financial sustainability, including revenue diversification, public-private partnerships, research commercialization, and tax-based grant models. This review calls for a coordinated and ethically grounded funding approach to safeguard academic quality and ensure the long-term resilience of Canada's post-secondary sector.

Chapter 5: *Mastery, participation, and motivation in secondary school*; by May Olaug Horverak, Gerd Martina Langeland, Emre Sari, & Tommy Haugen. Mental health issues have been on the increase for years in Norway, and after the pandemic, school absence has been an increasing problem. To meet these challenges, several national initiatives have been launched. The current study will present experiences from a health promoting project called SAMM – A systematic approach to mastery, participation, and motivation, where a five-step method has been applied. A quasi-experimental study with test and control groups was carried out, including an intervention of four sessions spread over about a month, and repeated throughout the school year. Seven upper secondary school classes were included as test groups, resulting in 132 student participants. Five control groups were included, resulting in 132 control students. Finding an appropriate scale to measure the effects of the intervention proved challenging. The General Self-Efficacy Scale was used despite

a rather limited focus. An ANOVA-analysis has been carried out, showing no significant difference between test and control groups over time. However, the approach in the intervention relates to several aspects of health promotion, and a more extensive scale would perhaps have been more adequate to measure possible effects.

Chapter 6: *Butterfly-Piano: A playful learning proposal for children with Autism Spectrum Disorder*; by Priscila Gambary. This chapter discusses the importance of teachers' openness to new teaching methodologies and tools, especially in the context of inclusive music education for individuals with Autism Spectrum Disorder (ASD). In addition to the challenges arising from adaptive pedagogical practice, the chapter proposes a reflection on the use of the piano as an instrument that mediates learning and socialization. The present study aims to suggest new and creative possibilities for using the piano – considered one of the most traditional musical instruments – through the application of a non-conventional graphic element. The methodological proposal presented here, called Butterfly-Piano, involves not only a playful and diversified design, but also a therapeutic association between musical notes and colors, which can effectively complement treatments for this population. It is expected that this “new instrument,” which can be made at home using cardboard, will provide children—especially nonverbal children and those with limited social interaction—with a better quality of life.

Chapter 7: *Hackathons in the era of grand challenges: A tool fit for management education objectives?*; by Sandrine Stervinou, Jennifer Goodman, Laurent Noël, Aline Polipowski, & Jean-Marc Charlot. In management education, hackathons have become a popular tool, originally designed to foster technology prototyping. This study examines their suitability for tackling grand challenges like climate change, poverty, inequality, and environmental sustainability. It focuses on hackathons for sustainable development held at a business school since 2016. Adopting a multi-stakeholder approach, the research includes data from students, professors, programme management, and external stakeholders via questionnaires and interviews to analyse one specific hackathon. The findings reveal that each group attributes different value to the hackathon experience, leading to significant tensions. The study, therefore, advises caution in adopting hackathons as a one-size-fits-all solution for teaching complex grand challenges. Ultimately, the research suggests that hackathons fail to satisfy all stakeholders simultaneously. This highlights the need to adapt the hackathon format to specific contexts to maintain its pedagogical integrity. These insights are crucial, given the growing emphasis on multi-stakeholder approaches in sustainable development education and the widespread use of hackathons in higher education.

Chapter 8: *Becoming a stem focused school: Initial priorities for school transformation*; by Wendy P. Ruchti & Cory A. Bennett. The global importance of science, technology, engineering, and mathematics (STEM) education is growing, prompting schools and policymakers to seek more effective ways to implement STEM instruction. Ministries of education are responding by creating specialized STEM-focused schools, which aim to cultivate critical thinking, experiential learning, and innovative problem-solving through an integrated, interdisciplinary curriculum. These schools often use project-based learning to connect with real-world applications and prepare a diverse student body, particularly those from underrepresented populations, for STEM careers. However, the implementation of such programs presents challenges. These obstacles can be better overcome with a purposeful pre-implementation framework that addresses key structures and conditions before significant changes are made. This chapter will review existing literature on STEM-focused schools and propose a research-based framework for initial priorities for the transformation to becoming a STEM focused school. This framework will provide teachers, administrators, and policymakers with a clear roadmap for successful school-wide STEM transformation.

Chapter 9: *Navigating contradicting expectations: Study demands and resources in European games, animation and VFX education*; by Silke Hassreiter, A. Treshi-Marie Perera, Tuki Clavero, Lindsey Bouwels, & Mata Haggis-Burridge. The games, animation, and visual effects (VFX) creative industries are characterised by high-pressure team projects and oversaturated job markets, leading to contradictory demands for students to become both humble team players and highly competitive self-promoters. Using qualitative semi-structured interviews and focus groups, this study examined the study demands and resources experienced by 50 participants across 12 European countries: educators (n = 28), students (n = 14), and recent graduates (n = 8). Drawing on Study Demands-Resources (SD-R) theory, which emphasises the importance of educational institutions balancing study demands and resources to support student well-being, this study demonstrates how curriculum reforms, faculty guidance, and peer networks (factors that should function as study resources) can instead transform into demands for students in these specific contexts. The findings also reveal adaptive strategies students developed in response to these conditions. This study extends SD-R theory by demonstrating conditions under which traditional resource-demand relationships operate differently than established patterns, contributing to theoretical understanding of student well-being in creative industries in higher education.

Chapter 10: *Future educators' perceptions of vicariance as a design tool in early childhood education services in the presence of visually impaired children*; by Addolorata Amadoro, Umberto Veneruso, & Diana Carmela Di Gennaro. Neuroscience highlights the body's central role in cognition, showing the close link between perception, action, and thought. Vicariance is a creative capacity of the brain that enables humans to devise alternative solutions to the complexity and

unpredictability of reality. It thus represents an adaptive resource that fosters flexibility and responsiveness, both essential for survival. In the case of visual impairment, vicariance allows the body to compensate for the lack of sight by enhancing other senses and supporting movement. This concept is highly relevant to education, where biological and cultural dimensions intersect. In the learning processes of visually impaired children, vicariance can be understood in two ways. On the one hand, it reflects the child's ability to develop strategies that compensate for the absence of vision. On the other hand, it refers to the educator's role in designing flexible responses tailored to specific educational needs, within an Adaptive Decision-Making perspective. On these grounds, a questionnaire was administered to students in the Educational Sciences degree program at the University of Salerno during the course "Inclusive Design of Early Childhood Services." The aim was to explore future educators' perceptions of designing activities for early childhood contexts with children with visual impairments, and to assess how they envision using vicariance as a creative tool to foster inclusive education for all.

Chapter 11: *"You can bring yourself into your piece."* *Young women's agency in making*; by Ken Rafanan, Nuria Jaumot-Pascual, Elise Levin-Güracar, & Teresa Lara-Meloy. While many makerspaces are created by and cater to middle-aged males, our research has found that young women enjoy engaging in a multitude of making disciplines, including those traditionally thought of as masculine such as woodworking. In the AAMASE project, we worked with participants and program staff to co-design an eight-week program focusing on introducing several making disciplines with a set of principles, activities, and tools to support youths' agency in a community-based makerspace in the mid-Atlantic region of the United States. Most participants were African American high-school-aged young women from two out-of-school learning organizations and a private school. Making projects ranged from single-day projects, such as creating resin art pieces, to longer multi-session projects, such as making a laser engraved cutting board. We found that projects supported participants' agency as assessed through a framework we developed consisting of five criteria (self-efficacy, personalization, connection, planfulness, and iteration) consistent with the research literature on agency. Our research found that single-day projects supported participants' self-efficacy, personalization, and connection, and longer final projects supported their planfulness and iteration. The paper also briefly describes the researchers' use of artifact elicitation and provides recommendations for future research on agency and for practices that support agency.

Chapter 12: *Model of functional literacy for teachers concerning the application of 3D printing in secondary schools*; by Tetjana Tomášková, Jan Krotký, & Jarmila Honzíková. Teachers' functional literacy includes not only basic reading and writing skills but also the ability to use modern technologies effectively. In the context of 3D Printing, this requires understanding technical principles, working

with 3D modeling software, managing the printing process, and addressing technical issues. 3D Printing serves as an innovative educational tool that enables students to visualize and explore complex concepts, fostering creativity, critical thinking, and practical skills essential for the 21st century. Teacher preparation plays a crucial role and includes technical training as well as pedagogical strategies for meaningful integration of this technology into instruction. This may involve workshops, online courses, or collaboration with experts. However, the implementation of 3D Printing also brings challenges such as financial costs, the need for technical support, and curriculum updates. Identifying barriers and seeking solutions—through grants or resource sharing among schools—is therefore essential. The chapter presents examples of good practice and emphasizes that teachers’ functional literacy also includes adaptability to new technologies. Successful integration of 3D Printing requires school leadership support and continuous professional development. The chapter concludes with a model of teachers’ functional literacy applicable in educational practice.

Chapter 13: *De-centering the human: Critical posthumanism and the refiguration of educational futures*; by Valerija Vendramin. My starting point is critical posthumanism as a post-anthropocentric deconstruction of both cultural and technological determinism. This paper aims to lay the groundwork for critically examining the possible refigurations of the broader purposes of education. I will be looking into (1) the adoption (or resistance to adoption) of technology in schools and also into (2) the need for decentring the human, rethinking the position of other-than-human actors and their role in shaping knowledge and practices within (post-)educational contexts. My approach challenges the official or commonly accepted understanding of social reality, political relations, and conceptual categories by examining alternative viewpoints (e.g., “traditional” education vs. education in light of technological innovations), thereby offering an analysis of fundamental concepts. By employing a posthumanist lens, I foreground several “failures” of humanist assumptions, including the framing of education as a purely human-centered project and the presumed clear ontological separation between the human and the nonhuman. A still prevailing narrative suggests that digital technology inherently makes education “better” (i.e., more efficient, more accessible, etc.); however, the question arises of how well education is equipped to deal with present complexities, one of them being how to treat educational technologies so as not to mask their agency and power.

Chapter 14: *The importance of integrating engineering and science students in banking: Enhancing innovation and security*; by Didier Mbela Kalengay, Kaarina Anna Paulus, Boniface Kerima, & Alex Banze Wa Mutombo. The digital transformation of the banking sector has created an unprecedented demand for technical, analytical, and creative problem-solving skills. This chapter examines how scientific and engineering (STEM) students might be strategically integrated into the banking industry to meet this need, with a focus on Namibia and the Democratic

Republic of the Congo (DRC). Despite the widespread recognition of the potential benefits of this type of integration, including enhanced cybersecurity, data-driven innovation, and operational efficiency, many questions remain regarding practical implementation strategies and how to overcome sector-specific barriers, particularly in developing countries. This study examines the key contributions, perceived benefits, and significant obstacles of integrating STEM talent into banking using a mixed-methods approach (in-depth interviews with 30 participants and surveys with 200 respondents). The findings indicate that 85% of banking professionals firmly believe that STEM students foster creativity. Additionally, quantitative research reveals a substantial positive correlation between integration and process innovation ($r = 0.65$, $p < 0.01$). However, there are still barriers including cultural reluctance at banks (55%) and a lack of awareness of STEM competencies (60%). According to the chapter, successful integration requires specific strategies including transdisciplinary project design, structured mentorship, and updated recruitment frameworks in order to effectively use STEM skills for banking's impending challenges.

Chapter 15: *Artificial intelligence as a catalyst for fashion's digital future - Insights from university-company collaboration*; by Xiaozhu Lin & Matteo Oreste Ingaramo. Since the Industrial Revolution, six essential innovation waves have been widely acknowledged as having significantly transformed the world economy and society. Today, we are witnessing the emergence of the sixth wave, characterized by breakthroughs in artificial. In the fashion sector, AI has already emerged as a game-changer. It can enhance trend forecasts and design processes, optimize supply chain management, and boost personalized customer engagement. These innovations collectively lead to significant improvements in efficiency, profitability, and sustainability within the sector. The rapid convergence of fashion and technology has created a pressing need for individuals possessing strong digital skills. Fashion companies must rapidly adapt to this changing environment, while fashion education must simultaneously evolve to provide students with the essential competencies they need. This paper presents a case study of a collaborative workshop between a university and a company, designed to provide students with hands-on experience in advanced AI applications within the fashion sector. This effort enables students to gain a deep understanding of the industry's digital transformation while cultivating a passion for emerging technologies. The authors hope that the experiences presented in this paper will be a valuable resource for researchers and practitioners investigating the convergence of fashion, design, and technology.

Chapter 16: *Use of AI agents and agentic AI to evaluate university curricula*; by Deirdre Pratt & Pregalathan Reddy. AI agents are specific AI tools, while agentic AI shows many aspects of human thinking, and is touted as replacing functions which human educators now perform. This chapter first discusses the differences between AI agents and agentic AI, and then identifies which aspects of the university curriculum they appear best suited to perform, before discussing a model of AI functions enhancing human thinking processes. These AI augmentations constitute

technological evolution, involving ongoing adaptation to emerging technologies, not just in education, but in everyday life, as we now live in cities which are technosystems. However, while methods, media and tools are constantly evolving, there are basic functions which remain constant in the teaching/learning process. The functions performed by AI agents or agentic AI are discussed in terms of how they might facilitate the basic teaching/learning functions in a generic model of course design. Two applications, one based on AI agents, the other, on agentic AI, are then described to show how they operate in evaluating aspects of university curricula. It is emphasized that AI agents and agentic AI should be used to serve the key human social purposes of education, rather than education being reshaped to fit technological innovations.

Chapter 17: *Reframing subject advisors' professional roles as catalysts for sustainable life sciences education*; by Nomzamo Xaba. This chapter examines how partnerships between universities and Life Sciences subject advisors can foster sustainable teacher professional development in rural South African contexts, aligned with Sustainable Development Goal 4. Drawing on Sociocultural Theory, the study explores how subject advisors mediated learning, negotiated authority, and demonstrated resilience during a collaborative professional development initiative with university facilitators. A qualitative multiple case study design was employed, involving two subject advisors from Northern KwaZulu-Natal who participated in a series of university-facilitated workshops. Data was generated through semi-structured interviews, questionnaires, reflective journals, and observations, and analysed thematically through constant comparison and triangulation. Findings reveal that Life Sciences subject advisors' roles evolved from administrative oversight to collaborative mediation, enabling richer teacher engagement and contextualised curriculum support. However, structural constraints such as workload, limited resources, and lack of policy recognition impeded sustained participation. The chapter argues that sustainable teacher professional development requires reframing subject advisors' roles as pedagogical partners and knowledge brokers. It concludes that intentional, interactive partnerships between universities and education departments are vital for achieving the inclusive and equitable quality education envisioned by SDG 4.

Chapter 18: *The use of 3D printing as a didactic tool in technical drawing education with an emphasis on ecodesign*; by Tetjana Tomášková, Jan Krotký, & Jarmila Honzíková. This chapter explores the use of 3D printing as a didactic tool in the teaching of technical drawing, with an emphasis on ecodesign. 3D printing offers an innovative approach to education, enabling students to better understand complex geometric shapes and constructions through interactive and tangible models. At the same time, it provides hands-on experiences that significantly support the development of spatial imagination and technical skills. The chapter also highlights key aspects of ecodesign and sustainability in modern education. The use of ecological materials for 3D printing, such as biodegradable plastics, contributes to environmental protection and encourages sustainable practices. Furthermore, the efficient use of resources inherent to 3D printing can help reduce waste and material

consumption compared to traditional production methods. Practical applications are illustrated through specific project examples in which 3D-printed models have been successfully integrated into technical drawing instruction. Feedback from students and teachers shows that this technology can enrich the learning process and increase interest in technical subjects. The chapter additionally provides an overview of essential software and hardware tools required for 3D printing, along with a discussion of challenges and possible solutions related to its implementation. Overall, the chapter offers a comprehensive view of the potential of 3D printing as a tool for modern and sustainable technical drawing education.

Chapter 19: *Leadership of place to build anthropologies of presence: An alternative educational response to disinformation*; by Victoria Konidari & Manolis Koutouzis. This study contends that the limitations of the current educational responses to disinformation underscore the need for a complementary educational approach. In this context, the chapter stresses the importance of moving from a correctional paradigm to one that frames combating disinformation as a political action, focusing on how young people engage in digital spaces. To support this shift, this study draws on the spatial characteristics of youth political participation and highlights the spatial dimensions of political engagement through Arendt's concept of space of appearance and de Certeau's distinction between strategies and tactics. A thematic analysis of 40 semi-structured interviews with Greek secondary education students aged 13 to 17 years revealed limited student engagement with the digital information space, societal issues, and informed opinions. The analysis also found that students received limited resources to navigate the digital space, and an equal number of students perceived safety in both the school and digital environments. Based on these findings, the chapter uses Riley's conceptualization of place leadership to propose a complementary educational response that could foster anthropologies of presence at school as a prerequisite for place-making in digital spaces.

Chapter 20: *A relational framework for professional development in rural science education: Integrating Ubuntu, indigenous knowledge, & inquiry-based practice*; by Nomzamo Xaba, Mayaba Brian, & Aviwe Sondlo. This chapter examines how collaborative professional development can enhance Life Sciences teachers' practical work competencies in rural South African schools by integrating Indigenous Knowledge Systems, Ubuntu, and inquiry-based practice. The qualitative case study involved 25 Grade 10 and 11 teachers from twelve resource-constrained rural schools who were both convenient and purposively sampled. Data was generated through video and audio recorded observations, fieldnotes, focus group discussions, and written artefacts, which were all analysed thematically using constant comparison and triangulation. Findings reveal that teachers reconceptualised practical work when exposed to culturally grounded, embodied activities, such as ingoma (Zulu song/singing) and ukugida (Zulu dance), which linked communal cultural practices to scientific inquiry. Collaborative mapping of Indigenous Knowledge System-based practicals fostered professional creativity, epistemic engagement, and teacher agency, while Ubuntu principles

underpinned relational learning, emphasising collective reflection, mentorship, and shared responsibility. Structural constraints, including workload, limited resources, and policy rigidity, were identified as barriers to sustained innovation. The chapter argues that sustainable PD in rural contexts requires recognising learners, teachers and subject advisors as pedagogical partners and knowledge brokers, creating relational, culturally responsive spaces that transform both teacher practice and the enactment of practical work in Life Sciences classrooms.

Chapter 21: *“Does it save time and make you smarter?” – Lessons learned from a workshop developing teachers’ prompting competence with ChatGPT*; by Björn Sjöden & Jeroen Lievens. The use of generative AI (GenAI) such as ChatGPT highlights the need for educators to develop novel critical competencies. We present a process-oriented approach for developing teachers’ prompting competence – the ability to formulate effective instructions to GenAI tools – and our first evaluation of its implementation in a workshop for teachers in higher education. We argue for an “anti-shortcut” approach, meaning that effective AI use requires slowing down, reflecting, and collaboratively refining one’s interactions to reach desirable outcomes. 15 teachers participated in the workshop, which focused on a typical professional task (assessing student essays) using stepwise prompts in ChatGPT. The participants were instructed to use ChatGPT or similar GenAI tool to grade a short student essay, using a scoring rubric, and to write some feedback to the student. The GenAI output was then compared to a human professional assessment of the same text. As part of developing the teachers’ skills, we introduced the strategies “prompt chaining” and “few-shot prompting”. The participants were asked to revise and improve their prompts, so that the GenAI assessment matched that of the human as closely as possible. The results fueled a discussion on teachers’ use of GenAI, from which we report some key insights.

Section 2, entitled “Organizational Issues”, gives a glance on tools for implementing organizational learning and change in the education context.

Chapter 22: *Principals’ leadership practices in a digitally evolving world: A human rights perspective*; by Ngozi Blessing Enebe & June Monica Palmer. The rapid pace of digital revolution in education requires school principals to reconsider and adjust their leadership styles. To handle the opportunities and difficulties presented by digital transformation, this study suggests a Human Rights Leadership (HRL) action toolkit. The study emphasized human rights leadership practices necessary for promoting inclusive learning, reducing digital divides, and guaranteeing that technological improvements benefit all learners. The Human Rights-Based Approach (HRBA) was used as the theoretical framework for this paper. We qualitatively analysed stipulations from UNICEF’s Policy Guide on Children and Digital Connectivity (2018) to show the nature and importance of fostering human rights leadership practices in an era of digital transformation. The results demonstrated that in an era of digital change, affordable access, protection from harm and privacy and identity can be useful tools for advancing principals’ human

rights leadership practices which we propose in a human rights leadership action toolkit. By integrating digital innovation with human rights imperatives, the findings advance school principals' responsibilities as agents of educational and societal transformation and digital leadership. To promote human rights leadership in the digital age, this paper recommends that principals strive to be agents of transformation to advance HRL in an era of digital transformation.

Chapter 23: *Knowledge management approach to remote care competence development*; by Sonja Fröjd, Nina Helander, & Jussi Myllärniemi. This paper presents a Knowledge Management approach to developing competencies among nurses working in remote healthcare. The study addresses the challenges and opportunities of hybrid healthcare environments, where professionals operate remotely from patients and colleagues. Through a case study involving interviews with remote care nurses at Finnish Heart Hospital, the research identifies key competencies required for effective remote care, such as technical skills, communication, and adaptability. The study introduces a competence development model grounded in Knowledge Management principles, particularly the SECI-model, to facilitate the transformation and sharing of tacit knowledge. The model emphasizes systematic identification, assessment, and development of competencies, supported by structured orientation and continuous education. The findings highlight the importance of regular competence assessment and knowledge sharing to ensure high-quality and efficient remote care delivery.

Chapter 24: *Participatory design of a health-promoting university – The project mindful campus at Leibniz university Hannover*; by Ariane Steuber & Natalie Banek. This article presents the project “Mindful Campus – Strengthening Mental Health Literacy among Students” (MinCa), which aims to establish a student health management system (SHM) at Leibniz University Hannover (LUH). The overarching objective of MinCa is to develop a participatory concept and strategy for establishing SHM through measures at the curricular and structural level. Participation is understood as the individual or collective involvement of individuals in health-related decisions. This is considered as a central principle of health promotion at universities. The project is being funded by Techniker Krankenkasse, a German health insurance, for the period from January 2025 to December 2026. MinCa examines how the organizational structures of the LUH can contribute to supporting students in their individual learning of Mental Health Literacy (MHL). This question will be investigated in a qualitative accompanying study. The article explains the conceptual approach of the project and the design of the study. In addition, initial findings and conclusions will be presented and opened up for discussion.

Chapter 25: *Development of the university research center and transfer of its results and new knowledge into teaching*; by Tetjana Tomášková & Miloslav Kepka. Education is an important area of the socio-economic life of any country, which serves to accumulate knowledge, experience and skills and to ensure the individual's intellectual development. Professional application of existing forms and teaching

methods and active dissemination of new forms of education within the process of higher education is an important issue. For the successful implementation of new methods in higher education, it is necessary to define the requirements for the student, e.g., communication skills, technological skills and personality traits. No less important are the requirements for the qualifications of university teachers. E.g., technical skills, technological skills, consulting skills, lifelong learning skills, a process approach to solving different situations, and personal characteristics. The research and development in which they participate significantly contributes to the development of university pedagogues, as well as their institutions. The organisational structure of research and development plays an important role and can impact the educational process differently. The contribution deals with this in general and on the example of a specific technical faculty. The case study presents 3 main periods of the existence of one mechanical engineering research center at a technical faculty in an industrial region (from 2010 to the present). An overview of the main research results achieved, including income from contract research, is presented. An organisational change is suggested, which should bring about an improvement in the transfer of new research findings into student education.

Chapter 26: *The role of the local school in the rural community: A perspective of school multifunctionality*; by Liga Paula & Anda Grinfelde. Latvia is facing major demographic changes that threaten the existence of local schools in rural communities. National education policy has led to closing small rural schools; this process, however, affects not only children and teachers but also the whole community: it increases social inequality, makes it difficult to provide qualitative education as close as possible to where children live, and promotes further depopulation of rural areas. Transforming schools into multifunctional community centres can increase the quality of life of local communities. As a result of the case study of Garoza elementary school in Jelgava County (Latvia) conducted in 2025, the authors support the idea of more opened schools experimenting with different forms of learning in collaboration with the community as suitable scenario for small rural schools in Latvia. The research aimed to explore the opportunities for rural school multifunctionality in local communities, taking into account their needs as well as to develop recommendations to promote sustainable development of local schools. The results show that the multifunctionality of rural schools can provide solutions for their sustainable development and strengthening local community through adapting schools to the different needs of local communities and acknowledging significant advantages of the rural environment and small schools.

Chapter 27: *The impact of the extended curriculum programmes: The narratives from current and graduate students*; by Jeanine N. Mwambakana-Mutombo. This study investigates the efficacy of Extended Curriculum Programmes (ECPs) in Science and Commerce at a South African University, aimed at addressing persistent educational inequality. The ECPs provide an alternative access pathway for students who do not meet standard admission requirements, offering four streams: commerce, physical sciences, mathematical sciences, and biological sciences, with the objective

of completing a three-year degree within an extended timeframe (n+1). A cohort analysis of students enrolled between 2017 to 2020 indicates a modest improvement in graduation within the (n+1) period, increasing from 17% to 19.5%. Despite this positive trend, substantial challenges remain. Approximately 32% of students discontinued their studies at the end of the fourth year, while many of those who remained required more than the prescribed timeframe to graduate. To contextualise these outcomes, the study includes a qualitative component comprising interviews with twenty randomly selected students who commenced their studies in the foundational year. These interviews explore the students' lived experiences, identifying factors that facilitated or hindered their academic progress. The qualitative findings enrich the quantitative results by providing insight into both effective practices and persistent barriers within the ECPs structure. Student-generated recommendations offer practical guidance for strengthening programme design and enhancing student success.

Chapter 28: *Tri-theory approach for mitigating the impacts of poly-violence exposure on learners in South African schools*; by Oluwasola Babatunde Sasere & Martha Matashu. The incessant episodes of learners' exposure to poly-violence and their attendant traumatic consequences in South African schools present a complex challenge that significantly impacts learners' well-being and academic outcomes. The lack of trauma-informed approaches in school safety management creates a cycle of disadvantage that can have long-lasting effects on learners and broader societal outcomes. This situation highlights a gap in the existing school safety framework. Hence, this study aims to propose a trauma-informed blueprint that empowers school leaders to mitigate the impact of poly-violence exposure trauma on learners' academic outcomes and general well-being. The study adopted a conceptual analysis research design to synthesise three theories and relevant literature. This study underscores the multifaceted negative impact of poly-violence exposure on learners' emotional, psychological, and academic well-being. The deficiencies in current school safety interventions are also highlighted. The study proposes an integrative trauma-informed school system (ITISS) to mitigate the impact of trauma associated with learners' exposure to poly-violence. Implementing the ITISS is anticipated to enhance learners' emotional and social competence and improve their well-being and learning outcomes. The study calls for a school safety policy reform that institutionalises trauma-responsive professional development and budgets for educational practitioners to be effective.

Chapter 29: *Enhancing social inclusion: The role of cognitive and emotional regulation in adolescents with specific needs*; by Eva Vancu. This study examines the role of cognitive and emotional regulation in promoting social inclusion among adolescents with specific needs. Drawing on theoretical frameworks and current practices, it explores how regulatory processes support adaptive functioning and inclusive participation in school settings. A mixed-methods design combined quantitative data from the short version of the Cognitive Emotion Regulation Questionnaire (CERQ) and the Emotion Regulation Questionnaire (ERQ) with

qualitative data from semi-structured interviews. The sample comprised 158 high school students with identified specific needs. Quantitative results showed a significant age effect on cognitive reappraisal, with older adolescents using this strategy more frequently, while no significant gender differences were observed. Qualitative findings revealed ongoing barriers to inclusion, including limited peer support and insufficient institutional measures. The study highlights the developmental importance of emotional and cognitive regulation and underscores the need for targeted interventions. Enhancing regulatory skills and integrating social-emotional learning into inclusive educational practices may strengthen adolescents' resilience and foster supportive, socially inclusive school environments.

Chapter 30: *Ethical leadership woven with integrity: Emerging pathways for school principals*; by Edwin Darrell De Klerk & Sipiwe Mudadigwa. Recent research in the academic literature expressed the urgency for emerging pathways to assist school principals to understand ethical leadership (EL) toward leading with integrity. Notably, leading with integrity is a continuing learning process, yet the rewards are inevitable. The aim of this chapter, therefore, was to showcase how EL is woven with integrity, proposing moral pathways that can be used by school principals to act ethically in the line of their duties. Through the lens of integrity theory, this conceptual chapter presents an analysis of selected texts in the South African Standard for Principalship (SASP) which outlines significant pathways for school principals in supporting educational ethics. Data mining techniques were used to search for and select texts that could provide insights into school principals' application of EL toward acting with integrity. The findings suggest that relational transparency, inclusive moral vision and moral reasoning can be dynamic moral pathways to fuel school principals with innovative pathways on how to apply EL woven with integrity. These proposed pathways should be regarded as a source of light for the enactment of integrity in the hope that principals will be able to safely navigate issues of ethical concern in schools.

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Section 1

Projects and Trends

Chapter # 1

GENERATIVE AI IN HIGHER EDUCATION: IMPACTS ON TEACHING AND LEARNING

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ABSTRACT

The rapid advancement of artificial intelligence (AI) technologies, particularly generative AI and Natural Language Processing (NLP) tools is transforming higher education. This study investigates the integration of AI in tertiary educational settings, focusing on its impact on teaching practices and learning outcomes. Our corpus analysis highlights the prominence of AI in education, with frequent references to AI applications such as ChatGPT and large language models. These technologies offer innovative solutions for personalized learning, intelligent tutoring systems, and enhanced pedagogical methods. The analysis reveals a significant focus on practical implementations of AI, emphasizing the transformation of traditional teaching methodologies. The study also addresses critical issues such as the technological infrastructure required for AI integration and the ethical considerations of AI use in education. The findings suggest that while AI holds promise for revolutionizing education, there is a need for a balanced approach that includes developing critical thinking skills and addressing ethical implications. This research contributes to the growing body of literature on AI in education by providing a detailed exploration of current trends, challenges, and future directions in the field.

Keywords: generative AI, natural language processing (NLP), higher education, innovative pedagogy.

1. INTRODUCTION

The relationship between human intelligence and artificial intelligence (AI) has become a central topic over time and in various fields of knowledge, including philosophy, cognitive science, and technology. While both aim to address complex problems and adapt to new situations, they differ significantly in their origins, mechanisms, and capabilities. Human intelligence evolves through biological processes, social interaction, and lived experience, and encompasses consciousness, emotions, creativity, and tacit knowledge. In contrast, AI is a system designed by humans to replicate or surpass specific cognitive tasks. It exhibits advanced skills in managing data and discerning patterns but lacks self-awareness, emotional depth, and holistic reasoning. (Korteling et al. 2021).

Artificial Intelligence (AI) has emerged as an overarching change force in all levels of learning, transforming pedagogical practice from pre-school classes to vocational training centers and college classrooms. While early implementation of AI was predominantly restricted to the tertiary education sphere, generative applications like ChatGPT (OpenAI, 2023) currently permeate different learning spaces, including schools and colleges in K-12 (Kindergarten to 12th grade), corporate training modules, and non-formal lifelong learning settings. Bahroun et al. (2023), situate this democratization of technology in the context of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), analyzing 207 studies to identify such major gaps in fields such as medical and engineering education,

where intelligent tutoring systems and adaptive learning driven by generative AI (GAI) are transforming pedagogical standards.

The AI is transforming the educational field in terms of improving pedagogical practices, raising students' engagement, and reducing administrative workload (Villamil, et al. 2024). Generative AI, such as Natural Language Processing (NLP) tools like ChatGPT, has been demonstrated to be largely promising in facilitating personalized learning experiences, intelligent tutoring systems, and tailored evaluation (Quezada and Urbina, 2025) and (Gavira-Duron, 2023). These technologies underpin learning theories like constructivism, connectivism, and adaptive learning, promoting student-centered, adaptive, and data-driven learning (Pineda et al. 2024). However, the use of AI in education also has ethical effects on equity, digital literacy, and institutional readiness (Gómez, Fuentes and Castro, 2024). This model discusses how generative AI reconfigures teaching methods and learning processes and resolves these significant concerns.

Building on these foundations, Katonane (2024) extends this ground by illustrating how AI adaptive learning systems improve learning outcomes and at the same time raise ethical issues regarding their scalability, particularly in resource-scarce environments, the voracious expansion of large language models (LLMs) has hastened such shifts. Teachers at all levels have grappled with its meaning since ChatGPT came into public view in November 2022. Saariluoma and Karvonen (2024) investigate the languages of AI construction at the back of which rests underlying theory restrictions in educational technology construction. Formal, computational, and natural language are distinguished as formal languages (mathematics and logic) not having semantics relevant to the world, computational languages having domain-limited references, and natural language with dynamic creative expression. These distinctions clarify the perennial debate between strong AI (human-like cognition) and weak AI (task-specific solutions), revealing how design choices in theory languages shape AI's pedagogical potential and limitations.

From high school teachers redesigning writing assignments to medical schools incorporating AI diagnostics simulations (Lund and Wang 2023). López-Chila et al. (2024) quantify this trend through bibliometric analysis of 870 articles, which indicate the prevalence of computer science and education journals for AI research. Their focus on higher education nevertheless points to a significant omission: only 12% of the publications reviewed focused on primary or vocational contexts despite growing evidence of AI adoption in these sectors. Papadogiannis, Wallace and Karountzou (2024) justify these facts on the basis of educational data mining (EDM), demonstrating that algorithms such as classification, natural language processing (NLP), and regression analysis enable customized learning experience on a global level but with concern about algorithmic bias in the case of non-rigorous ethical frameworks.

Democratization of AI technologies carries special meanings in developing countries where technological leapfrogging crosses over with limited resources. These programs are compatible with Bahroun et al. (2023) calls for multidisciplinary directions in considering explainable GAI models capable of mitigating cultural bias. The issue should be addressed in educator preparation Adekunle et al. (2024) point to the importance of AI literacy for pre-service teachers, who will turn out to be constructors of learning institutions.

This study challenges such multifaceted changes in terms of through cross-contextual analysis. By synthesizing evidence from peer-reviewed studies, industry case studies, and policy documents, we aim to map concrete AI deployments across education levels (K-12, vocational, higher), analyze competing pedagogical and ethical concerns by institutional context, and propose equity-focused frameworks for responsible AI deployment.

2. BACKGROUND

Constructivist theories, explained by Jean Piaget (1969) and Lev Vygotsky (1926), focus on the construction of knowledge through active learning and social interaction. Recent studies show that AI technologies support these theories by personalizing learning experiences. For example, AI adaptive learning systems in early childhood improve understanding and recall by modifying content to fit individual needs (Veces et al. 2024). Interactive content, like AI-backed simulations, allows students to discover and actively participate in constructing knowledge (Quezada and Urbina, 2025). In addition, AI-generated content supports independent learning, where students connect information based on their own comprehension (Peralta, Patraca and Martínez, 2024).

Contemporary analysis underscores the relevance of exploring the integration between the constructivist paradigm and developments in artificial intelligence, highlighting the potential of this combination to generate new theoretical and methodological perspectives and enhance the results of the cognitive process. Some examples will be presented below.

Mota-Valtierra, Rodríguez-Reséndiz, and Herrera-Ruiz (2019) applied constructivism methodologies in a course where the students have to develop their practical knowledge about artificial intelligence techniques and theoretical mathematics. The model was used in biomedical engineering and mechatronic engineering primarily and the final evaluations corroborate the increase in the knowledge of the students.

In a similar field of knowledge, Minalla and Fawad (2025) examine the integration and impact of AI tools, specifically ChatGPT and MATLAB Simulink, within undergraduate chemical engineering courses, the investigation concludes that the incorporation of AI contributes to personalized learning, improved academic performance, and increase student engagement, also, help students to independently explore and understand abstract concepts through simulations.

In the area of cybersecurity, Salman (2024) highlights that the incorporation of artificial intelligence stimulates in students the capacity to address real-world challenges, while simultaneously promoting greater engagement, improved technical performance, and stronger preparation for roles shaped by AI-driven practices.

Richter, Giroux, Piven, Sima, and Dodd (2025) present a case study on an undergraduate digital marketing course that integrates ChatGPT with other generative AI tools for text-to-image and text-to-video generation while simultaneously incorporating traditional digital marketing platforms such as HubSpot and SEMrush. As part of the study, representatives from the business sector were consulted regarding the usefulness of artificial intelligence in the development of student practices. Their feedback pointed out a positive impact, noting that AI facilitated the connection between students and relevant practical cases.

The application of artificial intelligence has also demonstrated notable advancements at the K–12 level, as evidenced in the research conducted by Kunnath and Botes (2025). The authors investigated the potential of using AI educational applications to promote Inquiry Based Learning (IBL) and critical thinking in the science classroom. Grounded in social constructivist theory, the paper highlights that AI tools can be useful in automated data collection, enabling virtual labs, and assisting in the evaluation of scientific data. Also, AI-powered educational platforms like Magic School, Edpuzzle, Labster, and LabXchange allow learners to conduct virtual experiments without the need for physical equipment. The combination of these platforms offers promising solutions by automatically creating interactive lessons that encourage scientific inquiry, critical thinking, and the practical

application of concepts. The investigation focuses on 7th and 9th level in South Africa classrooms.

Yim and Su (2025) analyzed 46 studies in academic conferences and journals to investigate the pedagogical strategies and learning tools in AI literacy education in K-12 contexts. In their study, they classify the most appropriate methodologies for AI literacy according to each educational level. Their findings indicate that for levels like kindergarten, the use of tools like Pop-Bots is important in combination with project-based approaches, human-computer interactions and play-based learning strategies to teach young students AI concepts. The project-based learning approach is also the most dominant in secondary schools, followed by collaborative learning. This review reveals that constructivism and computational thinking serve as key frameworks for addressing AI literacy education.

The impact of artificial intelligence is also significant when examined through the lens of other educational theories, like Vygotsky's sociocultural theory (1926) which is also supported by AI, which aids in learning. AI systems allow for the easier delivery of personalized content and improving student-teacher interaction to fill gaps in understanding (Arango et al., 2024). AI offers guided models within the Zone of Proximal Development (ZPD) and improves how students interact with technology, improving collaborative learning (Benavides et al. 2024). Digital constructivism emphasizes the capability of teachers and students to be technologically competent. Such competency is essential for AI to effectively facilitate autonomous learning (Villamil et al. 2024).

AI fits well with Adaptive Learning Theory and Gardner's Multiple Intelligences, showing that it can cater to different learning styles. By modifying lessons based on students' performance, AI renders the learning process individualized (Prince Torres, 2022), these systems recognize strengths and weaknesses in different intelligences, like language, spatial capacity, and math personalizing activities to stimulate students. For example, adaptive platforms convert difficulties to fit all learners, enhancing inclusivity and academic success (Veces et al., 2024). This not only boosts motivation but also guarantees equal access to education for all people, catering to different learning styles and needs.

Siemens (2005) connectivism argues that knowledge develops through networked interactions, which is a model fostered by AI. AI is supported by technologies such as dynamic content generators and collaborative platforms that enable peer-to-peer co-construction of knowledge, unlike static curricula, AI continuously analyzes students' progress, enabling real-time content adjustment and personalized feedback (Flores and Nuñez, 2024). Learning analytics allows educators to detect gaps using data, whereas computerized exams enhance self-regulation and computer literacy readiness (Gómez, Fuentes and Castro, 2024).

AI enhances teaching by stimulating students to inquire and discover. Interactive simulations and virtual tutors enable students to learn through real-world issues (Villamil et al., 2024). In flipped classrooms, AI personalizes the content that students learn prior to class, enabling them to devote more class time to critical thinking and collaboration (Montenegro-Rueda and Fernández-Cerero, 2022). Educators move from simply presenting information to facilitating student learning, utilizing AI to assist and promote in-depth comprehension (Villamil et al., 2024).

AI applications bring up essential ethical issues. We need to reduce algorithms' bias and data privacy (Gómez, Fuentes and Castro, 2024). Students need to study AI so that they can critically evaluate AI-generated materials (Peralta, Patraca and Martínez 2024). We need to focus on equity and inclusiveness so that no one is excluded. Training teachers on the ethics of AI will facilitate the responsible usage of AI (Gómez, Fuentes and Castro, 2024). These steps are crucial towards fostering positive behavior online in AI-based education.

3. METHODS

This study employs a mixed-methods design to analyze generative AI's role in education, combining natural language processing (NLP) of academic literature with qualitative case studies. This approach ensures methodological triangulation, balancing broad thematic trends with granular insights into real-world applications. A purposive sample of 52 peer-reviewed articles (2024) was extracted from Emerald Publishing Limited, focusing on AI in education. This sample aligns with NLP research conventions, where corpora of 50–60 articles suffice to identify disciplinary discourse patterns (Xu and Ouyang 2022); (Mousavinasab et al. 2018). Articles were filtered using keywords (generative AI, pedagogical innovation, educational transformation), supplemented by industry case studies and policy documents to contextualize findings.

The text preprocessing begins with the cleaning and tokenization of the data, non-alphabetic characters and words that do not provide results were eliminated (for example, “the”, “and”) and the texts were reduced to lowercase. Tokenization was then carried out with which texts were segmented into word-level units following white space boundaries (Webster and Kit, 1992), structuring data for computational analysis. After cleaning the data, lemmatization was performed, using NLTK's WordNetLemmatizer (Bird, Klein and Loper 2009), the inflected words (e.g., “learn” → “learn”) were assigned to their canonical form (Plisson, Lavrac and Mladenović 2004). This ensured terminological coherence, which is essential for analyzing conceptual constructions in academic texts (Korenius et al., 2004); (Sproat et al. 2001).

To then carry out the quantitative analysis in two parts:

1. *N-Gram Models*: Markov chain-based n-gram analysis identified recurring phrases (e.g., “adaptive learning systems,” “ethical implications”), revealing dominant pedagogical and technological trends.
2. *Topic Modeling*: Latent Dirichlet Allocation (LDA) algorithms clustered the 316,687-word corpus into themes (e.g., AI ethics, personalized learning), highlighting scholarly priorities.

4. RESULTS ANALYSIS

The n-gram analysis revealed key clusters shaping the current discourse on AI in education, aligning with the study's focus on pedagogical transformation and institutional adoption. Below, we synthesize the findings at the n-gram levels, emphasizing their theoretical and practical implications. The number of occurrences of each word or words in the n-grams is shown in Table 1.

Table 1.
N-gram results.

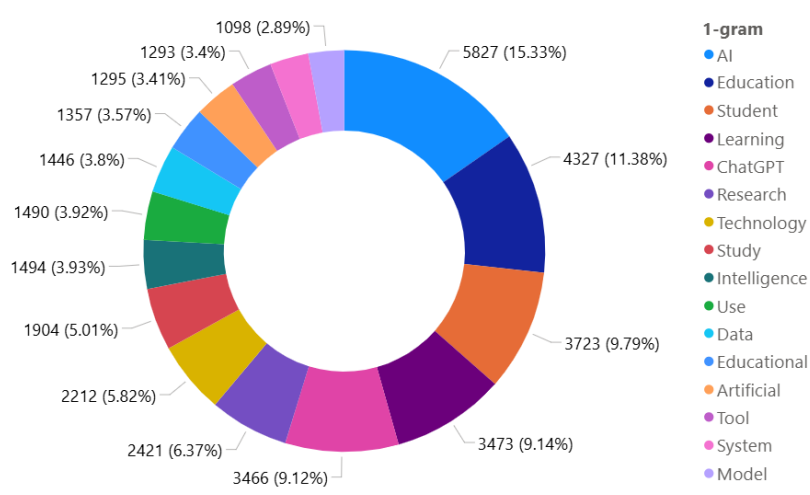
Place	1-gram word analysis	2-gram word analysis	3-gram word analysis
1	AI (5827)	Artificial intelligence (1193)	Artificial intelligence AI (165)
2	Education (4327)	Higher education (824)	Artificial intelligence education (146)
3	Student (3723)	Generative AI (444)	AI higher education (106)
4	Learning (3473)	AI tool (340)	Natural language processing (88)
5	ChatGPT (3466)	AI education (319)	Large language model (84)

Place	1-gram word analysis	2-gram word analysis	3-gram word analysis
6	Research (2421)	AI technology (270)	Generative artificial intelligence (84)
7	Technology (2212)	Use ChatGPT (257)	Higher education institution (63)
8	Study (1904)	Use AI (247)	Generative AI tool (61)
9	Intelligence (1494)	Teaching learning (226)	Education information technology (60)
10	Use (1490)	Machine learning (215)	Research innovative teaching (55)
11	Data (1446)	Learning experience (208)	ChatGPT Management education (53)
12	Educational (1357)	Management education (203)	Systematic literature review (51)
13	Artificial (1295)	Critical thinking (199)	Intelligent tutoring system (51)
14	Tool ((1293)	Language model (189)	Innovative teaching learning (48)
15	System (1184)	AI literacy (187)	System science education (47)
16	Model (1098)	Using ChatGPT (184)	Perceived ease use (45)

Note: Own elaboration.

In the 1-gram analysis, the corpus prioritized AI (5,827 occurrences) and education (4,327), reflecting the field's central focus on technological integration. The high frequencies of student (3,723) and learning (3,473) underscored a student-centered orientation, consistent with the constructivist principles highlighted in the literature review (Veces et al. 2024). In particular, ChatGPT (3466) emerged as the most cited tool, pointing to its disruptive impact on pedagogical practices. The prominence of research (2,421) and technology (2,212) reinforced the dual emphasis on empirical research and applied innovation, reflecting the mixed methods design of this study. Figure 1 shows the analysis of the 16 most common 1-gram words.

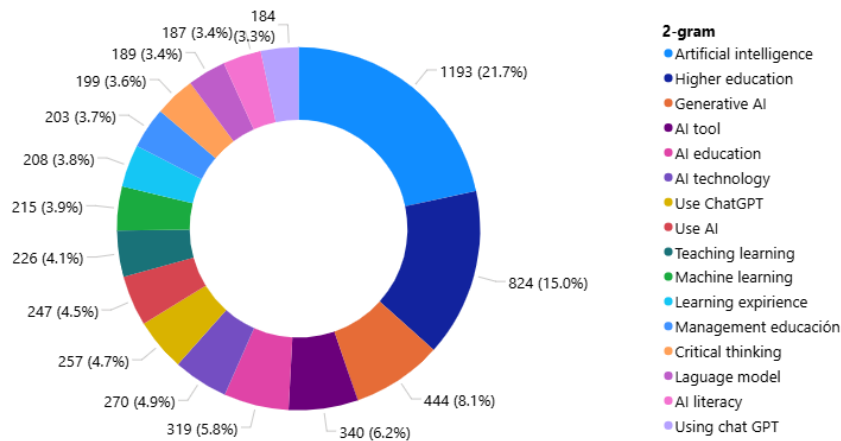
Figure 1.
Analysis of the 16 most common 1-gram words.



Note: Own elaboration.

The analysis of 2-grams emphasizes AI's central role in the corpus. Its high frequency (1193 occurrences) indicates that it is a fundamental concept around which much of the research revolves, aligning with the growing integration of AI technologies in educational settings and the increasing academic interest in this intersection. Showing the contextualization of AI applications, higher education predominated (824), suggesting an emphasis on university student research compared to K-12 or vocational contexts, a gap observed in the literature review (López-Chila et al., 2024). On the other hand, there is a rise in generative AI (444) and AI tools (340) highlighted the rapid adoption of technologies such as ChatGPT, aligning with studies on personalized learning (Quezada Vera and Urbina Velasco, 2025). Figure 2 shows the analysis of the 16 most common 2-gram words.

Figure 2.
Analysis of the 16 most common 2-gram words.



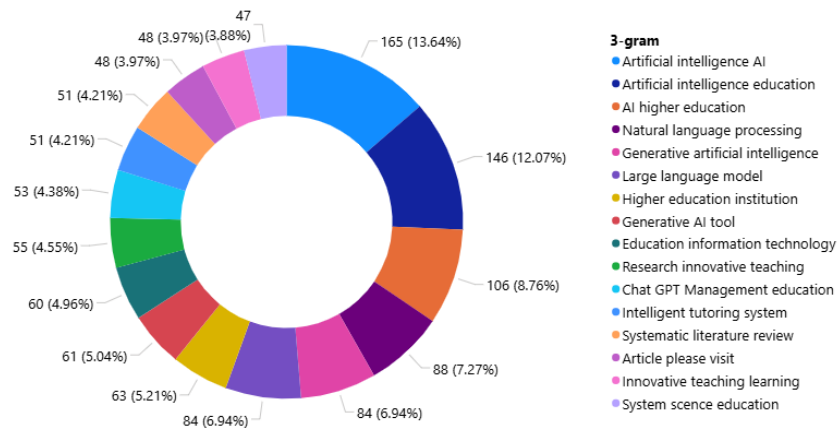
Note: Own elaboration.

Regarding practical implementation, phrases such as use ChatGPT (257) and AI technology (270) dominated the theoretical terms, emphasizing a pragmatic shift towards tool implementation. Regarding dual pedagogical objectives, AI education (319) and teaching-learning (226) revealed parallel interests in both teaching about AI and improving pedagogy with AI, echoing the literature's emphasis on AI literacy (Gómez, Fuentes and Castro, 2024).

Kathala and Palakurthi (2024) state that AI literacy has become a vital skill, comparable to reading, writing, and arithmetic in education and workforce development, and it is a core competency for employability and career progression. The authors define AI literacy as a combination of technical expertise, ethical reflection, and practical competencies. Its main elements generally include: familiarity with fundamental AI concepts and methods; the capacity to critically assess AI systems and their broader implications; ethical sensitivity and the ability to reason about AI's societal consequences; and learning through practical, real-world projects to effectively use and engage with AI tools. Unfortunately, while awareness of AI's relevance is increasing, many countries still lack the infrastructure and resources to implement widespread AI education. Other persistent challenges that AI literacy faces are: limited technological infrastructure, a shortage of qualified educators, curriculum gaps, language and cultural barriers, and insufficient policy support.

The 3-gram analysis shows us the emerging frontiers, AI higher education (106) and higher education institutions (63) reaffirmed the tertiary bias of the field, while educational information technology (60) highlighted critical infrastructural concerns for scaling AI (Papadogiannis, Wallace and Karountzou, 2024) Regarding technical and pedagogical innovation, natural language processing (88) and generative artificial intelligence (84) highlighted cutting-edge methodologies, while research in innovative teaching (55) linked AI with pedagogical experimentation, in resonance with connectivist frameworks (Siemens, 2005). Figure 3 shows the analysis of the 16 most common 3-gram words.

Figure 3.
Analysis of the 16 most common 3-gram words.



Note: Own elaboration.

The concept of Critical thinking which appears in the 2-gram with a frequency of 199 repetitions, highlights the interest in the role that artificial intelligence can play in the development of the cognitive skills required in the 21st century, commonly known as the 4Cs, which consist of: critical thinking, creativity, communication, and collaboration. In the context of the development of these cognitive skills, the impact of AI on educational environments has emerged as a central topic of study, generating significant debate due to the notable divergences regarding its possible positive and negative effects. When it comes to the development of critical thinking, we find opposing positions. For example, while some studies, such as Cantero et al. (2020), argue that AI has not yet reached full maturity and that there is insufficient empirical evidence linking its use to the development of this skill, other works, such as Parreño Sánchez et al. (2024), suggest a more optimistic outlook. Parreño's and colleagues findings suggest that incorporating AI as a teaching tool can enrich teaching strategies and methodologies aimed at fostering critical thinking. This process is enhanced by improved access to information, automated repetitive tasks, developed analytical skills, stimulated debate and discussion, and promoted problem-solving skills. The interaction between human experience and AI use already plays an important role in current lines of research. Understanding how this interaction could enhance key competencies in modern education is essential to progressing toward education that aligns with the sustainable development goals defined in the 2030 Agenda.

The results: management education (203) and intelligent tutoring system (51) reflect the growing trend of using AI as a facilitator in the autonomous learning process, as well as self-management and self-assessment of the cognitive process. Recent research, such as that by Clegg and Sarkar (2024), highlights that artificial intelligence can play a crucial role in supporting students' understanding of complex topics, acting as a personalized tutor that adapts to each student's pace, language, and learning style. Intelligent tutoring has significant advantages, such as personalized learning that adapts to each user's pace and difficulty level, as well as the ability to provide immediate feedback. However, there are also significant challenges, such as the cost of accessing these types of tools, the technical and human resources required for their development, the empathy with the student in the feedback process, and the creation of a possible dependency in the user.

The terms innovative teaching learning (48) and research innovative teaching (55) are linked to the interest in leveraging the advantages that artificial intelligence offers to transform and optimize learning experiences. This trend seeks not only to improve educational effectiveness but also to innovate in pedagogical methodologies, integrating advanced technologies that promote a better and more efficient learning process. In this regard, recent research, such as Clegg and Sarkar (2024), highlights that the automation of routine tasks allows for the optimization of time and effort, which, in turn, accelerates and enriches the cognitive process, favoring research and innovation.

The expression AI literacy (87) refers to the degree of knowledge, skill, or competence that a user may have in relation to the use of artificial intelligence. This term, with complex connotations, can vary depending on the context, as it should also focus on a person's ability to understand, use, and critically reflect on the results obtained through interaction with AI. Likewise, concerns arise in the field of research regarding cognitive biases associated with factors such as gender, area of knowledge, educational level, and profession. In this regard, Duan et al. (2025) shows notable differences in terms of skill and acceptance levels between disciplines, between men and women, and between undergraduate and graduate levels. Their results indicate greater adoption and adaptation of AI in STEAM areas, greater optimism toward its use by men compared to women, as well as a perception of greater knowledge of AI among men compared to women, and a positive correlation between the use of AI and the level of education attained.

Finally, the terms using Chat GPT (184), Chat GPT management education (53), and perceived ease of use (45) reinforce the enormous popularity that this language tool currently enjoys. Among the features that have driven this phenomenon of acceptance are: free access to basic functionalities, the possibility of interacting with the platform without prior knowledge, its intuitive use, and the tool's ability to personalize interactions and learn from each one. These features have positioned ChatGPT as a highly valued tool, not only for students but also for professionals in various fields, establishing it as a benchmark in the integration of AI in educational and work environments.

A key finding of this study is that current research tends to overlook the ethical challenges associated with the use of artificial intelligence in education. Instead, it places greater emphasis on potential applications, paying less attention to possible risks. This imbalance reveals a significant gap that could lead to considerable social and economic consequences.

In this regard, studies like Gallent-Torres, Zapata-González, and Ortego-Hernando (2023) identify risks such as plagiarism, the production of unoriginal content, excessive dependence on these technologies—which can weaken critical thinking and hinder the detection of misinformation—and the presence of bias in the results. For their part, Cárdenas, Penna, and Rascón (2024) emphasize ethical and moral challenges related to transparency

and accountability, the responsibility of software development companies, regulation and governance, cybersecurity, and technological unemployment as critical dimensions.

In a more specific context, Kunnath, and Botes (2025) show how infrastructure limitations in South African schools, especially in rural areas, can deepen the digital gap and increase educational inequalities. They also highlight the importance of contextualizing AI-generated content, given that the examples offered by these technologies may not reflect students' cultural experiences, affecting their engagement and reducing the value of practical cases.

In this scenario it is essential to recognize that the use of generative AI in education poses significant challenges to academic integrity and social equity. Therefore, it is necessary to delve deeper into the debate on the academic use of AI to ensure responsible practices in its application. Consequently, a deeper debate on the academic application of AI is required to ensure responsible practices. In addition, there is an urgent need to establish regulatory frameworks that safeguard data protection, security, algorithmic fairness, and accountability in automated decision-making.

The analysis confirms the transformative role of AI in higher education, particularly through generative tools like ChatGPT, but reveals three critical points:

1. Equity gaps: The tertiary focus of the corpus contrasts with the emphasis on the democratizing potential of AI, suggesting underexplored opportunities in K-12 and vocational training.
2. Theory-practice balance: The predominance of applied terms (use ChatGPT) over pedagogical theories (e.g. constructivism) suggests a risk of tool-centric discourse, requiring a stronger theoretical foundation.
3. Lack of an ethical component: In the development of n-grams, it is observed that the ethical component in AI research in education does not appear among the 20 most frequent n-grams. This indicates the need for deeper ethical scrutiny, as noted by Gómez, Fuentes, and Castro (2024).

These findings validate the literature's emphasis on adaptive learning and student-centered design, but challenge assumptions about the equitable reach of AI across educational levels.

5. FUTURE RESEARCH DIRECTIONS

The results obtained in this research reveal that current lines of study focus mainly on the adoption and use of artificial intelligence (AI) in higher education. At these academic levels, the application of artificial intelligence is closely related to complex cognitive objectives ranging from self-management and self-assessment of knowledge to the development of key cognitive skills such as critical thinking and innovation.

In the near future, it will be a priority to expand research on the possible pedagogical uses and potential effects in the field of K-12 education, as these may differ significantly from the results obtained here. While AI offers transformative opportunities at all educational levels, the degree of development and maturity, as well as differences in student competence levels, require rigorous research to guide the use of AI in a consistent manner with educational objectives and the comprehensive development of students at each of their respective cognitive stages.

The methodology used in this study could also be a valuable exercise for analyzing the evolution of research lines related to AI and education by observing their evolution over time, allowing for the identification of emerging trends by period, region, or country.

This approach would not only facilitate the detection of patterns of change but also offer a more complete view of the global research landscape in this area.

6. CONCLUSION

Generative AI is redefining educational paradigms by putting constructivist, adaptive and connectivist theories into practice, enabling personalized learning experiences and institutional innovation, particularly in higher education, as demonstrated by the predominance in the corpus of terms such as higher education. The analysis shows a significant relationship between constructivist learning theory and the potential of artificial intelligence to enhance autonomous learning. This is evident in the creation of interactive lessons, the study of practical cases, and the possibility of conducting simulations in laboratory environments, which contributes to the understanding of abstract concepts.

However, the findings also underscore three critical issues that require attention. First, there is a bias in the study of AI applied in university contexts as opposed to K-12 levels, which points to untapped potential in basic education or technical and vocational training, where AI could significantly contribute to reducing inequalities and expanding access to knowledge.

Secondly, there is insufficient treatment of ethical issues. We can observe that this aspect does not appear significantly in the corpus of texts analyzed which shows limited attention to issues such as transparency in information management, algorithmic fairness, academic integrity, excessive dependence on new technologies and resilience to their adoption, as well as low literacy in AI management. Added to this are inequality in access to technological advances, the potential educational gaps that may arise, technological unemployment, and other ethical and social challenges. For this reason, as Gómez, Fuentes, and Castro (2024) point out, it is essential to deepen ethical scrutiny in order to anticipate risks and establish regulatory frameworks to accompany technological development.

Finally, an imbalance between theory and practice is identified, given that applied terms—such as the use of ChatGPT—predominate over references to pedagogical theories, for example, constructivism. This emphasis on the tool over theoretical foundations can lead to a discourse focused on technology rather than learning processes, underscoring the need to strengthen the conceptual frameworks that guide its implementation.

Taken together, these three points reveal that, while AI represents a significant advance for higher education, its full impact will depend on the ability of research and educational practice to address inequalities, deepen ethical reflection, and balance the use of tools with a solid theoretical foundation. Only then will it be possible to harness its transformative potential without compromising the fundamental values of education.

REFERENCES

- Adekunle, A. M., Adelana O. P., Molefi R. R., Olalekan A., and Ishola A. M. (2024). Examining artificial intelligence literacy among pre-service teachers for future classrooms. *Computers and Education Open*, 6, 100179. <https://doi.org/10.1016/j.caeo.2024.100179>
- Arango, P. R., Sagrado A. L., González E. O., & de Bedout, L. F. (2024). Implicaciones filosóficas, éticas y pedagógicas del uso de la Inteligencia Artificial en educación. *Digital Education Review*, 45, 29-36. <https://doi.org/10.1344/der.2024.45.29-36>

- Bahroun, Z, Anane C., Ahmed V, & Zacca A. (2023). Transforming Education: A Comprehensive Review of Generative Artificial Intelligence in Educational Settings through Bibliometric and Content Analysis. *Sustainability*, 15(17). <https://doi.org/10.3390/su151712983>
- Benavides, L M. A., Cazales V. J. R., Lovera M. D. L. Á. G., & Mendiola, M. S. (2024). Formación para el uso de la inteligencia artificial generativa en el profesorado de la UNAM: primeros pasos. *DIDAC*, 84, 7-20. https://doi.org/10.48102/didac.2024.84_JUL-DIC.208
- Bird, S., Klein E., & Loper E. (2009). *Natural language processing with Python: analyzing text with the natural language toolkit*. O'Reilly Media, Inc.
- Cantero, C. L., Oviedo, G. B., Balboza, W. F., & Fera, M. V. (2020). Tecnologías emergentes en el proceso de enseñanza-aprendizaje: hacia el desarrollo del pensamiento crítico. *Revista electrónica interuniversitaria de formación del profesorado*, 23(3). <https://doi.org/10.6018/reifop.435611>
- Cárdenas, R. G., Penna, A. F., & Rascón, A. C. (2024). El Uso Ético y moral de La inteligencia artificial En educación e investigación. *Ciencia Latina Revista Científica Multidisciplinar*, 8(5), 3243-3261. https://doi.org/10.37811/cl_rcm.v8i5.13801
- Clegg, S., & Sarkar, S. (2024). Artificial intelligence and management education: A conceptualization of human-machine interaction. *The International Journal of Management Education*, 22(3), 101007. <https://doi.org/10.1016/j.ijme.2024.101007>
- Duan, S., Liu, C., Rong, T., Zhao, Y., & Liu, B. (2025). Integrating AI in medical education: A comprehensive study of medical students' attitudes, concerns, and behavioral intentions. *BMC Medical Education*, 25(1), 599. <https://doi.org/10.1186/s12909-025-07177-9>
- Flores J. D., & Olivera N. R. N. (2024). Aplicación de Inteligencia Artificial en la Educación de América Latina: Tendencias, Beneficios y Desafíos. *Revista Veritas De Difusão Científica*, 5(1), 01-22. <https://doi.org/10.61616/rvdc.v5i1.52>
- Gallent-Torres, C., Zapata-González, A., & Ortego-Hernando, J. L. (2023). El impacto de la inteligencia artificial generativa en educación superior: una mirada desde la ética y la integridad académica. *RELIEVE: Revista Electrónica de Investigación y Evaluación Educativa*, 29(2), 1-21. <https://doi.org/10.30827/relieve.v29i2.29134>
- Gavira-Duron. N. (2023). Cómo potenciar las habilidades matemáticas con ChatGPT. *Revista Mexicana de Bachillerato a Distancia*, 15(30). <https://doi.org/10.22201/cuaieed.20074751e.2023.30.86525>
- Gómez, C. R., Fuentes A. F., and Rascón A. C. (2024). El Uso Ético y Moral de la Inteligencia Artificial en Educación e Investigación. *Ciencia Latina: Revista Multidisciplinar*, 8(5), 3243-3261. https://doi.org/10.37811/cl_rcm.v8i5.13801
- Kathala, K. C. R., & Palakurthi, S. (2024, September). AI Literacy Framework and Strategies for Implementation in Developing Nations. *Proceedings of the 2024 the 16th International Conference on Education Technology and Computers* (pp. 418-422). <https://doi.org/10.1145/3702163.3702449>
- Katonane, G. I. (2024). The Role of AI-based Adaptive Learning Systems in Digital Education. *Journal of Applied Technical and Educational Sciences*, 14(2), 1-12. <https://doi.org/10.24368/jates380>
- Korenius, T., Laurikkala, J., Järvelin, K., & Juhola, M. (2004). Stemming and lemmatization in the clustering of finnish text documents. *ACM international conference on Information and knowledge management. Asociation for Computing Machinery* (pp. 625-633). <https://doi.org/10.1145/1031171.1031285>
- Korteling, J. E., van de Boer-Visschedijk, G. C., Blankendaal, R. A., Boonekamp, R. C., & Eikelboom, A. R. (2021). Human-versus artificial intelligence. *Frontiers in artificial intelligence*, 4, 622364. doi:10.3389/frai.2021.622364
- Kunnath, A. J., & Botes, W. (2025). Transforming science education with artificial intelligence: Enhancing inquiry-based learning and critical thinking in South African science classrooms. *Eurasia Journal of Mathematics, Science and Technology Education*, 21(6), em2655. <https://doi.org/10.29333/ejmste/16532>

- López-Chila, R., Llerena-Izquierdo J., Sumba-Nacipucha N., & Cueva-Estrada J. (2024). Artificial Intelligence in Higher Education: An Analysis of Existing Bibliometrics. *Education Sciences*, 14(1). <https://doi.org/10.3390/educsci14010047>
- Lund, B. D., & Wang, T. (2023). Chatting about ChatGPT: how may AI and GPT impact academia and libraries? *Library Hi Tech News*, 40(3), 26-29. <https://doi.org/10.1108/LHTN-01-2023-0009>
- Minalla, A., & Fawad, H. (2025). Artificial Intelligence Integration for Shaping Future Engineering Education at Higher Colleges of Technology, UAE. *Asean Journal of Engineering Education*, 9(1), 64-72. <https://doi.org/10.11113/ajee2025.9n1.193>
- Montenegro-Rueda, M., & Fernández-Cerero J. (2022). Realidad aumentada en la educación superior: posibilidades y desafíos. *Tecnología, Ciencia y Educación*, 23, 95-114. <https://doi.org/10.51302/tce.2022.858>
- Mota-Valtierra, G., Rodríguez-Reséndiz, J., & Herrera-Ruiz, G. (2019). Constructivism-based methodology for teaching artificial intelligence topics focused on sustainable development. *Sustainability*, 11(17), 4642. <https://doi.org/10.3390/su11174642>
- Mousavinasab, E, Zarifsanaiey, N., K. Niakan S., Rakhshan, M., Keikha, L., & Ghazi, S, M. (2018). Intelligent tutoring systems: a systematic review of characteristics, applications, and evaluation methods. *Interactive Learning Environments*, 29(1) <https://doi.org/10.1080/10494820.2018.1558257>
- OpenAI. (2023). *GPT-4 Technical Report*. Retrieved from: openai.com/research/gpt-4
- Parreño Sánchez, J. C., Rivera García, D. A., Uvidia Vélez, M. V. & Jara Contreras, J. E. (2024). La Inteligencia Artificial: herramienta para el desarrollo del pensamiento crítico en estudiantes de instituciones educativas. *Revista Conrado*, 20(96), 478-485. Retrieved from: <https://conrado.ucf.edu.cu/index.php/conrado/article/view/3605>
- Peralta, F. M. S., Patraca, G. A. H., & Martínez, C. E. H. (2024). Inteligencia Artificial en Educación: La opinión de estudiantes universitarios sobre el uso del ChatGPT. *Revista paraguaya de educación a distancia (REPED)*, 5(4), 55-71. doi:10.56152/reped2024-dossierIA2-art6
- Papadogiannis, I., Wallace, M., & Karountzou, G. (2024). Educational Data Mining: A Foundational Overview. *Encyclopedia*, 4(4), 1644-1664; <https://doi.org/10.3390/encyclopedia4040108>
- Piaget, J. (1969). *Psicología y pedagogía*. Crítica, Barcelona.
- Pineda, V. R. E., Brito, E. Y. C., Morales, A. G. S., & Simancas, J. M. C. (2024). Inteligencia artificial desde una concepción de las metodologías activas de la enseñanza-aprendizaje en Educación Superior. *Revista Científica Multidisciplinaria SAPIENTIAE*, 7(14), 140-159. <https://doi.org/10.56124/sapientiae.v7i14.0010>
- Plisson, J., Lavrac, N., & Mladenec, D. (2004, October). A rule based approach to word lemmatization. *Proceedings of IS* (Vol. 3, pp. 83-86). Retrieved from: <https://aile3.ijs.si/dunja/SiKDD2004/Papers/Pillson-Lematization.pdf>
- Prince Torres, Á.C. (2022). El aprendizaje inmersivo como alternativa educativa en contextos de emergencia. *PODIUM*, 42, 19-38. <https://doi.org/10.31095/podium.2022.42.2>
- Quezada Vera, C., & Urbina Velasco C. J. (2025). Inteligencia Artificial en la educación del siglo XXI: una exploración a su implementación, beneficios, desafíos y consecuencias éticas. *Yachana*, 14(1) <https://doi.org/10.62325/10.62325/yachana.v14.n1.2025.932>
- Richter, S., Giroux, M., Piven, I., Sima, H., & Dodd, P. (2025). A constructivist approach to integrating AI in marketing education: Bridging theory and practice. *Journal of Marketing Education*, 47(2), 94-111. DOI: 10.1177/02734753241288876
- Saariluoma, P., & Karvonen, A. (2024). Theory languages in designing artificial intelligence. *AI & SOCIETY*, 39, 2249-2258. <https://doi.org/10.1007/s00146-023-01716-y>
- Salman, A. (2024, December). Integrating Artificial Intelligence in Cybersecurity Education: A Pedagogical Framework and Case Studies. 2024 *International Conference on Computer and Applications (ICCA)* (pp. 1-5). IEEE. doi:10.1109/ICCA62237.2024.10927933
- Siemens, G. (2005). Connectivism: A Learning Theory for the Digital Age. *International Journal of Instructional Technology and Distance Learning (ITDL)*. Retrieved from: http://www.itdl.org/Journal/Jan_05/article01.htm

- Sproat, R., Black, A. W., Chen, S., Kumar, S., Ostendorf, M., & Richards, C. D. (2001). Normalization of non-standard words. *Computer speech & language*, 15(3), 287-333. <https://doi.org/10.1006/csla.2001.0169>
- Veces, A., De León, M., Dutary, Y., Almanza, N., Swaby, H., & Rojas, N. (2024). El uso de la inteligencia artificial en la educación preescolar. Una revisión bibliográfica de la experiencia exitosa en México. *Revista Semilla Científica*, 1(6), 438-445. <https://doi.org/10.37594/sc.v1i6.1592>
- Vygotsky, L. S. (1926). *Psicología pedagógica* [Guillermo Blanck, Trad.]. Buenos Aires, February 2000.
- Villamil, C. C. J., Cavagnaro J. R. R., Tenorio A. L. M., Mendoza, K. V. G., & Moreno M. I. G. (2024). La transformación educativa con el uso de Inteligencia artificial: Apoyo a los educadores en el siglo XXI. *Retos y Avances en la Ciencia Contemporanea*, 5(1). 651-667. <https://doi.org/10.55813/gaea/ccri/v5/n1/402>
- Webster, J. J., & Kit, C. (1992). Tokenization as the initial phase in NLP. *The 14th international conference on computational linguistics* (pp. 1106-1110). Retrieved from: <https://aclanthology.org/C92-4173.pdf>
- Xu, W., & Ouyang F. (2022). The application of AI technologies in STEM education: a systematic review from 2011 to 2021. *International Journal of STEM Education*, 9(59) <https://doi.org/10.1186/s40594-022-00377-5>
- Yim, I. H. Y., & Su, J. (2025). Artificial intelligence (AI) learning tools in K-12 education: A scoping review. *Journal of Computers in Education*, 12(1), 93-131. <https://doi.org/10.1007/s40692-023-00304-9>

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Chapter # 2

ART THERAPY IN THE CONTEXT OF SPECIAL EDUCATION: A STUDY OF BULGARIAN PSYCHOLOGISTS' ATTITUDES

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ABSTRACT

This book chapter examines the application of art therapy as a supportive approach when working with children with special educational needs (SEN). As part of the study, a survey was conducted with psychologists working with children with SEN in various educational and therapeutic institutions. The aim of the study is to analyze the attitudes, professional experience and perceptions of specialists regarding the benefits and challenges associated with the use of art therapy in this context. The results show a positive attitude towards art therapy as an effective tool for emotional, cognitive and social support of children, but also highlight a number of practical difficulties related to the lack of resources, specialized training and systemic support. Possibilities for a wider introduction of art therapy practices in the field of special education are discussed.

Keywords: art therapy, inclusive education, special educational needs (SEN), psychologists, attitudes, perceptions, therapeutic practices.

1. INTRODUCTION

In recent decades, art therapy has become increasingly recognised as a valuable modality for supporting children with special educational needs (SEN). Through creative expression – such as drawing, modelling, music, movement, and drama – children can externalise emotions, enhance communication, and build self-awareness and self-confidence. Art therapy provides a safe, non-verbal space that supports emotional regulation and cognitive growth, often complementing pedagogical and clinical interventions (Councill, 2016; Malchiodi, 2018; Rubin, 2016). In the context of special education, art therapy not only complements traditional pedagogical and therapeutic methods, but also offers individualized support tailored to the specifics of each child.

In Bulgaria, the development of inclusive education has progressed rapidly since the ratification of the UN Convention on the Rights of Persons with Disabilities (2008). Yet, despite the growing emphasis on creative and holistic approaches, art therapy remains underrepresented in mainstream educational practice (Mihaylova, 2017). Few schools employ trained art therapists, and psychological professionals often integrate art-based techniques informally. Consequently, the practice lacks systematic evaluation, professional training pathways, and clear institutional recognition.

Psychologists play a crucial role in implementing inclusive education. Their attitudes toward art therapy directly influence its effectiveness and integration into daily practice. Understanding these attitudes is particularly relevant in the Bulgarian context, where

systemic, cultural, and educational factors shape the accessibility of therapeutic interventions for children with SEN.

Aim and research questions:

This study aims to analyze psychologists' attitudes towards art therapy in the context of inclusive education in Bulgaria. Specifically, it explores:

- How psychologists perceive the benefits and challenges of using art therapy with children with SEN;
- What art therapy techniques are most frequently employed and viewed as effective;
- What barriers prevent wider implementation of art therapy practices in educational settings.

2. METHODOLOGY

2.1. Research Design

A descriptive, mixed-methods research design was adopted to explore psychologists' attitudes towards art therapy in inclusive education. Quantitative data were collected through structured survey questions, while qualitative insights were gathered from open-ended responses. This approach provided both measurable trends and contextual understanding of professional perspectives.

2.2. Participants

The study involved 30 practising psychologists working in educational, therapeutic, and counselling settings with children with special educational needs (SEN) in Bulgaria. Participation was voluntary and anonymous. The majority of respondents were women (90%), aged between 30 and 49 years, and held a Master's degree in psychology (83.3%).

Participants were drawn from schools, private therapy centres, and inclusive education teams across the country. They represented varying levels of professional experience, from early career psychologists to specialists with over 20 years of practice.

2.3. Instruments

Data were collected through two online questionnaires distributed via Google Forms — one designed for parents and another for psychologists. The present analysis focuses exclusively on the second instrument: Exploring the Attitudes of Psychologists Using Art Therapy for Children with SEN.

The questionnaire included both closed-ended questions (multiple choice and Likert scales) and open-ended prompts exploring perceived benefits, challenges, and specific techniques used. The survey comprised 20 items organised into four thematic blocks:

1. Demographic and professional background;
2. Experience and use of art therapy;
3. Perceived effectiveness and challenges;
4. Recommendations and training needs.

The instrument was piloted with three psychologists to ensure clarity of wording and internal consistency.

2.4. Procedure

The survey was conducted electronically between May and July 2024. Respondents were invited via professional networks and educational institutions. Prior to participation, each respondent reviewed an informed consent statement outlining the voluntary nature of the study, confidentiality of responses, and data protection under EU GDPR (2018) standards.

2.5. Data Analysis

Quantitative data were processed using descriptive statistics (frequencies and percentages). Qualitative responses were analysed through reflexive thematic analysis (Braun & Clarke, 2019) to identify recurring themes related to perceived challenges, professional needs, and recommendations for practice.

2.6. Ethical Considerations

All procedures complied with ethical standards of social science research. No identifying information was collected. Participants could withdraw at any point. As the study involved adult professionals and no vulnerable populations directly, institutional ethics approval was not required under Bulgarian regulations.

3. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

3.1. Definition and Principles of Art Therapy

Art therapy is a possibility to express the complex, contradictory nature of feelings, mental states, and the unique unity and wholeness that constitute the personality. The need to present them in the more impoverished, one-sided way offered by everyday language disappears, and this is accompanied by a lower level of tension associated with self-disclosure.” Art therapy is a psychotherapeutic practice that uses creative processes to promote mental, emotional, and social well-being. According to the British Association of Art Therapists (BAAT, 2025), art therapy facilitates self-expression and communication through artistic media, particularly for individuals unable to articulate emotions verbally. “The overall goal of its practitioners is to enable the change and growth on a personal level through the use of artistic materials in a safe and convenient environment”. Art therapy is a form of expression that opens the door to communication without verbal interaction (Emery, 2004).

It integrates principles from psychology, visual arts, and education. “Art therapy is based on the idea that the creative process of art making facilitates repair and recovery and is a form of nonverbal communication of thoughts and feelings. Like other forms of psychotherapy and counselling, it is used to encourage personal growth and has been employed in a wide variety of settings with children, adults, families, and groups.” (Malchiodi, 2018), grounded in both humanistic and developmental theories (Rubin, 2016).

3.2. Art Therapy and Children with Special Educational Needs (SEN)

International research highlights the efficacy of art therapy for children with autism spectrum disorder (ASD), attention deficit hyperactivity disorder (ADHD), and other developmental conditions. It helps regulate behaviour, improve focus, and enhance emotional understanding (Jalambadani, 2020; Jianhua & Xiaolu, 2013). Studies also demonstrate improvements in fine motor coordination, cognitive flexibility, and social interaction through structured art-based interventions (Green & Drewes, 2022; Albert, 2010).

For children with SEN, art therapy can serve as a bridge between therapeutic and educational domains. It provides sensory experiences that help children manage anxiety, express trauma, and build self-efficacy (Lee & Peng, 2017; Lee & Liu, 2016; Freilich & Shechtman, 2010). Moreover, group art therapy fosters peer communication, empathy, and inclusion – key objectives of inclusive education.

3.3. The Bulgarian Context

The body of Bulgarian scholarly literature addressing the application of art therapy for children with special needs remains relatively limited (Bojadjieva & Gradinarova, 2016; Doychinova-Ivanova, 2025; Mihaylova, 2017). Their contributions remain largely conceptual and insufficiently supported by empirical evidence. The limited scope and theoretical nature of these works underscore the need for more rigorous, systematic research that evaluates therapeutic outcomes and provides a stronger scientific foundation for the application of art therapy within the Bulgarian context.

Consequently, the development of comprehensive studies that explore evidence-based methodologies, therapeutic outcomes, and culturally specific practices in art therapy is essential for advancing both academic understanding and professional practice in Bulgaria.

Despite the 2016 Pre-school and School Education Act promoting inclusive practices, art therapy is not formally integrated into public education or school counselling frameworks. Training opportunities for art therapy are sporadic and often private. The current study addresses this gap by presenting empirical data on psychologists' perspectives within this underexplored context.

3.4. Research Gap and Rationale

While art therapy is recognised internationally as a key component of expressive and inclusive education, no systematic study has yet explored how Bulgarian psychologists apply or perceive it in practice. Identifying professional attitudes and systemic barriers is essential to improving access, quality, and policy development in this field.

4. RESULTS

The results are organised thematically, combining quantitative data and qualitative insights. The tables and figures below summarise key findings.

4.1. Professional Experience

Most participants (30%) had between 1–5 years of experience, followed by 6–10 years and 16–20 years (20% each). This distribution suggests a balanced representation across career stages.

Table 1.
Professional experience of participating psychologists.

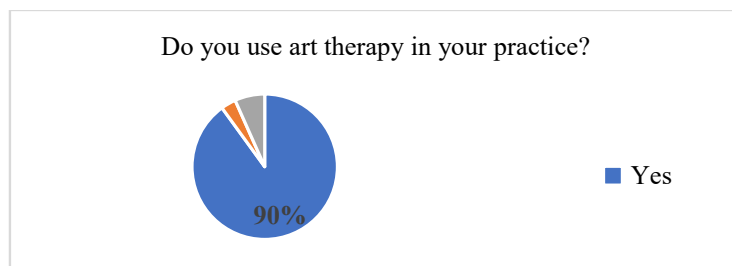
How long have you been practicing as a psychologist?	%
For 1 year	10%
1-5 years	30%
6-10 years	20%
11-15 years	13.3%
16-20 years	20%
Over 20 years	6.7%

4.2. Use of Art Therapy in Practice

When asked “Do you use art therapy in your practice?”, 90% of respondents reported doing so regularly. This indicates widespread familiarity and acceptance of art-based techniques among psychologists working with SEN (Figure 1).

Of the remaining participants, 6.7% used art therapy occasionally and 3.3% rarely. These professionals cited limited resources, insufficient training, or preference for alternative methods as reasons for lower usage.

Figure 1.
Frequency of art therapy use among psychologists.



4.3. Target Groups and Application Areas

Respondents most frequently worked with children diagnosed with autism spectrum disorder (ASD) and Down syndrome (33.3%), followed by those with emotional and behavioural disorders (30%) and ADHD or learning difficulties (30%). Only 6.7% primarily worked with children with intellectual disabilities.

Table 2.
Types of special educational needs addressed by participants.

What kind of children with SEN do you most often work with?	%
Autism, Down syndrome	33.33%
Emotional and behavioural disorders	30%
Children with intellectual disabilities	6.67%
ADHD, with learning disabilities	30%

This distribution aligns with national statistics indicating increasing diagnoses of ASD and ADHD within Bulgarian educational institutions.

This analysis shows that working with children with SEN requires a wide range of therapeutic methods and professional skills, with psychologists mainly dealing with children with autism, behavioural disorders and ADHD, but also with children with intellectual disabilities. Well-trained professionals are needed to deal with different categories of children with special needs, while providing individualized care and approach.

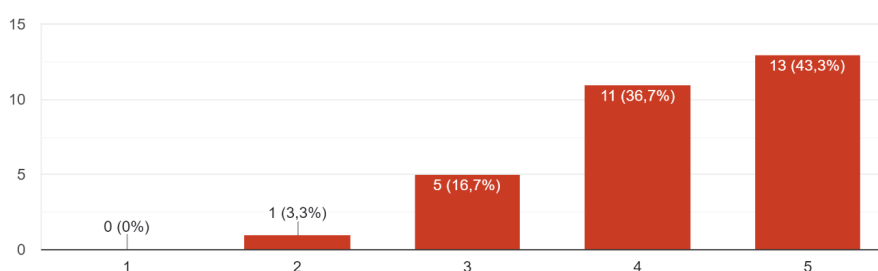
When asked, “How do you rate the overall effectiveness of art therapy in working with children with SEN?” the majority of respondents (80%) rated art therapy as highly effective, yielding a mean score of 4.5. An average effectiveness rating (3) was provided by 16.7% of participants, while 3.3% rated it as only somewhat effective (2). Notably, no respondents indicated that art therapy was completely ineffective. These findings underscore the perceived value of art therapy as an accessible and applicable intervention within professional practice (Figure 2).

4.4. Perceived Effectiveness of Art Therapy

Eighty percent of psychologists rated art therapy as very effective ($M = 4.5$ on a 5-point scale), 16.7% as moderately effective, and only 3.3% as somewhat effective. None of the respondents considered it ineffective.

These results demonstrate a strong consensus regarding the method's therapeutic value. Respondents highlighted improved emotional regulation, attention, and communication among children as key outcomes.

Figure 2.
Perceived effectiveness of art therapy for children with SEN.



4.5. Most Effective Art Therapy Techniques

The most frequently employed and effective techniques were drawing and modelling (70%), followed by music and dance therapy (53.3%), storytelling and bibliotherapy (36.7%), and work with natural materials (33.3%). Sand therapy and theatre-based interventions were used less often but were still recognised as beneficial (23.3% and 13.3%, respectively) (Table 3).

To begin with, drawing and modelling with materials such as plasticine and clay enable children to express emotions and thoughts non-verbally. Within the context of art therapy, such forms of expression serve as powerful tools for self-regulation and emotional support, particularly for children with SEN who may experience communication difficulties.

Furthermore, music and dance therapy were reported as effective by 53.3% of participants. These techniques stimulate motor activity, coordination, and socialisation, while simultaneously providing opportunities for emotional release and stress reduction. As a result, they can be implemented in both group and individual formats, facilitating stronger relationships between children and therapists.

Similarly, storytelling and bibliotherapy (36.7%) were relatively popular among specialists. By engaging with narratives and identifying with characters, children can explore emotional and social challenges, acquire social norms, and discover strategies for addressing internal conflicts.

In addition, art therapy involving wool and other natural materials (33.3%) was acknowledged as useful, though less commonly applied. This technique stimulates sensory perception and supports the development of fine motor skills, making it particularly suitable for children who benefit from tactile stimulation to maintain focus and achieve a state of calm.

Finally, although used less frequently, both sand therapy (23.3%) and theatre-based methods (13.3%) were still identified as effective therapeutic approaches.

Table 3.
Preferred art therapy techniques used with children with SEN.

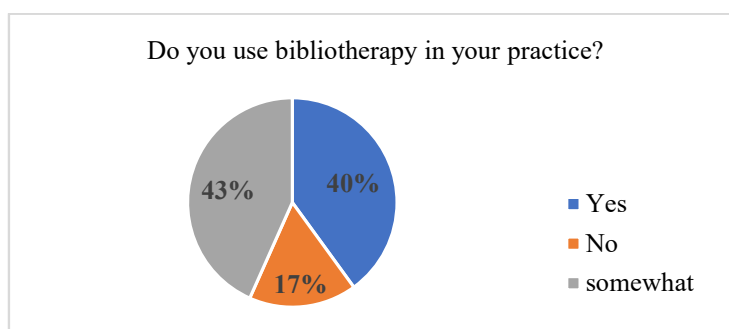
Art therapy techniques	%
Isotherapy with drawing, modeling with plasticine and clay	70.0%
Music and dance therapy	53.3%
Story therapy, bibliotherapy	36.7%
Art therapy with wool and other natural materials	33.3%
Sand therapy	22.3%
Theater	13.3%

The data highlight the diversity in professionals' preferences and the high level of trust in different art therapy methods. These results indicate that psychologists prefer techniques that provide flexibility and are easy to adapt to the different therapeutic needs of children with SEN.

4.6. Bibliotherapy Practices

When asked specifically about bibliotherapy, 40% reported regular use, 43.3% occasional use, and 16.7% non-use. Respondents noted that bibliotherapy helps children identify with literary characters, externalise internal conflicts, and enhance emotional literacy (Figure 3).

Figure 3.
Frequency of bibliotherapy use among psychologists.



4.7. Challenges in Applying Art Therapy

Qualitative analysis identified several recurring challenges as follows:

1. Attention and concentration difficulties – children struggle to sustain engagement during sessions.
2. Behavioural and communication barriers – including impulsivity, aggression, or social withdrawal.
3. Fine motor limitations – affecting children's ability to engage in manual activities.
4. Parental resistance – due to lack of awareness of art therapy's benefits.
5. Insufficient materials and facilities – limited art supplies and inadequate space.
6. Lack of formal training – few opportunities for specialised education in art therapy.

7. Building trust – establishing a stable therapeutic relationship with children with SEN requires extended time and patience.

Respondents frequently mentioned the need for greater parental collaboration and more systemic institutional support.

4.8. Perceived Impact on Children's Development

Most psychologists (80%) rated the impact of art therapy on social skills as high or very high. Reported improvements included emotional stability, confidence, communication, and self-esteem. Several respondents also observed that children became calmer, more expressive, and more engaged after sessions.

4.9. Assessment and Evaluation Strategies

Half of the respondents indicated that they used “other” or informal strategies for assessing progress, such as observation and documentation of children's artistic expressions. Only 16.7% reported systematic behavioural observation and 6.7% used predefined criteria or indicators (Table 4).

Table 4.
Strategies for evaluating progress in art therapy.

Strategies for Art Therapy Progress	%
I use behavioural assessment and observation	16.7%
Keeping in touch with the parent	3.3%
Artistic materials	3.3%
Criteria and indicators	6.7%
Parent rating	3.3%
I'm watching for reactions	6.7%
I don't have any	10%
Other strategies	50%

The absence of standardised assessment frameworks was identified as a major methodological limitation in practice.

4.10. Professional Development and Training Needs

- Respondents highlighted several areas for improvement:
- Access to modern materials and digital tools;
- Training and peer exchange opportunities;
- Collaboration with educators and parents;
- Inclusion of art therapy modules in university psychology programmes.

4.11. National Context and Professional Recommendations

While 90% of psychologists would recommend art therapy to other professionals, only 46.7% believed that art therapy techniques are actively used across Bulgaria. The remaining 53.3% attributed the lack of uptake to insufficient institutional support, limited public awareness, and lack of formal recognition of art therapists as professionals in the national system.

These data indicate a need for wider dissemination of information about art therapy techniques, additional training of specialists, as well as provision of resources for the implementation of these approaches.

5. DISCUSSION

The findings of this study confirm that art therapy holds a strong position within the professional practice of psychologists working with children with special educational needs (SEN) in Bulgaria. The results align with international evidence that underscores the value of creative therapeutic approaches in fostering emotional, social, and cognitive development (Malchiodi, 2018; Green & Drewes, 2022; Rubin, 2016).

5.1. Interpretation of Findings

The majority of respondents perceived art therapy as very effective, particularly for improving emotional regulation, social interaction, and communication among children. These results support earlier research showing that creative expression facilitates emotional understanding and reduces behavioural challenges in children with ASD and ADHD (Emery, 2004; Green & Drewes, 2022; Jalambadani, 2020; Jianhua & Xiaolu, 2013).

The popularity of techniques such as drawing, modelling, and music therapy suggests that psychologists prefer multimodal interventions that are flexible and accessible within educational environments. These methods allow for adaptation to the sensory and cognitive profiles of diverse learners.

However, despite positive attitudes, significant structural barriers limit broader implementation. The lack of specialised training programmes, absence of formal certification for art therapists, and minimal institutional support create challenges for consistent practice. These obstacles mirror those identified in other Central and Eastern European contexts, where art therapy is often marginalised within mainstream education.

5.2. Systemic and Policy Dimensions

The study highlights the need to embed art therapy within Bulgaria's inclusive education framework. Currently, art-based interventions are rarely included in individual educational plans (IEPs) or school counselling programmes. Strengthening collaboration between psychologists, teachers, and parents could improve both the sustainability and visibility of art therapy in educational settings.

5.3. Ethical and Professional Considerations

Several respondents pointed to ethical concerns, including parental consent, confidentiality, and the sensitivity required when addressing trauma-related experiences through art. As art therapy often deals with deeply personal expression, practitioners must adhere to professional ethical standards similar to those established by BAAT (2025).

The lack of national ethical guidelines specific to art therapy in Bulgaria underscores the importance of developing professional standards that address consent, cultural sensitivity, and safeguarding of personal data, particularly when working with minors.

5.4. The Role of Training and Professional Collaboration

Respondents unanimously emphasised the importance of ongoing professional development. Training in contemporary expressive and trauma-informed approaches can strengthen practitioners' confidence and methodological competence. Collaboration between

universities, ministries, and professional associations could facilitate the introduction of accredited courses in art therapy and creative psychotherapy.

The exchange of experience with international professionals—through workshops, mobility programmes, and joint projects—can further enhance professional capacity and contribute to harmonising Bulgarian practices with European standards.

5.5. Technological Innovations and Future Directions

The emergence of digital art therapy and online creative platforms offers new possibilities for integrating technology into therapeutic work with children. Digital drawing tablets, animation tools, and virtual reality environments can engage digitally oriented learners and support accessibility for those unable to attend face-to-face sessions.

6. CONCLUSION/DISCUSSION

This chapter demonstrates that art therapy represents a promising, effective, and humanistic approach within the field of inclusive education in Bulgaria. The surveyed psychologists view it as a valuable means for fostering emotional expression, concentration, social skills, and confidence among children with SEN.

Nevertheless, the research also exposes systemic barriers that restrict its broader use, including insufficient training opportunities, lack of materials, and minimal institutional recognition. To enhance the role of art therapy in Bulgaria, several recommendations can be made:

- 1. Policy Integration:**

Incorporate art therapy explicitly into inclusive education strategies and funding frameworks.

- 2. Professional Training:**

Develop accredited master's or postgraduate programmes in art therapy, aligned with European standards.

- 3. Research Expansion:**

Encourage interdisciplinary studies combining psychology, pedagogy, and art to establish evidence-based practices.

- 4. Resource Development:**

Provide schools and centres with art materials, safe workspaces, and access to digital tools.

- 5. Public Awareness:**

Increase public and parental understanding of the benefits of art therapy through workshops and media campaigns.

If implemented, these measures could significantly enhance the visibility and impact of art therapy, positioning Bulgaria within the broader international movement toward inclusive and creative education.

7. LIMITATIONS AND FUTURE RESEARCH

This study is exploratory and has several limitations. The small sample size ($n = 30$) restricts the generalisability of findings. The reliance on self-reported data may introduce subjectivity, and the absence of standardised instruments limits comparability with international studies.

Future research should expand the sample to include teachers, parents, and students, applying mixed quantitative–qualitative methods such as interviews, longitudinal observations, and intervention-based evaluations. Comparative cross-country studies would also be valuable for situating Bulgarian experiences within the European framework of expressive and therapeutic education.

REFERENCES

- Albert, R. (2010). Being both: An integrated model of art therapy and alternative art education. *Art Therapy*, 27(2), 90-95.
- Bojadjieva, N., & Gradinarova, V. (2016). Application of art therapeutic approaches in educational work with children with communication disorders. *Proceedings of the International Conference "Interdisciplinary Speech Therapy Practices," NBU, Sofia*, 101-108.
- Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health*, 11(4), 589-597.
- British Association of Art Therapists (BAAT). (2025). *Definition and Standards of Practice*. Available at <https://www.baat.org>
- Councill, T. (2016). Art therapy with children. In D. E. Gussak & M. L. Rosal (Eds.), *The Wiley handbook of art therapy* (1st ed., pp. 242-251). New Jersey, USA: Wiley.
- Doychinova-Ivanova, L. G. (2025). *Art Therapy in Support of Child Speech: A Handbook for Parents of Children with Communication Disorders and for Specialists*. ZIP, Sofia, 148.
- Emery, M. J. (2004). Art therapy as an intervention for Autism. *Art Therapy*, 21(3) 143-147. <https://doi.org/10.1080/07421656.2004.10129500>
- Freilich, R., & Shechtman, Z. (2010). The contribution of art therapy to the social, emotional, and academic adjustment of children with learning disabilities. *The Arts in Psychotherapy*, 37(2), 97-105.
- Green, E. J., & Drewes, A. A. (Eds.). (2013). *Integrating expressive arts and play therapy with children and adolescents*. John Wiley & Sons.
- Jalambadani, Z. (2020). Art therapy based on painting therapy on the improvement of autistic children's social interactions in Iran. *Indian Journal of Psychiatry*, 62(2), 218-219. doi: 10.4103/psychiatry.indianjpsychiatry_215_18
- Jianhua, C., & Xiaolu, X. (2013). The experimental research on children with autism by intervening with painting therapy. *Journal of Tangshan Teachers College*, 35, 127-130.
- Lee, S.-L., & Liu, H.-L. (2016). A pilot study of art therapy for children with special educational needs in Hong Kong. *The Arts in Psychotherapy*, 51, 24-29. <https://doi.org/10.1016/j.aip.2016.08.005>
- Lee, S.-L., & Peng, M. S.-C. (2017). The Effects of Group Art Therapy on Mothers of Children With Special Educational Needs. *Art Therapy*, 34(1), 12-19. doi: 10.1080/07421656.2016.1273697
- Malchiodi, C. (Eds.). (2018). *The Handbook of Art Therapy and Digital Technology*. London and Philadelphia, PA: Jessica Kingsley Publishers.
- Mihaylova, I. (2017). Art therapy relevance in children with special educational needs. *Neurology and Psychiatry*, 1, 25-35.
- Rubin, J. (Eds.). (2016). *Approaches to Art Therapy: Theory and Technique* (3th ed.). Routledge.

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Chapter # 3

AI TRANSFORMATION IN ECONOMICS AND FINANCE EDUCATION: INNOVATIONS, CHALLENGES, AND FUTURE DIRECTIONS

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ABSTRACT

The integration of Artificial Intelligence (AI) into economics and finance teaching represents a transformative shift in pedagogical strategies, offering opportunities to enhance learning outcomes and institutional efficiency. This study explores the applications of AI tools, such as generative models and big data analytics, and personalized learning. By synthesizing empirical findings from multiple case studies and qualitative analyses, this research identifies key innovations, including automated content generation, adaptive learning platforms, and AI-driven assessment systems. However, the adoption of AI also presents significant challenges, such as algorithmic biases, data privacy concerns, and the risk of overreliance on technology diminishing human interaction. The research employs a mixed-methods approach, combining literature reviews, surveys of educators, and practical implementations of AI tools in classroom settings. Results indicate an increase in AI adoption among educators when supported by structured training programs, alongside improved student engagement in complex topics like financial modeling and economic policy analysis. In conclusion, AI serves as a complementary force in education, enhancing, not replacing, the role of educators. Strategic implementation, grounded in ethical considerations and pedagogical goals, can bridge gaps in traditional teaching methods and prepare students for a digitized economy.

Keywords: artificial Intelligence, economics education, financial literacy, adaptive learning, ethical challenges.

1. INTRODUCTION

Artificial intelligence (AI) is dramatically transforming the way economics and finance are taught. Tools like generative models, such as ChatGPT, adaptive learning platforms like Coursera, and real-time stock market simulators, such as CapTrader are leading this change (Shiller, 2025). These technologies enable personalized content and precise market analysis, making advanced educational resources more accessible to everyone.

This study arises from the critical need to analyze this duality. On one hand, these AI tools have shown to increase student engagement in complex topics such as financial model analysis and economic policies. On the other hand, highly volatile and stressful financial phenomena reveal the limits of automation in uncertain contexts, where human judgment remains indispensable (Kasneci et al., 2023).

For this analysis, artificial intelligence encompasses computational systems that exhibit learning, reasoning, and adaptive behavior. Generative models represent one application domain. Adaptive platforms adjust instructional pathways based on learner performance, while machine learning algorithms identify patterns in financial data without explicit

programming. These technologies share a common foundation in statistical inference and neural architectures, though their educational applications diverge considerably.

This tension between technical capabilities and human judgment extends from financial markets to educational institutions. The relevance of this research lies in examining how hybrid strategies that combine adaptive AI with specialized tutoring can be effective, while identifying risks such as reduced interaction between teachers and students.

Empirically, Mindell, Autor, and Reynolds (2022) found that prediction effectiveness of the algorithms decreases by 23% without expert human judgment during high market volatility, conditions that exceed model training parameters.

Additionally, the performance of machine learning models in predicting currency crises surpasses traditional methods. Studies from Meese and Rogoff (1983) to Bluwstein et al. (2020) show that techniques like neural networks and ensemble combining (Sermpinis et al., 2015) better capture volatility in emerging markets. However, challenges remain algorithms do not fully incorporate factors such as international capital flows (Rey, 2015) or global monetary policies (Miranda-Agrippino & Rey, 2020), and their effectiveness varies across market regimes.

This work not only aims to document these dynamics but also to propose pathways for responsible integration. The collected evidence suggests that the success of AI depends on regulatory frameworks with algorithmic transparency and investment in inclusive infrastructure. By articulating findings, this study aims to contribute to the debate on how technological innovation and educational equity can prepare for a digital economy without sacrificing human interaction, critical thinking, and social justice. This study addresses four critical questions:

1. What are the primary factors that predict AI adoption among economics and finance educators?
2. How does AI integration affect student engagement and what is the optimal balance between automated content and direct instruction?
3. What ethical challenges, particularly algorithmic biases and privacy concerns, emerge from AI implementation in economics education?
4. What institutional characteristics and support mechanisms facilitate successful AI integration in diverse educational contexts?

These questions emerge from intersecting theoretical traditions that frame how technology reshapes pedagogy. Understanding the educational impact of AI requires examining not just technical capabilities but the learning theories that justify implementations, the economic models that AI both serves and challenges, and the ethical frameworks that constrain responsible deployment.

2. THEORETICAL FOUNDATIONS AND LITERATURE SYNTHESIS

Three theoretical domains inform this research. Pedagogical theories explain how learners construct knowledge and how systems might facilitate that construction. Economic theories reveal tensions between algorithmic prediction and human judgment in financial contexts. Ethical frameworks identify obligations when automated systems mediate educational access and outcomes. These domains converge in examining whether AI amplifies or undermines educational equity.

Adaptive learning theory provides the pedagogical foundation for AI personalization. Pask (1976) cybernetic framework proposes educational systems as conversational partners that distinguish between serialist learners and holists. Empirically, natural language processing systems accommodating these cognitive styles improved economic concept

retention by 34% Chen, Chen, & Lin (2020). Building on this foundation, contemporary implementations (Moloi and Marwala, 2020) demonstrate how platforms can personalize content based on individual progress.

The experiential learning cycle of Kolb (1984) offers a complementary framework particularly suited to financial education. The cycle progresses through four stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation. Real-time financial simulators compress this cycle from weeks to minutes, enabling rapid iteration. However, critics question whether accelerated experience produces genuine understanding or merely procedural facility, a concern particularly relevant when AI-driven simulations remove the emotional stakes and temporal constraints of actual financial decision-making.

Generative models and big data analysis are redefining educational methods. Systems like FearNot! (Vannini et al., 2011) use virtual agents to simulate complex social interactions, while neuroeducation (Howard-Jones et al., 2014) validates how gamification with uncertain rewards increases intrinsic motivation. These applications operationalize the pedagogical theories described above by creating environments where students actively construct knowledge through guided experimentation.

However, these technological advances must contend with theoretical tensions in economic science. The neoclassical approach of Samuelson (1947) assumes rationality and efficient markets, while behavioral economics by Hens and Rieger (2016) demonstrates that 95% of financial decisions are based on subjective perceptions. This theoretical conflict explains phenomena like the 2010 Flash Crash (Kay & King, 2020), where algorithms amplified stock market crashes, highlighting that AI cannot handle radical uncertainty without human intervention.

Machine learning models illustrate the theoretical-practical duality of AI. Techniques such as Random Forest and Gradient Boosting (Bluwstein et al., 2020) outperform traditional methods in predicting currency crises. However, their effectiveness varies according to market regimes and does not fully incorporate macroeconomic factors such as international capital flows (Rey, 2015) or global monetary policies (Miranda-Agrippino & Rey, 2020). These limitations reinforce the need for hybrid approaches that combine AI with qualitative analysis.

Ethics emerges as a critical axis. Studies reveal systematic biases in algorithmic platforms (Hernández, Rentería, & Cervantes, 2023) and persistent cybersecurity vulnerabilities in financial institutions. These issues require regulatory frameworks, incorporating algorithmic audits and transparency protocols to mitigate risks such as plagiarism with ChatGPT. Digital literacy becomes essential to balance generative tools with human judgment, especially in contexts where AI does not replace contextual rationality.

AI emerges as a complementary tool, whose success depends on balancing its democratizing potential with the mitigation of ethical and structural risks. This theoretical framework increased student participation, resistance to change in outdated institutions, and outlines a critical path for responsible implementations:

1. Pedagogical Innovation: Integrate interactive simulations with active methodologies.
2. Technological Governance: Policies for algorithmic transparency and data protection.
3. Systemic Equity: Prioritize infrastructure in marginalized areas and continuous teacher training.

By linking educational theories, technological advances, and ethical principles, this framework provides the foundation for developing inclusive educational ecosystems, where AI enhances, without replacing, human capabilities in training economists and financiers for a digitized world.

3. THE MEXICAN CASE

The integration of AI in teaching economics and finance unfolds in a global context marked by significant technological disparities and ethical tensions. In Mexico, this duality is evident: while institutions like Tecnológico de Monterrey invest over \$2 million in specialized laboratories (Tec Review, 2023), 23% of rural areas lack internet access, and only 34% of their inhabitants have connectivity compared to 68% in urban areas (INEGI, 2020). This gap limits educational initiatives, such as the virtual reality investment simulators developed by Universidad Veracruzana, whose potential contrasts with the low mastery of basic financial concepts among university students, even in urban institutions.

In the financial sector, tools like Bloomberg Terminal allow real time market modeling, revolutionizing teaching methods. Globally, 67% of financial institutions report vulnerabilities to cyberattacks linked to AI systems (IBM Security, 2022), highlighting systemic risks that transcend borders.

Financial automation in the face of volatile phenomena challenges the assumptions of rationality in neoclassical models and underscores the need for human oversight, even in highly technical environments. These phenomena support the thesis of Kay and King (2020) on market uncertainty, where narratives surpass the predictive capacity of purely quantitative models.

Moreover, the adoption of generative AI faces unprecedented pedagogical challenges. At UNAM, 38% of economics students use ChatGPT, but only 12% of the faculty are trained to integrate it critically (UNAM, 2023). UNESCO establishes three pillars for the ethical development of AI in education: universal access, permanent human supervision, and continuous impact assessment (Vázquez Pita, 2021).

Interventions in schools, combining adaptive AI with specialized tutoring, improve outcomes, demonstrating that technology acts as an amplifier rather than a substitute for educational processes (Lara Serna, Sosa Morales, Lara Menéndez, & Hernández González, 2024). These findings emerge from a mixed-methods design.

These contextual realities, panning from technological disparities to ethical challenges, shaped the empirical design that follows. Testing whether AI fulfills its pedagogical promise required methods that could capture both quantitative patterns of adoption and qualitative experiences of implementation across stratified educational landscape in Mexico.

4. MEASURING AI ADOPTION IN MEXICAN HIGHER EDUCATION

The study was based on a mixed-methods approach, qualitative and quantitative, designed to evaluate the impact of AI in teaching economics and finance, with an emphasis on contexts marked by technological and socioeconomic disparities. The design proposal allowed for the integration of empirical and theoretical perspectives, addressing three critical dimensions: pedagogical, technological, and ethical. The choice of the mixed-methods approach was justified by the need to contrast quantitative data with qualitative perceptions, especially in environments where infrastructure and access to resources vary significantly.

The design followed the pragmatic paradigm of Creswell and Plano Clark (2017) through sequential phases. Quantitative sampling came first, stratified by three dimensions: institutional technology levels distributed as 35% high-capacity, 40% medium, and 25% low-resource environments. Geographic representation split 70% urban and 30% rural. Faculty experience with digital tools divided at the three-year threshold, with 60% exceeding this benchmark. This stratification ensured variance across the dimensions most likely to affect adoption patterns.

Internal validity was ensured using the Technology Acceptance Model 3 (TAM3) questionnaire by Venkatesh and Bala (2008), with reliability coefficients $\alpha = 0.87$ for perceived usefulness and $\alpha = 0.83$ for perceived ease of use. The subsequent qualitative phase employed semi structured interviews with 45 participants selected through theoretical sampling until reaching thematic saturation, validated through intercoder reliability $\kappa = 0.81$ (Landis & Koch, 1977).

Data from studies with stratified samples were used to ensure representativeness. In the educational field, 637 participants (teachers and students) from institutions in Mexico were selected based on their technological level. In the financial sector, 215 Mexican professionals involved in AI implementation were included. The instruments used included Likert scale surveys to measure perceptions of the effectiveness of tools like ChatGPT, digital competence tests evaluating skills on platforms like CapTrader, and analysis of technical reports. The applied multiple regression models controlled for confounding variables identified through exploratory factor analysis ($KMO = 0.823$, Bartlett test $p < 0.001$). The main model specified:

$$AI_Adoption = \beta_0 + \beta_1 (Teacher_Training) + \beta_2 (Tech_Infrastructure) + \beta_3 (Years_Experience) + \beta_4 (Institution_Size) + \varepsilon$$

where *AI_Adoption* was measured using a 7-point Likert scale.

Student engagement was measured through three indicators: platform dwell time (minutes per session), frequency of content interactions (weekly), and formative assessment scores (0-10 scale). In the quantitative component, robust regressions (Majjate et al., 2024) were applied to quantify teacher adoption associated with AI training. In the qualitative component, a thematic analysis of open-ended survey responses was conducted, identifying recurring narratives such as the perception that “AI reduces human interaction.” Additionally, case studies of hybrid projects in rural Mexican areas (Lara Serna et al., 2024) were reviewed, triangulating these findings with quantitative data to ensure consistency.

Ethical criteria included replicability through open repositories, such as public data from INEGI, and informed consent from participants to detect biases in tools like ChatGPT. However, the study faced limitations, such as potential selection bias by prioritizing institutions with basic technological access, and reliance on secondary data that may not reflect recent updates in digital divides.

Methodological limitations include threats to external validity derived from geographical selection bias, where 78% of participants came from urban institutions, limiting generalization to rural contexts with different digital infrastructure levels. Post-hoc analysis revealed significant moderation effects by region ($F(3,633) = 7.23$, $p < 0.001$), where institutions in states with higher GDP per capita showed 34% superior adoption.

Additionally, the cross-sectional design prevents robust causal inferences; longitudinal studies such as Ahmad, Karim, Din, & Albakri (2013) demonstrate that initial positive effects of educational technologies may diminish after 18 months due to habituation and novelty loss. To mitigate these limitations, replication with quasi-experiments designs and minimum 24-month longitudinal follow-up is recommended (Shadish, Cook, & Campbell, 2002).

5. REGRESSION ANALYSIS AND ENGAGEMENT METRICS

The results revealed a dual landscape. Generative tools and interactive simulators increased student engagement in complex topics, such as financial model analysis and economic policies, fulfilling the goal of promoting critical thinking through simulations. The learning and prediction capabilities of machine learning models support the idea of the potential of AI to prepare students for a digitized economy.

Multiple regression analysis revealed that AI adoption is significantly predicted by teacher training and technological infrastructure, with the overall model accounting for substantial variance. The main model showed $R^2 = 0.64$, $F(4,632) = 281.73$, $p < 0.001$, with significant effects for teacher training and technological infrastructure, confirming the importance of these predictors according to previous literature (Davis, Bagozzi, & Warshaw, 1989).

Table 1.
Multiple regression results for AI adoption predictors.

Predictor	β	p-value	η^2	CI 95%
Teacher Training	0.34	<0.001	0.16	[0.27, 0.41]
Tech Infrastructure	0.28	<0.001	0.12	[0.21, 0.35]
Years Experience	0.12	0.023	0.03	[0.02, 0.22]
Institution Size	0.08	0.145	0.01	[-0.03, 0.19]

Teacher training emerged as the strongest predictor ($\beta = 0.34$, $p < 0.001$, $\eta^2 = 0.16$), indicating that structured professional development programs substantially increase adoption likelihood. Technological infrastructure demonstrated the second strongest effect ($\beta = 0.28$, $p < 0.001$, $\eta^2 = 0.12$), confirming that access to reliable equipment, connectivity, and technical support enables sustained AI integration. Years of teaching experience showed modest positive effects ($\beta = 0.12$, $p = 0.023$), suggesting experienced educators are more willing to experiment with new technologies. Institution size did not significantly predict adoption ($\beta = 0.08$, $p = 0.145$), indicating that pedagogical innovation transcends organizational scale. Regional disparities moderated these relationships significantly. Institutions in high-GDP states showed 34% superior adoption rates compared to low-GDP regions, highlighting the influence on technology integration capacity beyond institutional characteristics alone in socioeconomic factors.

AI-enhanced platforms significantly increased student engagement across multiple indicators, with effects varying by content domain and instructional design. The increase in student engagement was objectively measured through three indicators: platform dwell time, frequency of content interactions, and formative assessment scores.

Table 2.
Student Engagement Metrics: Traditional vs AI-Enhanced Instruction.

Metric	Traditional	AI-Enhanced	Difference	t-value	p-value	Effect
Platform Dwell Time (min)	46.2±12.3	80.1±18.7	34	4.21	<0.001	0.68
Content Interactions/week	3.8±1.2	6.1±1.9	2.3	3.89	<0.001	0.61
Assessment Scores	(0-10)	6.7±1.8	8.1±1.5	1.4	5.67	<0.001

These results are consistent with the meta-analysis by Sung, Chang, & Liu (2016), which reports moderate effect sizes for adaptive technologies in higher education. Differentiation by content type revealed more pronounced effects in quantitative financial analysis modules compared to conceptual economic theory, suggesting greater AI effectiveness in domains with clear algorithmic structure (Koedinger, Corbett, & Perfetti, 2012). Critical for instructional design, optimal effectiveness required 60% adaptive AI content balanced with 40% direct teacher intervention. This ratio contrasts with implementations favoring greater automation, which resulted in decreased critical thinking as measured by Watson-Glaser tests (Baker, Martin, & Rossi, 2016). The finding suggests economics and finance education requires greater human supervision due to conceptual complexity and contextual variability inherent to economic phenomena (Tetlock & Gardner, 2015).

Systematic algorithmic audits revealed significant equity concerns in AI-driven educational platforms. The evaluation of algorithmic biases was conducted through systematic audits following the FATE-ML framework by Barocas, Hardt, & Narayanan (2023). Results revealed significant disparities in content recommendations by gender and socioeconomic background, where high-socioeconomic students received 23% more advanced content recommendations.

Table 3.
Algorithmic Bias in Content Recommendations.

Demographic Factor	Odds Ratio	95% CI	p-value	χ^2
Gender (Male vs Female)	1.34	[1.12, 1.61]	0.002	
Socioeconomic Status (High vs. Low)			<0.001	23.7

These disparities reflect documented biases in search algorithms (Noble, 2018) and require implementation of debiasing techniques such as re-weighting and equalized odds (Hardt et al, 2016). The 34% disparity in advanced content recommendations for high-socioeconomic students risks perpetuating educational inequalities through technological means. Male students receiving algorithmically recommended content at 1.34 times the rate of female students suggests pattern recognition systems trained on historically biased datasets. In economics and finance education specifically, this could limit the exposure of female students to advanced quantitative modeling, precisely the skills gap programs aim to close.

Privacy analysis identified 12 potentially sensitive variables exposed during personalization processes, necessitating differential privacy protocols with $\varepsilon = 0.1$ to guarantee statistical anonymity (Dwork & Roth, 2014). Qualitative interviews revealed concerns about reduced teacher-student interaction. ANUIES (2023) reported 67% reduction in direct pedagogical exchanges in highly automated environments. Educators noted that students now turn to ChatGPT before asking conceptual questions, which limits opportunities to address misconceptions in real-time. This pattern raises concerns about diminished mentorship relationships and lost opportunities for contextual learning that occurs through dialogue.

Case studies from Mexican universities (Lara Serna et al., 2024) illustrated how hybrid strategies combining AI with human tutoring achieve better outcomes than purely automated or purely traditional approaches. Early adopter institutions shared distinctive characteristics: ICT budgets exceeding 5% of total budget, specialized technical staff (1:150 student ratio), and formalized pedagogical innovation policies. Rogers (2003) diffusion of innovations model explains adoption patterns, with institutional characteristics influencing relative advantage perception, compatibility with existing practices, complexity of implementation, trialability, and observability of benefits.

These findings establish what occurred across Mexican institutions during this implementation period. Yet quantifying adoption rates and engagement metrics leaves deeper questions unexamined. Why do these patterns emerge? What do they reveal about the actual of AI versus promised educational value? How should institutions and policymakers respond?

6. FROM EMPIRICAL PATTERNS TO EDUCATIONAL POLICY

The empirical patterns validate the capacity of AI to enhance engagement when supported by adequate training infrastructure, though this validation comes with caveats. Engagement increased: students spent more time with platforms, interacted more frequently with content, and achieved higher assessment scores. Whether this engagement translates to deeper understanding or merely greater activity remains uncertain. Conceptual complexity demands human interpretation that algorithms cannot yet provide.

Structural and ethical challenges emerged prominently. Institutional resistance to change, particularly in under-resourced environments, limited the effectiveness of even well-designed interventions. Operational risks included the constant risk of cyberattacks on financial and educational institutions that compromise user data. Pedagogical tensions became evident as excessive automation reduced teacher-student interactions. Furthermore, only 12% of the economics faculty at UNAM are trained to critically integrate tools like generative models (UNAM, 2023), highlighting the need for continuous teacher training.

While AI democratizes advanced resources such as simulations with real data, financial platforms replicate biases, highlighting ethical challenges. Machine learning models improve financial predictions, though the need for supervision in the face of uncertainty is emphasized. The theoretical implications reveal limits of rationality and algorithmic uncertainty, where behavioral economics perspective challenges assumptions underlying AI applications in finance education. While machine learning models outperform traditional methods in currency crisis prediction (Bluwstein et al., 2020), their 23% effectiveness decrease without human judgment during volatility (Mindell et al., 2022) reveals limitations. The 2010 Flash Crash exemplifies how algorithms amplify market instability under radical uncertainty conditions (Kay & King, 2020).

The implications for educational policy derive from the diffusion of innovations model of Rogers (2003), where institutional adoption of educational AI follows predictable patterns influenced by relative advantage, compatibility, complexity, trialability, and observability. As demonstrated in the findings, early adopter institutions with higher ICT investment and specialized staff facilitate AI diffusion. To accelerate diffusion in late majority institutions, specific incentives are required: targeted infrastructure funding, intensive 40 academic-hour training programs, and creation of inter-institutional communities of practice following the model of Wenger (1998). This gradual strategy has shown effectiveness in similar contexts, such as the Digital Education Revolution program in Australia, which achieved 89% institutional adoption in 5 years (Department of Education, 2021).

Based on the findings, strategic implementation pathways are proposed that combine hybrid pedagogy by combining adaptive AI with human tutoring, ethical governance through developing regulatory frameworks with algorithmic transparency to mitigate biases and protect sensitive data, technological inclusion by prioritizing projects that provide connectivity, access to devices, and teacher training, and global collaboration that promotes partnerships between academia, industry, and governments.

7. CONCLUSIONS

This research demonstrates the dual character of AI in economic and financial education. Technology enhances pedagogical effectiveness when implemented thoughtfully, supported by training infrastructure, and balanced with human instruction. Yet enhancement falls short of transformation. The persistent need for human interpretation, the ethical complications of algorithmic bias, the infrastructure inequities that limit access, these realities temper optimistic narratives about educational revolution through technology.

Several limitations constrain these conclusions. The cross-sectional design prevents causal claims about AI effectiveness. Measuring engagement rather than learning outcomes leaves fundamental questions about skill development unresolved. Does increased platform time indicate deeper comprehension or merely prolonged activity? The urban concentration sample limits generalization to rural institutions operating under different resource constraints. Cost-benefit analysis remains absent; whether educational in AI gains justify implementation expenses cannot be determined from this evidence alone. These gaps suggest directions for subsequent investigation rather than fatal flaws in current findings.

Longitudinal studies are required to evaluate medium-term impacts that measure not only statistical accuracy but also effects on critical thinking. This responds to the call for creating sustainable and inclusive educational ecosystems, where AI enhances rather than replaces human capabilities. The responsible implementation of AI in education is not merely a technical challenge but a social one. We emphasize that its success depends on prioritizing equity, ethics, and global collaboration, ensuring that technology serves as a bridge rather than a barrier to a more just and digitally competent society.

REFERENCES

- Ahmad, M., Karim, A. A., Din, R., & Albakri, I. S. M. A. (2013). Assessing ICT competencies among postgraduate students based on the 21st century ICT competency model. *Asian Social Science*, 9(16), 32-39. <https://doi.org/10.5539/ass.v9n16p32>
- ANUIES. (2023). *Estado actual de las tecnologías de la información y las comunicaciones en las instituciones de educación superior en México: Estudio 2023* [Current state of information and communication technologies in higher education institutions in Mexico: 2023 study]. Asociación Nacional de Universidades e Instituciones de Educación Superior en México. https://publicaciones-tic.anui.es.mx/descargas/2023/libros/Estado_Actual_Tecnologias_2023.pdf
- Baker, R. S., Martin, T., & Rossi, L. M. (2016). Educational data mining and learning analytics. In A. A. Rupp & J. P. Leighton (Eds.), *The handbook of cognition and assessment: Frameworks, methodologies, and applications* (pp. 253-272). Wiley. <https://doi.org/10.1002/9781118956588.ch16>
- Barocas, S., Hardt, M., & Narayanan, A. (2023). *Fairness and machine learning: Limitations and opportunities*. MIT Press.
- Bluwstein, K., Buckmann, M., Joseph, A., Kang, M., Kapadia, S., & Simsek, Ö. (2020). *Credit growth, the yield curve and financial crisis prediction: Evidence from a machine learning approach* (Bank of England Staff Working Paper No. 848). Bank of England. <https://www.bankofengland.co.uk/working-paper/2020/credit-growth-the-yield-curve-and-financial-crisis-prediction-evidence-from-a-machine-learning>
- Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *IEEE Access*, 8, 75264-75278. <https://doi.org/10.1109/ACCESS.2020.2988510>
- Creswell, J. W., & Plano Clark, V. L. (2017). *Designing and conducting mixed methods research* (3rd ed.). SAGE Publications.
- Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science*, 35(8), 982-1003. <https://doi.org/10.1287/mnsc.35.8.982>
- Department of Education, Skills and Employment. (2021). *Digital education revolution: Final evaluation report*. Australian Government.
- Dwork, C., & Roth, A. (2014). The algorithmic foundations of differential privacy. *Foundations and Trends in Theoretical Computer Science*, 9(3-4), 211-407. <https://doi.org/10.1561/04000000042>
- Hardt, M., Price, E., & Srebro, N. (2016). Equality of opportunity in supervised learning. *Advances in Neural Information Processing Systems*, 29, 3323-3331.
- Hens, T., & Rieger, M. O. (2016). *Financial economics: A concise introduction to classical and behavioral finance* (2nd ed.). Springer. <https://doi.org/10.1007/978-3-662-49688-6>
- Hernández, R. V. R., Rentería, J. L. M., & Cervantes, G. O. (2023). La educación financiera de los estudiantes universitarios de contaduría pública: Un estudio de caso [Financial education of public accounting university students: A case study]. *Ciencia Latina Revista Científica Multidisciplinar*, 7(6), 1330-1343. https://doi.org/10.37811/cl_rcm.v7i6.8769
- Howard-Jones, P., Holmes, W., Demetriou, S., Jones, C., Tanimoto, E., Morgan, O., & Davies, N. (2014). Neuroeducational research in the design and use of a learning technology. *Learning, Media and Technology*, 40(2), 1-20. <https://doi.org/10.1080/17439884.2014.943237>
- IBM Security. (2022). *Reporte anual de amenazas cibernéticas en educación* [Annual report on cybersecurity threats in education]. IBM Corporation. <https://latam.newsroom.ibm.com/2022-02-23-Reporte-IBM-ransomware-persistio-como-el-tipo-mas-comun-de-ataque-en-America-Latina-en-2021>
- INEGI. (2020). *Encuesta nacional de ingresos y gastos de los hogares 2020* [National survey of household income and expenditure 2020]. Instituto Nacional de Estadística y Geografía. https://www.inegi.org.mx/contenidos/productos/prod_serv/contenidos/espanol/bvinegi/productos/nueva_estruc/889463918189.pdf

- Kasneci, E., Seßler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günnemann, S., Hüllermeier, E., Krusche, S., Kutyniok, G., Michaeli, T., Nerdel, C., Pfeffer, J., Poquet, O., Sailer, M., Schmidt, A., Seidel, T., ... Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences*, 103, Article 102274. <https://doi.org/10.1016/j.lindif.2023.102274>
- Kay, J., & King, M. (2020). *Radical uncertainty: Decision-making beyond the numbers*. W. W. Norton & Company.
- Koedinger, K. R., Corbett, A. T., & Perfetti, C. (2012). The knowledge-learning-instruction framework: Bridging the science-practice chasm to enhance robust student learning. *Cognitive Science*, 36(5), 757-798. <https://doi.org/10.1111/j.1551-6709.2012.01245.x>
- Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice Hall.
- Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 33(1), 159-174. <https://doi.org/10.2307/2529310>
- Lara Serna, L., Sosa Morales, E., Lara Menéndez, A., & Hernández González, D. F. (2024). Educación financiera en universidades mexicanas: Desafíos y oportunidades de mejora a través de la tecnología [Financial education in Mexican universities: Challenges and opportunities for improvement through technology]. *Ciencia Latina Revista Científica Multidisciplinar*, 8(3), 10973-10991. https://doi.org/10.37811/cl_rcm.v8i3.12253
- Majjate, H., Bellarhmouch, Y., Jeghal, A., Yahyaouy, A., Tairi, H., & Zidani, K. A. (2024). AI-powered academic guidance and counseling system based on student profile and interests. *Applied System Innovation*, 7(1), Article 6. <https://doi.org/10.3390/asi7010006>
- Meese, R. A., & Rogoff, K. (1983). Empirical exchange rate models of the seventies: Do they fit out of sample? *Journal of International Economics*, 14(1-2), 3-24. [https://doi.org/10.1016/0022-1996\(83\)90017-X](https://doi.org/10.1016/0022-1996(83)90017-X)
- Mindell, D. A., Autor, D. H., & Reynolds, E. B. (2022). *The work of the future: Building better jobs in an age of intelligent machines*. MIT Press. <https://doi.org/10.7551/mitpress/14109.001.0001>
- Miranda-Agrippino, S., & Rey, H. (2020). U.S. monetary policy and the global financial cycle. *The Review of Economic Studies*, 87(6), 2754-2776. <https://doi.org/10.1093/restud/rdaa019>
- Moloi, T., & Marwala, T. (2020). *Artificial intelligence in economics and finance theories*. Springer. <https://doi.org/10.1007/978-3-030-42962-1>
- Noble, S. U. (2018). *Algorithms of oppression: How search engines reinforce racism*. New York University Press.
- Pask, G. (1976). *Conversation theory: Applications in education and epistemology*. Elsevier.
- Rey, H. (2015). *Dilemma not trilemma: The global financial cycle and monetary policy independence* (NBER Working Paper No. 21162). National Bureau of Economic Research. <https://doi.org/10.3386/w21162>
- Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.
- Samuelson, P. A. (1947). Some implications of "linearity". *The Review of Economic Studies*, 15(2), 88-90. <https://doi.org/10.2307/2295997>
- Sermpinis, G., Stasinakis, C., Theofilatos, K., & Karathanasopoulos, A. (2015). Modeling, forecasting and trading the EUR exchange rates with hybrid rolling genetic algorithms—Support vector regression forecast combinations. *European Journal of Operational Research*, 247(3), 831-846. <https://doi.org/10.1016/j.ejor.2015.06.052>
- Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Houghton Mifflin Company.
- Shiller, R. (2025). *Mercados financieros* [Financial markets] [Curso en línea]. Coursera. <https://www.coursera.org/learn/financial-markets-global-es>
- Sung, Y. T., Chang, K. E., & Liu, T. C. (2016). The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis. *Computers & Education*, 94, 252-275. <https://doi.org/10.1016/j.compedu.2015.11.008>

- Tec Review. (2023). *Reporte anual de innovación tecnológica* [Annual report on technological innovation]. <https://tec.mx/sites/default/files/repositorio/Marketing/informe-anual/pdf/resumen-informe-2023-tec.pdf?srsltid=AfmBOoqy6Kb7ka2i5JdMBc5TQPihD6euUrtnih9yqtlVIGkZPX7xHWJI>
- Tetlock, P. E., & Gardner, D. (2015). *Superforecasting: The art and science of prediction*. Crown Publishers.
- UNAM. (2023). *Recomendaciones para el uso de inteligencia artificial generativa en la docencia* [Recommendations for the use of generative artificial intelligence in teaching]. Universidad Nacional Autónoma de México, Coordinación de Universidad Abierta, Innovación Educativa y Educación a Distancia. <https://cuaed.unam.mx/descargas/recomendaciones-uso-iagen-docencia-unam-2023.pdf>
- Vannini, N., Enz, S., Sapouna, M., Wolke, D., Watson, S., Woods, S., Dautenhahn, K., Hall, L., Paiva, A., Andre, E., Aylett, R., & Schneider, W. (2011). "FearNot!": A computer-based anti-bullying programme designed to foster peer intervention. *European Journal of Psychology of Education*, 26(1), 21-44. <https://doi.org/10.1007/s10212-010-0035-4>
- Vázquez Pita, E. (2021). La UNESCO y la gobernanza de la inteligencia artificial en un mundo globalizado [UNESCO and the governance of artificial intelligence in a globalized world]. *Anuario de la Facultad de Derecho de la Universidad de Extremadura*, 37, 273-302. <https://doi.org/10.17398/2695-7728.37.273>
- Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision Sciences*, 39(2), 273-315. <https://doi.org/10.1111/j.1540-5915.2008.00192.x>
- Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge University Press.

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Chapter # 4

PRECARIOUS PROSPERITY: RETHINKING FINANCIAL DEPENDENCE ON INTERNATIONAL STUDENTS IN CANADIAN HIGHER EDUCATION

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ABSTRACT

This paper examines the growing financial dependence of Canadian universities on international student tuition and the risks associated with this funding model. Applying Resource Dependence Theory, the study explores how institutional reliance on unregulated international tuition revenue has made universities vulnerable to external shocks, including recent federal policy changes limiting study permits. The analysis highlights three core issues: financial instability, ethical concerns around the commodification of education, and reputational risks in global academic markets. It also underscores the consequences of decentralized governance and declining public investment in higher education. Drawing on international comparisons, the paper outlines a range of policy and institutional strategies to promote financial sustainability, including revenue diversification, public-private partnerships, research commercialization, and tax-based grant models. This review calls for a coordinated and ethically grounded funding approach to safeguard academic quality and ensure the long-term resilience of Canada's post-secondary sector.

Keywords: Canadian higher education, international students in Canada, international student tuition, financial sustainability, higher education policy, revenue diversification.

1. INTRODUCTION

Higher education institutions around the world rely on various funding sources to sustain their operations. Canadian universities are funded through “a combination of provincial funding, tuition fees, scholarships, bursaries, loans, endowments and private-sector support” (Christy, 2013, p. 5). Declining public funding has forced Canadian universities to seek alternative revenue sources, and increasing revenue from international student tuition fees has become a dominant feature of this strategy (Heringer, 2020). Canada is not alone in this respect. Revenues derived from international student enrollment are a major source of revenue for the operation of many universities in OECD countries (Cantwell, 2015; Whatley & Castiello-Gutiérrez, 2022).

In Canada, universities charge three to four times more for international student tuition fees than for their domestic student counterparts (Heringer, 2020; Statistics Canada, 2021). In recent years, revenue from international tuition has become a central component of institutional budgets in Canada, as declining public funding has pushed universities to rely more heavily on this income stream (Howe et al., 2023). In 2006-07, the federal government launched the "Imagine Education au/in Canada" branding campaign to elevate Canada's global education profile (Trilokekar, 2013, p. 4). The initiative proved successful, with Canadian institutions participating in over 170 promotional events across 60 countries by 2012, contributing to a 51% increase in international student enrollment (Bozheva, 2020).

Between 2000 and 2011, international student enrollments at colleges and universities grew by over 99%, while university undergraduate international student enrollments grew by 167% during this period (Anderson, 2015; Heringer, 2020). While this financial model benefited institutions for several years, it also raised questions about over-dependence on international student tuition fee revenue, financial volatility, and ethical concerns regarding the exploitation of international students and furthering the commodification of education (Cantwell, 2015; Heringer, 2020; Hune-Brown, 2021; Kirby, 2024; McGinn, 2022).

In 2024, the Canadian federal government announced new immigration policies intended to cap the annual issuance of international student visas (Immigration, Refugees and Citizenship Canada, 2024; Torres-Arends & Jacobsen, 2024). As a result of the budgetary risks triggered by these changes, Canadian colleges and universities responded with austerity measures including reductions in staff, programs, and student services (Baxter, 2025; Rana, 2024; Talati, 2025).

The purpose of this review is to explore how Canadian universities are impacted by fluctuations in international student enrollments. This review applies Resource Dependence Theory to examine how Canadian universities are affected by fluctuations in international student enrollment (Fowles, 2014; Schmidt, 2020). More specifically, in what follows this paper explores: (a) universities' reliance on international tuition revenue, (b) risks and challenges associated with this financial model, and (c) potential strategies to attract and retain international students while building a more sustainable financial model.

2. BACKGROUND AND CONTEXT HIGHER EDUCATION FUNDING SHIFTS

Canadian higher education was once primarily funded through robust public investments, but declining public funding has forced institutions to seek alternative revenue sources (Anderson, 2015). In many cases, this has been compounded by a declining domestic student population that colleges and universities rely on. Deering and Sá (2014) highlight that the reduction in government support led to tuition increases and greater financial dependence on international student enrollment. This trend aligns with patterns of public funding and student enrollment in other Western countries (Weber et al., 2023). For example, Marginson's (2018) research on international student recruitment at universities in the United Kingdom draws parallels to trends of financial dependence in Canada. Marginson notes that universities in the United Kingdom similarly rely on non-European Union international student enrollment, a population that generated 12.7% of revenue for UK higher education institutions in 2013-14.

Marginson also highlights that there are increasing budgetary pressures on institutions as the UK government attempts to reduce immigration and migration.

Canada's decentralized education system has further compounded this issue. Unlike many countries, Canada lacks a national department of education, with education falling under provincial jurisdiction as established by Section 93 of the 1867 British North America Act (Arfaie et al., 2022). This decentralized structure, while allowing provinces to tailor policies to their specific needs, has led to policy and funding inconsistencies across the country (Waddington, 2018). As public funding has declined, colleges and universities have increasingly turned to international student tuition as a key revenue source. While domestic tuition is frequently regulated and capped, international tuition remains largely unregulated. Consequently, in 2021-22, the average tuition for international undergraduate students in Canada was \$33,623, compared to just \$6,693 for domestic students (Statistics Canada, 2021). This gap between tuition fee levels highlights the growth of financial dependence on

recruiting international students. Heringer (2020) adds that this tuition-based financial model creates vulnerabilities for Canadian universities, especially when economic or policy shifts affect student enrollment. The potential for volatility in institutional finances is illustrated by the fact that, while tuition fee frameworks are set at the provincial government level, the number of study permits issued to international students annually is determined by the federal government.

2.1. Resource Dependence Theory

Resource Dependence Theory (RDT) views organizations as open systems that depend on external actors to gain resources, making them vulnerable to uncertainty and power imbalances (Celtekliligil, 2020). Since most organizations cannot meet their needs alone, they form relationships to access scarce resources. Heavy reliance on a single revenue source increases external control and limits autonomy. In higher education, RDT has been used to examine how declining public funding pushes universities to diversify income, which shapes their behaviour and strategic decisions (Mohd Said et al., 2023). Research from Kholmuminov et al. (2019) shows that when universities grow more dependent on tuition revenues, their expenditure decisions and priorities increasingly align with that revenue source. Now that we have established how institution's structure some of their financial needs around international enrollment levels, RDT can be applied to explain this financial dependency. With international tuition becoming a primary revenue stream, universities have increasingly adapted their financial and operational strategies to align with external funding conditions. RDT provides a useful framework to analyze this financial transformation. According to Fowles (2014), institutions that are reliant on external resources must continually adjust to ensure long-term sustainability.

Schmidt (2020) applies this theory to higher education institutions, arguing that financial dependence on tuition fee revenues can shape institutional priorities, sometimes at the expense of academic program quality. Bound et al. (2020) found that many universities in the United States that rely heavily on tuition fee revenue tend to allocate resources toward enhancing the student experience. This strategy ensures enrollment stability and maintains competitiveness in the global education market. Similar trends can be observed in the Canadian context. However, this reliance also creates risks, particularly when there are policy changes, geopolitical events, economic downturns, or other external crises such as the COVID-19 global pandemic, which can significantly impact student mobility and enrollment levels.

While RDT helps to explain why Canadian universities have structured their finances around international student enrollment levels, it is evident that this dependency comes with significant risks. Over-reliance on international tuition creates financial vulnerabilities, especially in the wake of policy shifts such as the federal government's 2024 study permit cap (Immigration, Refugees and Citizenship Canada, 2024; Mallapaty, 2024). Additionally, the prioritization of revenue from international students raises ethical concerns, as universities are increasingly seen as furthering the commercialization of higher education, potentially to the detriment of academic integrity (Cantwell, 2015; Hune-Brown, 2021; Weber et al., 2023). These issues will be explored in the next section, which examines both the financial and reputational risks of tuition dependency.

2.2. Risks of Dependence on International Student Fees Financial Risks of Over-Reliance

The financial model that prioritizes international tuition over stable government funding can create significant risks for Canadian universities. As noted, international tuition remains largely unregulated, allowing institutions to charge significantly higher fees to students who choose to study abroad in Canada (Weber et al., 2023). However, this financial reliance introduces vulnerabilities, particularly when external factors such as government policies or unforeseen events affect international student mobility and enrollment.

2.2.1. Declining International Enrollment

Recent policy shifts in Canada, such as the federal government's 2024 cap on study permits, have raised significant concerns for universities (Immigration, Refugees and Citizenship Canada, 2024; Mallapaty, 2024; Torres-Arends & Jacobsen, 2024). The cap is projected to reduce international student permits by at least 10%, limiting new student enrollments and disrupting the financial planning and budgets of many colleges and universities (Mallapaty, 2024). Early media reports already indicate substantial declines in enrollment (Baxter, 2025; Talati, 2025). For example, the University of Regina in the province of Saskatchewan has reported an enrollment decline of more than 50% amongst newly admitted international students as compared to January 2024 (Talati, 2025). Centennial College in Ontario has reduced its program offerings by 28%—a reduction of 49 programs—after a reported loss of nearly 5,000 new international students (Carter, 2025). The Council of Ontario Universities has projected losses of \$330 million in 2025, with an expected deficit of \$600 million in the following fiscal year (Baxter, 2025). The president of Universities Canada, an umbrella organization representing most of Canada's degree-granting institutions, has said that “The drop in international students is like an earthquake hitting an education system that's already structurally weakened by years of underinvestment” (Scace & Alhmidi, 2025, para. 2).

While there are limited peer-reviewed sources on the experiences of Canadian universities facing this crisis, media reports show that further research is needed to assess the extent of the international student study permit cap's financial impacts on institutional sustainability in Canada. Reported declines in new international student enrollments align with prior research on how policy changes impact international student mobility. Whatley and Castiello-Gutiérrez (2021), for example, reported that restrictive U.S. immigration policies led to notable declines in international student admissions which significantly impacted those institutions most heavily reliant on tuition fee revenue. Similarly, Sin et al. (2023) found that COVID-19-related travel restrictions reduced international student numbers in major destination countries, thus placing a downward pressure on institutional budgets. Given these precedents, Canada's study permit policy shift poses a significant financial risk to colleges and universities that depend on international student enrollments.

2.2.2. Economic Fluctuations and Market Sensitivity

Beyond policy-related risks, reliance on international tuition revenue exposes colleges and universities to economic vulnerabilities arising from unforeseen events such as geopolitical instability, global conflicts, economic recessions, and public health crises. Historically, economic recessions have led to declines in international student mobility, as seen during the 2008 financial crisis (Bound et al., 2020). Moreover, currency fluctuations can make studying in Canada prohibitively expensive for students from developing economies, further destabilizing enrollment numbers (Weber et al., 2023).

2.3. Ethical and Reputational Risks in Internationalization

2.3.1. Commercialization of Higher Education

In addition to financial vulnerabilities, universities face ethical concerns regarding the commodification of education. Scholars such as Cantwell (2015) and Weber et al. (2023) argue that framing international students as financial assets rather than academic contributors creates an ethical dilemma. Heringer (2020) highlights that many institutions market aggressively to international students without adequately supporting their academic and social integration, leading to concerns about exploitation. For instance, Legusov et al. (2023) point out that some Canadian colleges have established campuses solely for international students, which limits their chances to mix with local students and adjust to the culture. Hune-Brown (2021) reported that many international students in Canada “say they’re being used as cash cows” (The Schools section, para. 7) and that “the entire system in Canada is built around the false premise that education, not work and immigration, is the primary aim for most students” (The Agents section, para. 15).

Bitschnau (2023) drew parallels between Canada and the United Kingdom, where international students are also charged substantially higher tuition fees and are sometimes viewed as economic burdens rather than valued members of academic communities. Echoing Hune-Brown’s observation, Su and Harrison (2016) similarly argued that international students are often treated as “cash cows”, particularly those attending the more financially strained institutions. Such a perspective risks undermining the reputation of Canadian colleges and universities, particularly as international students increasingly prioritize destinations where they are valued as integral members of academic and cultural communities rather than being regarded primarily as sources of revenue.

2.3.2. Educational Quality and Long-Term Sustainability

Over-reliance on tuition revenue may lead colleges and universities to prioritize the financial gain from student fees over educational quality and student academic experiences. Budget constraints and reduced funding can result in hiring freezes, increased use of precarious, short-term contract faculty, larger class sizes, and reduced student services (Deering & Sá, 2014). Cost-cutting measures such as these may diminish the quality of education, affecting student satisfaction and institutional rankings (Bound et al., 2020). A decline in perceived institutional prestige may deter prospective student applicants, contributing to reduced enrollment. Considering the recent cap on study permits for international students, institutions that do not diversify their revenue streams risk compromising academic quality—further jeopardizing their reputations and long-term viability.

2.4. Alternative Strategies for Financial Sustainability in Higher Education

As Canadian colleges and universities face increasing financial pressures due to capped international student enrollments, declining domestic student enrollments, and insufficient public funding, alternative revenue strategies must be considered. Other countries have implemented financial measures to ensure institutional stability and long-term sustainability. These range from enhanced public funding to entrepreneurial initiatives and private-sector collaborations. While post-secondary education in Canada is overseen at the provincial level, the federal government has historically influenced vocational and higher education through indirect funding mechanisms such as student loan programs, research funding, and infrastructure development programs (Arfaie et al., 2022). Hence, there are potential avenues for national-level financial support from government in addition to private sector investment and partnership.

2.5. Diversifying Revenue Beyond International Tuition

To reduce institutional financial reliance on international student tuition revenue, colleges and universities could diversify their income streams by adjusting domestic tuition frameworks, securing additional government funding beyond base operating grants, and exploring alternative financial mechanisms. Nik Ahmad et al. (2019) highlight that many universities have successfully expanded their revenue sources through increased reliance on alumni contributions and endowments, research commercialization initiatives, and private-sector partnerships.

Lessons can be taken from other countries around the world. For instance, Kim and Park (2018) explain that the South Korean government has implemented specialized grants to assist with different expenses related to higher education. These grants can be categorized into different types of purposes, such as operating expenses for public institutions, student scholarships, and funding programs for specific purposes. The government has been using these specialized grants to incentivize universities to innovate and improve their educational offerings, often through competitive application processes that evaluate institutions and funding outcomes based on their performance and labour market needs (Kim & Park, 2018). In the UK, Marginson (2018) notes that universities rely on income-contingent loans (ICL), where student financial aid repayments are linked to post-graduation earnings. An ICL is a debt instrument where repayments are based on the debtor's income after graduation, differing from standard loans which mandate fixed repayment terms (Larkin & Corbet, 2021). Marginson points out that ICLs have provided additional institutional income and reduced financial challenges. However, Larkin and Corbet (2021) caution that while ICLs may contribute to inequities amongst graduates by linking repayments to earnings; for example, ICLs may result in higher student loan debts in some instances, disproportionately affecting low-income graduates and/or graduates in fields with lower annual earnings. Elsewhere, in the U.S., Fowles (2014) highlights that institutions have sought to expand the revenues they derive from alumni donations and other philanthropic sources to replace losses in public funding.

2.6. Public and Private Partnerships

While not common among Canadian public universities, collaboration with the private sector can provide universities with new funding opportunities. Deering and Sá (2014) suggest that Canadian institutions could benefit from expanding partnerships with industry, particularly in applied areas such as technology, engineering, and other research-driven sectors. Such partnerships may generate financial resources while also enhancing avenues for student employment during and after graduation. One shortcoming of this approach is that such increasing reliance on private or corporate funding sources may be regarded as a form of tacit privatization and a further diminution of the status of public higher education institutions.

Higher education institutions in other countries provide useful examples of approaches to implementing public-private partnerships. Jacob et al. (2018) observes that in several Asian countries, such as China and Taiwan, universities generate revenue through external funding sources. In some instances, for example, universities in these jurisdictions embarked on entrepreneurial activities such as the establishment of branch campuses in other countries. A number of Canadian universities have explored this option, establishing international branch campuses in countries such as Kuwait, Qatar, and Shanghai, and further expansion in this area may prove to be highly beneficial at a time when the federal government has capped the number of incoming international students (Jing, 2022; Kinser, 2011). Moreover, in China, Japan, and other countries in Southeast Asia, some institutions have built strong ties

through university industry collaborations, particularly in the areas of corporate-funded research, technology transfer, research commercialization, and patent monetization (Huang, 2018; Jacob et al., 2018). Similarly, Nik Ahmad et al. (2019) point to several higher education institutions in Australia and Malaysia which engage in research-focused joint ventures with the private sector and corporations to secure funding for the development of research centres and innovation hubs.

Canadian universities have long engaged in forms of research commercialization (Colletet & Gingras, 2022). Likewise, the more vocationally oriented community college sector has also pursued entrepreneurial activities and nurtured ties with business and industry (Knowles, 1995). In the current environment where funding from the government of Canada towards post-secondary institutions has been reduced, Canadian universities face increasing pressure to gravitate towards entrepreneurial revenue strategies as part of their sustainability efforts (Howe et al., 2023; Usher & Balfour, 2024). Within this context, expanding research initiatives and externally supported projects may offer Canadian institutions additional avenue to offset funding constraints.

2.7. Policy-Driven Solutions

Government interventions and policy adjustments can also play a significant role in stabilizing college and university finances. For example, the Australian government supports university funding through the Australian Strategy for International Education (ASIE) 2021–2030 (Fenton-Smith & Gurney, 2025). This strategy highlights the economic impact of international education initiatives, including student recruitment, which contributed \$40.3 billion to the economy and supported around 250,000 jobs in the country prior to the COVID-19 pandemic. To ensure long-term sustainability, the ASIE advocates for the recruitment of a more diverse pool of international students, with the government working with universities to achieve this balance. If adapted for Canada, federal and provincial governments could, for example, assist colleges and universities with student recruitment and retention initiatives to help enable institutions to remain financially sustainable despite fluctuations in the fee revenues derived from international student enrollment.

A different mechanism, proposed by Kim and Park (2018), in the South Korean context constitutes both tax-based and grant-based funding. Kim and Park explore the potential of introducing a dedicated higher education tax to provide institutions with a more stable source of public funding and reduce the financial instability caused by inconsistencies in government funding allocations. Such a tax would ensure that a more predictable portion of public revenue is directed toward funding higher education institutions. Additionally, dedicated tax-financed higher education grants would be a way to better formalize government's responsibility in funding colleges and universities. By securing a fixed portion of tax revenue for higher education, these grants would help stabilize university budgets and improve the overall quality of education by ensuring predictable and consistent financial support. This measure could be implemented in Canada at the provincial or federal levels or both because, while the provinces have authority over education, the federal government has a constitutional responsibility for the economy. The latter is why the federal government already funds some aspects of post-secondary education (e.g., student financial aid, research funding, etc.).

3. DISCUSSION

This review highlights three key insights regarding the financial implications of international student enrollment for the Canadian post-secondary sector. First, the current funding approach reveals an underlying instability, as institutions have become increasingly dependent on international tuition revenue. This reliance is unsustainable and places colleges and universities in a vulnerable position, exposing them to external disruptions and limiting their ability to maintain consistent academic priorities.

Second, there is a pressing need for colleges and universities to diversify their sources of funding. Lessons from international examples suggest that a broader mix of financial strategies—such as public grants, tax-based funding models, industry partnerships, and commercialization of research—could provide more stable and resilient income streams. However, structural challenges, including Canada’s decentralized approach to higher education governance (i.e., provincial jurisdiction), make the implementation of nationwide financial reforms particularly complex.

Third, ethical concerns arise from the growing perception of international students as revenue sources rather than integral members of academic and cultural communities. This commodification of education undermines the principles of internationalization and poses reputational risks for Canadian institutions. Treating students primarily as financial assets not only contradicts the values of inclusion and global engagement but also jeopardizes Canada’s standing as a welcoming destination for international learners.

This review contributes to the existing literature by applying Resource Dependence Theory to the financial dynamics of Canadian higher education. The Canadian context has received comparatively limited research despite its rapid shift toward international tuition dependence. While other countries such as the U.S., U.K., and several in Asia have been studied for similar vulnerabilities, Canada presents a distinct case marked by decentralized governance, unregulated international tuition, and long-term public underfunding. This paper is uniquely positioned by bringing together recent Canadian enrollment trends and international comparisons.

Considering these findings, several forward-looking recommendations emerge. To begin with, colleges and universities should diversify revenue sources by expanding alumni contributions, philanthropic partnerships, and research commercialization initiatives, which are approaches already used successfully in countries such as Malaysia and Australia. Next, colleges and universities could pursue public–private partnerships in high-demand sectors, drawing on examples from Japan, Taiwan, and Southeast Asia where industry collaboration has supported both research capacity and institutional revenues. Moreover, expanding entrepreneurial ventures such as international branch campuses and research commercialization could help generate alternative income. Finally, a more centralized and coordinated national approach to post-secondary education funding may be necessary to promote long-term sustainability and equity across institutions. Federal and provincial coordination on international student recruitment and retention would help reduce volatility resulting from sudden policy shifts, while maintaining Canada’s global competitiveness.

4. CONCLUSION

In the current era of fiscal uncertainty and declining public investment, Canadian colleges and universities have become increasingly reliant on international student tuition to maintain financial viability. While this strategy has temporarily bolstered institutional revenues, it has also introduced substantial risks—ranging from policy-induced enrollment

fluctuations to ethical concerns regarding the commodification of education. The federal government's recent cap on international study permits has underscored the fragility of this model, exposing systemic vulnerabilities that threaten academic quality, institutional stability, and Canada's reputation as one of the top receiving countries for international students.

To address these challenges, a shift toward a more diversified and sustainable funding framework is essential. Drawing on international examples, Canadian institutions should consider expanding revenue sources beyond international tuition through well-established alternatives such as public and private partnerships, research commercialization, and predictable and dedicated funding mechanisms. Additionally, a coordinated national policy approach—balancing provincial autonomy with federal economic stewardship—may help safeguard the sector's long-term future. Without such reforms, Canadian higher education risks compromising both its academic mission and its international standing.

REFERENCES

- Arfaie, K., Mohammadi, A., & Soligo, R. (2022). Governance of higher education in Canada: A comparative analysis. *Higher Education Policy*, 35(1), 84-105.
- Baxter, D. (2025, January 18). International student cap sees universities facing 'across the board' cuts. *Global News*. <https://globalnews.ca/news/10966102/international-student-cap-university-impact>
- Bitschnau, M. (2023). Students or internationals? Divergent patterns of governing international student mobility in Germany and the United Kingdom. *Comparative Migration Studies*, 11(1), 24-18. <https://doi.org/10.1186/s40878-023-00332-5>
- Bound, J., Braga, B., Khanna, G., & Turner, S. (2020). A passage to America: University funding and international students. *American Economic Journal. Economic Policy*, 12(1), 97-126. <https://doi.org/10.1257/pol.20170620>
- Bozheva, A. M. (2020). From neoliberal to supra-neoliberal: Canadian education industry formation. *International Journal of Qualitative Studies in Education*, 33(5), 549-582. <https://doi.org/10.1080/09518398.2019.1693069>
- Cantwell, B. (2015). Are international students cash cows? Examining the relationship between new international undergraduate enrollments and institutional revenue at public colleges and universities in the US. *Journal of International Students*, 5(4), 512-525. <https://doi.org/10.32674/jis.v5i4.412>
- Carter, A. (2025, January 21). Centennial College suspending 49 programs as international enrollment declines. *CBC News*. <https://www.cbc.ca/news/canada/toronto/centennial-college-suspending-programs-1.7437250>
- Celtekligil, K. (2020). Resource dependence theory. In H. Dincer & S. Yüksel (Eds.). *Strategic outlook for innovative work behaviours: Interdisciplinary and multidimensional perspectives* (pp. 131-148). Cham: Springer International Publishing.
- Christy, R. D. (2013). Changes in Canadian post-secondary education: Rising costs and gender participation. *The International Journal of Humanities Education*, 10(2), 41-49. <https://doi.org/10.18848/2327-0063/CGP/v10i02/43775>
- Colleret, M., & Gingras, Y. (2022). Out of the ivory tower: The patenting activity of Canadian university professors before the 1980s. *Minerva*, 60(2), 281-300.
- Deering, D., & Sá, C. M. (2014). Financial management of Canadian universities: Adaptive strategies to fiscal constraints. *Tertiary Education and Management*, 20(3), 207-224. <https://doi.org/10.1080/13583883.2014.919604>
- Fenton-Smith, B., & Gurney, L. (2025). A critical policy analysis of the Australian strategy for international education 2021–2030. *Policy Futures in Education*, 23(1), 243-258. <https://doi.org/10.1177/14782103241256018>
- Fowles, J. (2014). Funding and focus: Resource dependence in public higher education. *Research in Higher Education*, 55(3), 272-287. <https://doi.org/10.1007/s11162-013-9311-x>

- Heringer, R. (2020). From enrollment rates to collaborative knowledge production: A critique to the internationalization of higher education in Canada. *Higher Education for the Future*, 7(2), 169-186. <https://doi.org/10.1177/2347631120930838>
- Howe, E. R., Ramirez, G., & Walton, P. (2023). Experiences of International Students at a Canadian University: Barriers and Supports. *Journal of Comparative and International Higher Education*, 15(2), 115-133.
- Huang, F. (2018). Higher education financing in Japan: Trends and challenges. *International Journal of Educational Development*, 58, 106-115. <https://doi.org/10.1016/j.ijedudev.2016.12.010>
- Hune-Brown, N. (2021). The shadowy business of international education. *The Walrus*. <https://thewalrus.ca/the-shadowy-business-of-international-education>
- Immigration, Refugees and Citizenship Canada. (2024, November 15). *New international student program regulations take effect*. <https://www.canada.ca/en/immigration-refugees-citizenship/news/2024/11/new-international-student-program-regulations-take-effect.html>
- Jacob, W. J., Neubauer, D., & Ye, H. (2018). Financing trends in Southeast Asia and Oceania: Meeting the demands of regional higher education growth. *International Journal of Educational Development*, 58, 47-63. <https://doi.org/10.1016/j.ijedudev.2016.11.001>
- Jing, X. (2022). *Global integration and local responsiveness in managing international branch campuses: An empirical investigation of three Canadian cases*. [Doctoral dissertation, McGill University].
- Kholmuminov, S., Kholmuminov, S., & Wright, R. E. (2019). Resource dependence theory analysis of higher education institutions in Uzbekistan. *Higher Education*, 77(1), 59-79.
- Kim, B., & Park, N. (2018). Lessons learned from financing universal higher education in Korea. *International Journal of Educational Development*, 58, 116-127. <https://doi.org/10.1016/j.ijedudev.2017.09.010>
- Kinser, K. (Ed.). (2011). *Multinational colleges and universities: Leading, governing, and managing international branch campuses*. *New Directions for Higher Education*. John Wiley & Sons.
- Kirby, D. (2024). Canadian universities in the pandemic: Differing policy responses to international and domestic student financial needs. *Journal of International Students*, 4(1), 347-365.
- Knowles, J. (1995). A matter of survival: Emerging entrepreneurship in community colleges in Canada. In J. D. Dennison (Ed), *Challenge and opportunity: Canada's community colleges at the crossroads* (pp. 184-207). University of British Columbia Press.
- Larkin, C., & Corbet, S. (2021). Generating stable university funding mechanisms: Income contingent loan structure choice within the Irish education system. *Journal of Education Finance*, 47(1), 92-110. <https://doi.org/10.1353/jef.2021.a806388>
- Legusov, O., Jafar, H., & Begin-Caouette, O. (2023). International students at Canadian colleges: Emerging trends. *Journal of International Students*, 13(3), 254-279. <https://doi.org/10.32674/jis.v13i3.5019>
- Marginson, S. (2018). Global trends in higher education financing: The United Kingdom. *International Journal of Educational Development*, 58, 26-36. <https://doi.org/10.1016/j.ijedudev.2017.03.008>
- Mallapaty, S. (2024). Limits on foreign students worry universities. *Nature*, 636(8041), 19-20. <https://doi.org/10.1038/d41586-024-03807-2>
- McGinn, S. (2022). The pandemic has exposed the need to better support international students. *University Affairs*. <https://www.universityaffairs.ca/news/news-article/the-pandemic-has-exposed-the-need-to-better-support-international-students>
- Nik Ahmad, N. N., Siraj, S. A., & Ismail, S. (2019). Revenue diversification in public higher learning institutions: An exploratory Malaysian study. *Journal of Applied Research in Higher Education*, 11(3), 379-397. <https://doi.org/10.1108/JARHE-04-2018-0057>
- Rana, U. (2024, January 25). *How international student caps could affect services at universities and colleges*. Global News. <https://globalnews.ca/news/10250089/international-student-cap-affect-services-universities-colleges/>
- Scace, M., & Alhmid, M. (2025, January 31). International study permit data an 'earthquake' for Canadian university finances. *The Globe and Mail*. <https://www.theglobeandmail.com/canada/article-international-study-permit-data-an-earthquake-for-canadian-university>

- Schmidt, A. (2020). Are international students getting a bang for their buck? The relationship between expenditures and international student graduation rates. *Journal of International Students*, 10(3), 646-663. <https://doi.org/10.32674/jis.v10i3.1279>
- Sin, C., Tavares, O., & Aguiar, J. (2023). COVID-19: Threat or opportunity for the Portuguese higher education's attractiveness for international students?. *Journal of Studies in International Education*, 27(1), 21-38. <https://doi.org/10.1177/10283153221121396>
- Statistics Canada. (2021). *Tuition fees for degree programs, 2021/2022*. Ottawa, ON. <https://www150.statcan.gc.ca/n1/daily-quotidien/210908/dq210908a-eng.htm>
- Su, M., & Harrison, L. M. (2016). Being wholesaled: An investigation of Chinese international students' higher education experiences. *Journal of International Students*, 6(4), 905-919. <https://doi.org/10.32674/jis.v6i4.325>
- Talati, S. (2025, February 18). *Sask. universities see significant drop in international student enrollments*. CBC News. <https://www.cbc.ca/news/canada/saskatchewan/sask-universities-international-students-1.7461157>
- Torres-Arends, I., & Jacobsen, M. (2024). "I am not complaining": Listening to international students' requests and complaints as expressions of diverse learning needs. *Journal of International Students*, 14(3), 385-407. <https://doi.org/10.32674/jis.v14i3.6298>
- Trilokekar, R. D. (2013). Imagine: Canada as a leader in international education. How can Canada benefit from the Australian experience? *Canadian Journal of Higher Education* (1975), 43(2), 1-26. <https://doi.org/10.47678/cjhe.v43i2.2103>
- Usher, A., & Balfour, J. (2024). *The state of postsecondary education in Canada: 2024*. <https://eduq.info/xmlui/handle/11515/39523>
- Waddington, D. (2018). Challenges of Canada's decentralized education system. *College Quarterly*, 21(2).
- Weber, T., van Mol, C., & Wolbers, M. H. J. (2024). International students as sources of income? Moving beyond the neoliberal framing of internationalization. *Journal of Studies in International Education*, 28(4), 526-545. <https://doi.org/10.1177/10283153231211999>
- Whatley, M., & Castiello-Gutiérrez, S. (2022). Balancing finances, politics, and public health: International student enrollment and reopening plans at US higher education institutions amid the COVID-19 pandemic. *Higher Education*, 84(2), 299-320. <https://doi.org/10.1007/s10734-021-00768-7>

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Chapter # 5

MASTERY, PARTICIPATION, AND MOTIVATION IN SECONDARY SCHOOL

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ABSTRACT

Mental health issues have been on the increase for years in Norway, and after the pandemic, school absence has been an increasing problem. To meet these challenges, several national initiatives have been launched. The current study will present experiences from a health promoting project called SAMM – A systematic approach to mastery, participation, and motivation, where a five-step method has been applied. A quasi-experimental study with test and control groups was carried out, including an intervention of four sessions spread over about a month, and repeated throughout the school year. Seven upper secondary school classes were included as test groups, resulting in 132 student participants. Five control groups were included, resulting in 132 control students. Finding an appropriate scale to measure the effects of the intervention proved challenging. The General Self-Efficacy Scale was used despite a rather limited focus. An ANOVA-analysis has been carried out, showing no significant difference between test and control groups over time. However, the approach in the intervention relates to several aspects of health promotion, and a more extensive scale would perhaps have been more adequate to measure possible effects.

Keywords: health promotion, mastery, participation, motivation, secondary school.

1. INTRODUCTION

Mental health issues have been on the increase for years in Norway (Reneflot et al., 2018), and school absence has been an increasing problem (Alver, 2020). Some of the problems students report concern lack of motivation, pressure, varying degrees of anxiety, high drop-out, loneliness, and increased degree of bullying (Bakken, 2024; Enstad & Bakken, 2022; Parlikar et al., 2023). As much as 10 % of the students drop out of upper secondary school (SSB, n. d., table 12971), and the number is highest for boys in vocational studies, with 19 % dropping out. There is a significant need for implementation of measures to improve the situation and to support students in dealing with their struggles. To meet these challenges, several national initiatives have been launched. Renewed curricula emphasizing life mastery and public health have been implemented (The Norwegian Directorate of Education, 2017). In addition, various health promotion projects have been developed and executed in schools as part of a national public health programme (Helmersen & Stiberg-Jamt, 2019). The goal of implementing life mastery and health promotion as part of the teaching is to strengthen the students' robustness and their mental health and prevent school dropout and all the consequences that may follow. One of the challenges related to dropout is unemployment. Studies have shown correlations between employment and school results, and that disability benefits and financial social assistance are almost exclusively received by people who have not completed upper secondary school (Falch et al., 2009).

In general, young people most in need of being followed up in social systems have not completed upper secondary school, and they have a higher risk of getting drug problems and mental health issues (Furuberg & Myklebø, 2013). Costs related to social problems and benefits are high in Norway, and these costs are carried by society. This is some of the background for the recent initiatives in school, implementing life mastery and health promotion in education.

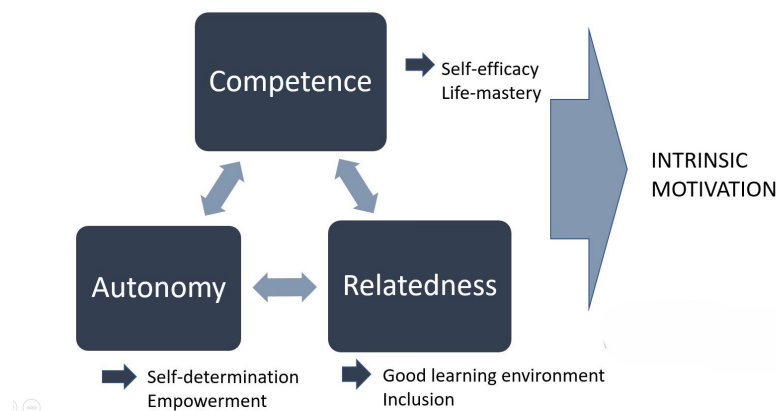
The current study presents an example of a health promoting initiative - a project called SAMM – A Systematic Approach to Mastery, Participation and Motivation, and investigates the potential of a five-step method developed in this project. The following research questions will be discussed: Can the five-step method support students to experience mastery, participation, and motivation? Does the approach support students' self-efficacy? How can possible effects of the five-step method be measured? To answer these questions, a quasi-experiment has been carried out, examples of students' reflections are given, and the results are discussed in relation to other studies from the SAMM-project, as well as the theoretical foundation of the method.

2. BACKGROUND

The five-step method in SAMM was developed in the context of upper secondary school to support students who struggled with requirements in school (Langeland & Horverak, 2021). The SAMM-project was part of a regional initiative in the south of Norway, called Health Promoting Kindergartens and Schools, which started in 2017, as one of several initiatives in a national public health programme. The method was transferred from upper secondary school and adjusted to lower secondary school, primary school and adult learning during the project period from 2017 to 2023. The current study includes data from the implementation in upper secondary school.

The approach builds on a combination of self-determination theory (Ryan & Deci, 2017) and health promotion theory (Antonovsky, 2012). According to Ryan and Deci's (2017) self-determination theory, intrinsic motivation is achieved when the basic needs of competence, autonomy, and relatedness are met (figure 1).

Figure 1.
Self-determination theory and intrinsic motivation.



Competence concerns mastery of tasks in everyday life, and this could be related to Bandura's (1997) theory on self-efficacy: If a person experiences mastery in one situation, the expectation to master again, or the self-efficacy, is strengthened. Autonomy concerns participating in making decisions and having agency, setting own goals, and working towards these (Ryan & Deci, 2017). Relatedness concerns having relations to others, which for example may be achieved by feeling included in a learning environment. The term "self-determination" implies the importance of autonomy for individuals, but according to Ryan and Deci (2017), autonomy is not enough - the needs for competence and relatedness must also be met to achieve intrinsic motivation.

The theory on intrinsic motivation has some parallels to health promotion theory, or more specifically, Antonovsky's (2012) salutogenic theory. According to Antonovsky, people who experience that they understand a situation, have resources to manage it, and find it meaningful to invest in doing something, achieve a strong sense of coherence (SOC), which makes them robust in dealing with stress. Both Antonovsky (2012) and Ryan and Deci (2017) are concerned with identifying competence, or resources to handle situations, having the possibility to influence one's own situation, and finding motivation and meaning. In the following, the different aspects of self-determination theory will be elaborated on in relation to studies on which the theory is based, followed by an explanation of Antonovsky's (2012) salutogenic theory.

2.1. Intrinsic Motivation and Self-Determination Theory

Intrinsic motivation concerns having a wish to do an activity, and the activity in itself is the goal or the reward (Ryan & Deci, 2017, p. 70). In contrast to this, extrinsic motivation concerns a wish to achieve something because of an act or behavior. To be intrinsically motivated means seeking new situations and challenges to explore and learn (Ryan & Deci, 2000). To do something based on one's own wish is also a typical example of autonomous behavior, as this implies being in control of one's own actions. Studies have shown that students who have teachers that facilitate autonomy in the learning situation experience increased intrinsic motivation, curiosity, and a desire for challenges (Deci et al., 1981; Flink et al., 1990; Ryan & Grolnick, 1986). A review of studies on language learning strategies shows that experiencing having control in one's own learning process influences students' motivation positively (Lamb, 2017).

Different nuances of motivation are defined in the frame of self-determination theory, from amotivation, via extrinsic motivation to intrinsic motivation (Ryan & Deci, 2000; 2017). Even though one may not be intrinsically motivated to do something, one may experience autonomous motivation. This means that the value of the action is appreciated, even though one may not wish to do the action itself. The more autonomously motivated an action is, the more likely it is that one may develop a wish to act. In a school context it is unlikely that students will be intrinsically motivated for all learning activities. Therefore, it is important that they have integrated the value of learning, and of participating in learning activities, so that they become active learners by setting goals, choosing strategies, and working towards achieving their learning goals.

The second basic need described by Ryan and Deci (2017), the need for competence, is not only met by experiencing mastery, but also by getting positive feedback from the surroundings, which again leads to intrinsic motivation (Boggiano & Ruble, 1979; Deci, 1971). As mentioned, Bandura's (1997) social cognitive theory also emphasizes motivation and the experience of mastery. However, in Bandura's (1977) theory on self-efficacy, mastery and motivation are related through the belief in one's own ability to master, leading to motivation to act in a new situation, while in self-determination theory, the needs for

competence, autonomy, and relatedness are the driving forces for intrinsic motivation (Ryan & Deci, 2017). The concepts are still related; if one believes one can master something, this could be argued to be the same as experiencing competence.

The third basic need presented by Ryan and Deci (2017), the need for relatedness, is related to studies showing that students who experience their teachers as warm and caring, show more intrinsic motivation than other students (Ryan & Grolnick, 1986; Ryan et al., 1994). Findings from studies concerning language learning, also confirm that a sense of belonging may lead to intrinsic motivation for students (Dörnyei, 2001; Chang, 2010; Koga, 2010). Experiencing acknowledgement and being included by peers are also sources for good mental health and quality of life (Skaalvik & Skaalvik, 2018). Studies have shown that a safe and including environment, where students are supported by peers and teachers, positively influences students' engagements, efforts, thriving, and attendance in school (Fredricks et al., 2004).

2.2. Health Promotion Theory and Sense of Coherence

Antonovsky (2012) was concerned about identifying what made people experience good health, rather than focusing on symptoms causing health problems. He identified three factors that made people resilient and robust in handling stress in everyday life through having a strong sense of coherence, and these were comprehensibility, manageability, and meaningfulness (figure 2). Comprehensibility concerns understanding a situation, and one's own role in that situation, manageability is about identifying own resources and resources in one's surroundings, and meaningfulness includes seeing the value of own contribution and feeling a possibility to influence a situation.

Figure 2.
Health promotion theory and sense of coherence.



The definition of comprehensibility does not separate between wanted or unwanted situations in life, it is about having the ability to place what happens in an understandable context. Having an understanding of the situation, leads to experiencing manageability, which includes identifying resources in oneself and one's surroundings, and to use these to handle situations in life in the best possible way. The third factor, meaningfulness, is about

seeing the value of one's own engagement, participation, and involvement when facing challenges. Antonovsky (2012) points to meaningfulness as most central and refers to this as a motivation component.

To see meaning in being engaged and participating actively in one's own life will increase the chances of being able to cope with challenges and different happenings in life. This could also be related to the theory of agency, emphasising active participation in one's life as a central motivation (Skaalvik & Skaalvik, 2015). Conditions for agency include having the possibility to set personal goals, plan strategies to reach the goals, carrying out the plans, and adjust goals and strategies when needed. Believing in one's ability to manage this is crucial to develop self-efficacy, which again influences the motivation to be an agent in one's life (Bandura, 1997). Experiencing meaningfulness is also related to participation, or more specifically influencing decision making (Payne, 1980). Without the possibility to participate and influence decisions, one may experience that one's potential is ignored, which again would negatively affect the experience of meaningfulness (Antonovsky, 2012).

Antonovsky (2012) points to research on robustness and resilience that emphasizes the importance of experiencing engagement in one's self and life (Kobasa & Maddi, 1982). Engagement is described as a robustness factor, and concerns having the ability to believe that what one does is right, important, and interesting. Another factor is the feeling of having control, or being able to influence one's surroundings. People with a large degree of control feel less powerless and paralyzed in difficult situations; they feel competent to take responsibility, to act, and to influence what happens in life. A third factor is the ability to see changes in life as an opportunity for development rather than a threat towards the existing.

A central metaphor in Antonovsky's (2012) work is the description of life as a river (figure 3, based on Antonovsky's metaphor, previously published in Langeland & Horverak, 2021). A river may be calm or have strong currents. What decides to what degree a person may be able to swim does not only depend on the river, but on the person's swimming ability. Without swimming skills, the person will drown, regardless of whether the river is calm or not. Being able to swim is compared with having a strong sense of coherence, which makes a person able to cope with stressful and challenging situations. Believing in one's own ability to understand and handle situations, at the same time as experiencing motivation and meaning, will strengthen a person's robustness in dealing with adversities, challenges, and difficult events in life (Antonovsky, 2012).

Figure 3.
Life as a river.



3. RESEARCH METHODOLOGY

This study has a mixed methods design (Teddle & Tashakkori, 2009), including a quasi-experiment (Shadish et al., 2002) with test and control groups, but without randomization. An intervention with the five-step method described below was implemented through four sessions over a month and repeated every two to four weeks throughout the school year in the test groups. In the control groups, there was no such intervention, and teaching was carried out as usual. The General Self-Efficacy Scale (Schwartz & Jerusalem, 1995) was used to measure at the beginning and the end of the school year as pre- and post-tests. All data was collected anonymously and on paper, and the students were informed that it was voluntary to participate in research. The students elected their own codes so that the responses on pre- and post-tests could be related for each student. As there was no way to identify the respondents, the project was not reported to the Norwegian data protection services for research. A two-way repeated measures ANOVA was used to analyze possible significant differences between test and control groups. In addition to quantitative data collected, the students' reflections from the implementation of the five-step method were collected as qualitative data. Examples from the students' reflections are included in the findings. The sample and the implementation of the method are described in the following.

3.1. Sample

The sample included seven test groups and five control groups from the same upper secondary school, in total 132 student participants in each group. The school where the study took place is a combined upper secondary school with both general study students and vocational students, as well as students taking a third extra year to build on vocational studies to achieve competence to be admitted to universities. The sample was a convenience sample, and it was collected in the period from 2018 to 2022.

Table 1.
Participants.

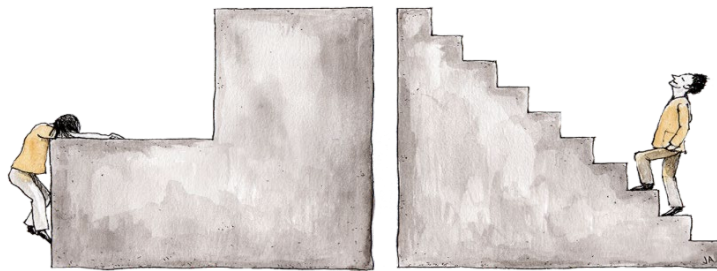
Test or control group	Year in uss. (and age)	Type of group	Number of students
Test 1	1 (15-16)	General studies class with media specialization	22
Test 2	1 (15-16)	Vocational class – sales and transport	14
Test 3	2 (16-17)	Vocational class – sales and transport	4
Test 4	2 (16-17)	Vocational class – child and youth worker	12
Test 5	3 (17-18)	Extra year vocational class (study comp.)	25
Test 6	1 (15-16)	General studies class	30
Test 7	2 (15-16)	General studies class	25
Control 1	1 (15-16)	General studies class	25
Control 2	3 (17-18)	Extra year vocational class (study comp.)	26
Control 3	1 (15-16)	General studies class	29
Control 4	2 (16-17)	General studies class	24
Control 5	2 (16-17)	General studies class	28

Note. uss. = upper secondary school

3.2. The Five-Step Method Intervention

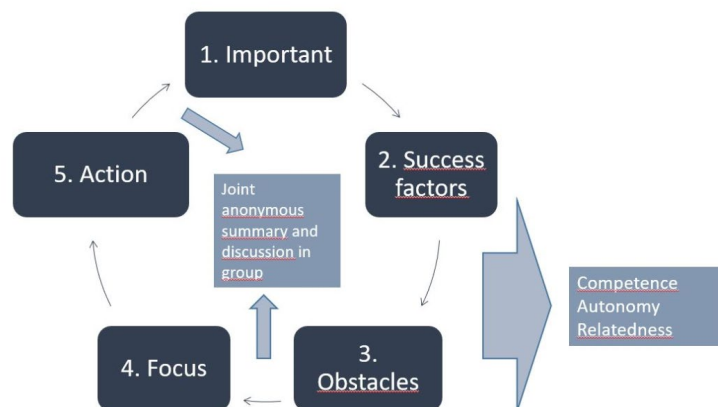
When applying the method, an illustration of two different sets of stairs was shown, one with extremely large steps, and one with small, appropriate steps (figure 4, previously published in Langeland & Horverak, 2021). The students were asked to reflect on how they experienced life, learning, and tasks, and how they could make the steps manageable. The five-step method was presented as a tool to help the students make the steps become more manageable.

*Figure 4.
Life compared with stairs.*



The five steps include the following questions the students were to discuss and answer (figure 5): 1) What is important in your life, and what goals do you have? 2) What about yourself and your life is good? Can you use this to achieve your goals? 3) Is there something in yourself or in general that stops you from reaching your goals? 4) What do you choose to work on the next month to achieve your goals? 5) What will you do to carry this out? In the first session, questions one to three were discussed, and in the second session, the students moved on to discussing questions four and five and making an action plan. In the following sessions, the plan was evaluated and revised.

*Figure 5.
The five-step approach in SAMM.*



In each session, the students wrote their personal reflections in books without names, which were handed over to the teacher at the end of the session. This is the qualitative data collected in the study. The teacher made an overview of the students' reflections and showed it to the students in a PowerPoint presentation the following session, followed up by a discussion on how to solve different challenges, what strategies that could be used, and how to make a good plan for handling difficulties. The reason why the process was done anonymously is that the students are to dare to be honest without fear of stigmatization or evaluation. In addition, this process creates an openness where the students see themselves in a community and recognize common strengths and challenges.

4. FINDINGS AND DISCUSSION

This study aimed at investigating the potential of a five-step approach to support mastery and motivation for upper secondary school students. The results of the ANOVA-analysis showed no significant difference between the groups. However, the reflections from the implementation of the method give some insight into the processes the students go through when applying the approach.

When reflecting on question one, what is important to them and what are their goals, they listed for example friends, family, education, good grades, a good job, and sports. In addition to these types of external factors, some students expressed a strong wish for good health, both physically and mentally. Regarding the second question, identifying success factors, some students listed qualities as being a good listener, a good friend and a caring peer. One of the students expressed that what was her weakness was also her strength, as she had dyslexia, and this had made her the person that she had become – hardworking, stubborn, patient, and happy. To question three, many students listed grades, tests, pressure, stress, lack of sleep, levels of anxiety, sadness, mental issues, and lack of motivation as obstacles. Some students reported having low confidence, negative thoughts, and a feeling of not being good enough. Dyslexia and disruptions from social media were also mentioned.

When working with questions four and five, different focus areas and action plans were made. Several students chose more sleep as focus area and planned to go to bed earlier. Some planned to put the mobile phone away or turn it off. When it comes to school-related topics, some students listed that they wanted to do well in tests and exams, and to improve their grades. Some planned to practice or take breaks, others wrote that they wanted to improve their concentration. Some wanted to focus more on training and planned to exercise more regularly. These are examples of student reflections from working with the five-step method.

4.1. Theoretical and Practical Considerations related to the Five-Step Method

The first question, what is important in life, invites students to think about what they really want in life (Langeland & Horverak, 2021). It is important to reflect on this, because often other persons tell them what to do and what matters – learning grammar, achieving higher grades in mathematics, etcetera. In addition, youths are affected by friends and social media on how to act, look, or think. As different surveys have shown that an increasing number of children and youth experience health challenges of different types (Bakken, 2024; Reneflot et al., 2018), it is not surprising that there is a focus on health in the student reflections. Reflecting on what is important in life also relates to Antonovsky's (2012) theory, concerning meaningfulness, which is the most important factor to achieve a sense of coherence.

The second question, concerning what is good in life, may help students understand that everyone has strengths and qualities, and that success factors are individual and personal (Langeland & Horverak, 2021). Children and youths find themselves in a situation where they are evaluated by peers, friends, parents, and teachers, as well as known and unknown people on social media. This may result in them mixing up their own success factors with others' definitions and requirements of success and accomplishments. When a student finds qualities that are normally not evaluated or applauded by the surroundings, but that they understand are valuable, they may get increased belief in their own competence, which may lead to increased motivation (Ryan & Deci, 2017), and a better possibility to cope with stressful events in life (Antonovsky, 2012).

Reflections on question three, concerning obstacles, reveal that the students struggle with negative feelings about themselves. Students that over time experience not being good enough, or that they cannot handle different situations, will gradually lose their motivation and experience of mastery. Victories that may be huge for themselves, but small in the light of the society's or the school's requirements and expectations, lose their value when the feedback tells them that they are not good enough (Langeland & Horverak, 2021). Teachers may help students build self-confidence and self-efficacy by facilitating experiences of mastery (Bandura, 1977). This may be achieved by spending time on questions four and five in the method, about choosing focus areas and making plans, which may also support autonomy and intrinsic motivation (Ryan & Deci, 2017).

When working with question four and five, the teacher may show what obstacles or important aspects most of the students are concerned with, but also what a minority is concerned with, and the class may decide on individual or joint focus areas for their action plans (Langeland & Horverak, 2021). To work together as a group may contribute to the students acknowledging each other, which may empower the students by strengthening their self-feeling, and ability to handle adversities and become more resilient (Olsen & Traavik, 2010). At the same time, it is important that the students identify their individual strengths and qualities - resources that may help them cope in life (Antonovsky, 2012). A realistic approach to what is sensible to work on is also necessary. To achieve self-acknowledgement and see own victories, the students must choose realistic goals and strategies they can carry out. This is important to support manageability (Antonovsky, 2012) and autonomy (Ryan & Deci, 2017).

Sometimes the students reveal problems that may need support from people outside the classroom, for example the school nurse or other adults (Langeland & Horverak, 2021). This could be for example students who reveal eating disorders, self-hurting, or suicidal thoughts, and in these types of cases, qualified help is necessary, and urgent. Applying the five-step method in a classroom context is not sufficient for such serious issues, and a teacher is normally not qualified to handle these types of problems. In these cases, the teacher will have to try to identify the student, for example by looking at handwriting, recognizable signals in the text, or by having individual talks with each student in class. Sometimes, it may be difficult to know when interference is necessary, for example when it comes to gaming addiction and addiction to social media. If the teacher has a suspicion that a youth is up gaming all night, so it affects sleep, social life, or mental health, it should be considered whether the problem is to be discussed in class, or whether the problem is to be considered so serious that the student needs professional help. Even though it may not be problematic with gaming and social media, this may develop into serious problems that youths cannot solve on their own. It may be possible to discuss with the school nurse or the school counselor, if the teacher is uncertain about how to approach such situations.

What is important when working with the five-step method is to focus on finding solutions, and that all problems, small and big, most often have a solution, and that they can be dealt with either alone or with help from others (Langeland & Horverak, 2021). Everyone has resources in themselves and in their surroundings, and supporting students to identify these resources may make them develop a strong sense of coherence and robustness in life (Antonovsky, 2012). The students may be reminded of the importance of acknowledging their own and others' qualities and skills, and that using these may strengthen the experience of autonomy, mastery, and participation, which again strengthens intrinsic motivation (Ryan & Deci, 2017). Experiences from applying the five-step method reveal potential to support students to reflect on personal strengths and obstacles and finding solutions to deal with difficult situations in life by applying the approach.

4.2. Discussion of Findings

This study showed no significant effect on self-efficacy of the five-step method applied. However, previous studies show that many students report that they like the method, and many students have reported becoming more motivated and better at planning and following up on their plans (Horverak & Aanensen, 2019; Horverak et al., 2020; Horverak, 2020). Another study where the method was applied in a second language learning setting showed potential of the method to help students choose strategies for language learning, and to reduce foreign language anxiety (Horverak et al., 2022). The five-step approach is dynamic, and is adjusted to the students' needs, whether it concerns life skills or challenges in a subject. The dynamic nature of the five-step approach makes it difficult to carry out an effect study covering all aspects that may have been influenced by the approach.

One of the benefits of applying the five-step approach is that students are given acknowledgement and respect when provided with an opportunity to focus on their qualities and success factors (Langeland & Horverak, 2021). Reflecting on personal qualities is extra important for young people because they are easily influenced by and concerned with what others think, which can cause them to overlook or underestimate what is positive about themselves (Langeland & Horverak, 2021). Applying the five-step approach may help students balance their focus on positive aspects in their situation and possible challenges, and through discussions in the class and with their teacher, they may find solutions in difficult situations. An essential goal of using this method is that the students develop robustness and become better at finding solutions to deal with challenges (Langeland & Horverak, 2021). Identifying resources and solutions together with others may support students to experience intrinsic motivation through autonomy, competence and relatedness (Ryan & Deci, 2017), as well as a strong sense of coherence through comprehensibility, manageability, and meaningfulness (Antonovsky, 2012).

5. FUTURE RESEARCH DIRECTIONS

The sample of the current study was a convenience sample, limited to one school, which makes it difficult to generalize based on the findings of the study. Further studies that are more extensive and randomized are needed. In addition, finding an appropriate scale to measure the effects of the intervention proved challenging, as the purpose of using the method includes a multitude of different aspects related to the students' intrinsic motivation (Ryan & Deci, 2017), self-efficacy (Bandura, 1997), and sense of coherence (Antonovsky, 2012). As both Ryan and Deci's (2017) and Antonovsky's (2012) theories are linked to mastery and self-efficacy, the chosen measuring instrument was limited to measuring self-efficacy (Schwartz & Jerusalem, 1995). This means that the data collection for the

quasi-experiment had very limited scope, which may have caused other effects to have been ignored. The method's main purpose is to contribute to the students' experience of intrinsic motivation, mastery, and participation (Langeland & Horverak, 2021; Ryan & Deci, 2017), and to achieve this, there is a need for experiencing trust, autonomy, competence, relatedness, safe surroundings, recognition and respect, among others. These aspects are incorporated into a newly developed framework for health promotion (Horverak et al., 2024a, 2024b), building on Antonovsky's (2012) theory on sense of coherence. This framework also relates to descriptions of general resistance resources (Antonovsky, 2012; Idan et al., 2022), which include factors in an individual and the environment that support a sense of coherence. Analyses of general resistance resources show correlations between sense of coherence and the basic needs of autonomy and competence (Idan et al., 2022). The scales from both Antonovsky's (2012) tradition and self-determination theory (Ryan & Deci, 2017) were considered, but found inappropriate to apply in the context of the current study. The inappropriateness of the scales has been confirmed by youths in a more recent study (Horverak et al., 2025). A scale covering more of the health promoting aspects, and that youths find appropriate for a school context, is needed, and would have been more adequate to measure effects of the five-step method in SAMM.

6. CONCLUSION

To conclude, the results of this study show that applying the five-step method described above had no effect on students' self-efficacy. However, the five-step method for working with mastery, participation, and motivation relates to several aspects of self-determination and health promotion. Some of these are revealed in the examples of students' reflections from the implementation. A more extensive scale covering more of these aspects would perhaps have been more adequate to measure possible effects, however a scale that incorporates all the mentioned factors does not exist. There is a need for a scale covering more aspects of universal health promoting initiatives, aimed at supporting students to experiencing mastery and motivation.

REFERENCES

- Alver, V. (2020). *Lærerrommet: frafall i videregående, hva skal vi gjøre* [The teachers' room: dropout in upper secondary school, what should we do]? Utdanningsforbundet. <https://www.utdanningsforbundet.no/nyheter/2020/larerrommet-frafall-ividergaende-hva-skall-vi-gjore/>
- Antonovsky, A. (2012). *Helsens mysterium: Den salutogene modellen* [Unraveling the mystery of health: The salutogenic model]. Gyldendal.
- Bakken, A. (2024). *Ungdata 2024. Nasjonale resultater. NOVA Rapport 6/24* [Young Data 2024. National results. NOVA Report 6/24]. NOVA, OsloMet https://oda.oslomet.no/oda-xmlui/bitstream/handle/11250/3145138/Ungdata2024_NasjonaleResultater_UU.pdf?sequence=1&isAllowed=y
- Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioural change. *Psychological Review*, 84(2), 191-215. <https://doi.org/10.1037/0033-295X.84.2.191>
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. Freeman.
- Boggiano, A. K., & Ruble, D. N. (1979). Competence and the overjustification effect: A developmental study. *Journal of Personality and Social Psychology*, 37(9), 1462-1468. <https://doi.org/10.1037/0022-3514.37.9.1462>

- Chang, L. Y.-H. (2010). Group processes and EFL learners' motivation: A study of group dynamics in EFL classrooms. *TESOL Quarterly* 44(1), 129-154. <https://doi.org/10.5054/tq.2010.213780>
- Deci, E. L. (1971). Effects of externally mediated rewards on intrinsic motivation. *Journal of Personality and Social Psychology*. 18(1), 105-115. <https://doi.org/10.1037/h0030644>
- Deci, E. L., Nezlek, J., & Sheinman, L. (1981). Characteristics of the rewarder and intrinsic motivation of the rewardee. *Journal of Personality and Social Psychology*, 40, 1-10. <https://doi.org/10.1037/0022-3514.40.1.1>
- Dörnyei, Z. (2001). *Motivational strategies in the language classroom*. Cambridge University Press.
- Enstad, F., & Bakken, A. (2022). *Ungdata junior 2022. Nasjonale resultater. NOVA Rapport 6/22* [Young data junior 2022. National results. NOVA Report 6/22]. NOVA.
- Falch, T., Johannesen, A. B., & Strøm, B. (2009). *Kostnader av frafall i videregående opplæring* [Costs of dropout of upper secondary education]. <https://www.regjeringen.no/globalassets/upload/kd/vedlegg/grunnskole/frafall/kostnader-av-frafall.pdf2223>
- Flink, C., Boggiano, A. K., & Barrett, M. (1990). Controlling teaching strategies: Undermining children's self-determination and performance. *Journal of Personality and Social Psychology*, 59(5), 916-924. <https://doi.org/10.1037/0022-3514.59.5.916>
- Fredricks, J. A., Blumenfeld, P. C. & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, 74(1), 59-109. <https://doi.org/10.3102/00346543074001059>
- Furuberg, J., & Myklebø, S. (2013). *Unges tilknytning til arbeidslivet. NAV-rapport 2013:3* [Young people's attachment to working life. NAV-report 2013:3]. <https://www.nav.no/no/nav-og-samfunn/kunnskap/analyser-fra-nav/nav-rapportserie/nav-rapporter/unges-tilknytning-til-arbeidslivet>
- Helmersen, M., & Stiberg-Jamt, R. (2019). *HBS Agder: Førevaluering av tiltak for helsefremmende barnehager og skoler* [HBS Agder: Pre-evaluation of measures for health promoting kindergartens and schools]. NORCE Samfunnsforskning and Oxford Research. <https://norce-research.bragu.unit.no/norce-research-xmlui/handle/11250/2621192>
- Horverak, M. O., Langeland, G. M. & Aanensen, M. (2020). Systematic work with motivation and life mastery skills in upper secondary school: An action research study from a Norwegian context. *The 8th European Conference on Education – London 2020 Official conference proceedings* (pp. 65-76). <https://doi.org/10.22492/issn.2188-1162.2020.7> Retrieved from: <https://papers.iafor.org/submission57545/>
- Horverak, M. O. (2020). Developing resilience and life mastery skills in the classroom – a multiple case study comparing a Norwegian and Peruvian context ISSN: 2189-1036. *The 5th IAFOR International Conference on Education – Hawaii2020 Official conference proceedings* (pp. 31-44). <https://doi.org/10.22492/issn.2189-1036.2020.3> Retrieved from: <https://papers.iafor.org/submission53632/>
- Horverak, M. O. & Aanensen, M. (2019). Decreased motivation and increased mental illness among young people – a need for teaching life mastery skills in school. *The 7th European Conference on Education, Independence & Interdependence, official conference proceedings* (pp. 239-251). <https://papers.iafor.org/submission52464/>
- Horverak, M. O., Langeland, G. M., Aanensen, M., Hellang, Ø., Eide, S. E., Haugen, T. & Helmersen, M. (2024a). Et helsefremmende skolemiljø for økt skolenærver [A health promoting learning environment for increased school attendance]. *Forebygging.no*. <https://doi.org/10.21340/m9pw-ct37>
- Horverak, M. O., Hellang, Ø., Kühn, N. S., Helmersen, M., Langeland, G. M. & Haugen, T. (2025). Developing an instrument to measure health promotion in a youth environment – A pilot study from a Norwegian context. *Conference proceedings of the 16th Asian Conference on Psychology & the Behavioural Sciences*. <https://doi.org/10.22492/issn.2187-4743.2025.4>

- Horverak, M. O., Langeland, G. M., Kühn, N. S., Hellang, Ø. & Helmersen, M. (2024b). Health promotion principles and practices in school. *International Journal of e-Healthcare Information Systems*, 10(1). doi:10.20533/ijehis.2046.3332.2024.0036 Retrieved from: <https://infonomics-society.org/ije-his/published-papers/volume-10-2024/health-promotion-principles-and-practices-in-school/>
- Horverak, M. O., Langeland, G. M., Løvik, A., Askland, S., Scheffler, P. & Wach, A. (2022). Systematic work with speaking skills and motivation in second language classes. *IAFOR Journal of Education*, 10(1), 33-52. <https://doi.org/10.22492/ije.10.1.02>
- Idan, O., Eriksson M. & Al-Yagon, M. (2022). Generalized resistance resources in the salutogenic model of health. In M. B. Mittelmark, G. F. Bauer, L. Vaandrager, Pelikan, J. M., Sagy, S., Eriksson, M., Lindström, B & Magistretti, C. M., (Eds.) *The Handbook of Salutogenesis* [Internet] (2nd ed., Chapter 12). Cham (CH): Springer. <https://www.ncbi.nlm.nih.gov/books/NBK584114/>
- Kobasa, S. C. & Maddi, S. R. (1982). *Unpublished methodological memo on the hardiness scales* (revised). Department of Behavioral Sciences. University of Chicago.
- Koga, T. (2010). Dynamicity of motivation, anxiety and cooperativeness in a semester course. *System*, 38(2), 172-184. <https://doi.org/10.1016/j.system.2010.03.001>
- Lamb, M. (2017). The Motivational Dimension of Language Teaching. *Language Teaching*, 50(3), 301-346. <https://doi.org/10.1017/S0261444817000088>
- Langeland, G. M. & Horverak, M. O. (2021). *Hvordan legge til rette for mestring, medvirkning og motivasjon i ungdomsskole og videregående skole* [How to facilitate mastery, participation and motivation in lower and upper secondary school]. Cappelen Damm Akademisk.
- Olsen, M. I. & Traavik, K. M. (2010). *Resiliens i skolen: Om hvordan skolen kan bidra til livsmestring for sårbare barn og unge. Teori og tiltak* [Resilience in school: About how the school may contribute to life mastery for vulnerable children and youth]. Fagbokforlaget.
- Parlikar, N., Kvaløy, K., Strand, L. B., Espnes, G. A., & Moksnes, U. K. (2023). Loneliness in the Norwegian adolescent population: prevalence trends and relations to mental and self-rated health. *BMC psychiatry*, 23(1), <https://doi.org/10.1186/s12888-023-05404-5>
- Payne, R. (1980). Organizational Stress and Social Support. In C. L. Cooper & R. Payne (Eds.), *Current Concerns in Occupational Stress* (pp. 269-298). Wiley.
- Reneflot, A., Aarø, L. E., Aase, H., Reichborn-Kjennerud, T., Tambs, K. Øverland, S. (2018). *Psykisk helse i Norge* [Mental health in Norway]. Folkehelseinstituttet. https://www.fhi.no/globalassets/dokumenterfiler/rapporter/2018/psykisk_helse_i_norge2018.pdf
- Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55(1), 68-78. <https://doi.org/10.1037/0003-066X.55.1.68>
- Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. The Guilford Press.
- Ryan, R. M., & Grolnick, W. S. (1986). Origins and pawns in the classroom: Self-report and projective assessments of individual differences in children's perceptions. *Journal of Personality and Social Psychology*, 50(3), 550-558. <https://doi.org/10.1037/0022-3514.50.3.550>
- Ryan, R. M., Stiller, J. & Lynch, J. H. (1994). Representations of relationships to teachers, parents, and friends as predictors of academic motivation and self-esteem. *Journal of Early Adolescence*, 14(2), 226-249. <https://doi.org/10.1177/027243169401400207>
- Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Houghton, Mifflin and Company.
- Schwarzer, R., & Jerusalem, M. (1995). *General Self-Efficacy Scale (GSE)* [Database record]. APA PsycTests. <https://doi.org/10.1037/t00393-000>
- Skaalvik, E. M., & Skaalvik, S. (2015). *Motivasjon for læring. Teori og praksis* [Motivation for learning. Theory and practice]. Universitetsforlaget.
- Skaalvik, E. M., & Skaalvik, S. (2018). *Skolen som læringsarena. Selvoppfatning, motivasjon og læring* [The school as learning arena. Self-perception, motivation and learning] (3. Ed.). Universitetsforlaget.

- SSB. (n. d.). *Gjennomføring i videregående opplæring* [Completion of upper secondary education]. 12971: Gjennomføring i videregående opplæring, etter fullføringsgrad, todelt utdanningsprogram og kjønn (F) 2006-2012 - 2018-2024 [12971: Completion of upper secondary education: degree of completion, divided programme and gender (F) 2006-2012 - 2018-2024]. Retrieved August 19, 2025, from: <https://www.ssb.no/statbank/table/12971>
- Teddlie, C. & Tashakkori, A. (2009). *Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences*. Sage.
- The Norwegian Directorate of Education. (2017). *Core curriculum – values and principles for primary and secondary education*. <https://www.udir.no/lk20/overordnet-del/?lang=eng>

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Chapter # 6

BUTTERFLY-PIANO:

A playful learning proposal for children with Autism Spectrum Disorder

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ABSTRACT

This chapter discusses the importance of teachers' openness to new teaching methodologies and tools, especially in the context of inclusive music education for individuals with Autism Spectrum Disorder (ASD). In addition to the challenges arising from adaptive pedagogical practice, the chapter proposes a reflection on the use of the piano as an instrument that mediates learning and socialization. The present study aims to suggest new and creative possibilities for using the piano – considered one of the most traditional musical instruments – through the application of a non-conventional graphic element. The methodological proposal presented here, called Butterfly-Piano, involves not only a playful and diversified design, but also a therapeutic association between musical notes and colors, which can effectively complement treatments for this population. It is expected that this “new instrument,” which can be made at home using cardboard, will provide children—especially nonverbal children and those with limited social interaction—with a better quality of life.

Keywords: Autism Spectrum Disorder, learning proposal, American methodology, group piano, butterfly-piano.

1. INTRODUCTION

It is no longer a novelty to state that a teacher must always be open to different conjectures and teaching methodologies. The world is constantly changing, and as part of a social context that is in constant motion, we must be increasingly receptive to new tools that help us positively transform the reality in which we are immersed.

Unlike in the past, due to the greater ease in diagnosing conditions such as Autism Spectrum Disorder, today we face the challenge of adapting ourselves and embracing – with humanity and generosity – an increasingly inclusive and welcoming teaching practice.

In the field of music education, didactic conceptions still reveal, in many contexts, a conservative character, with little sensitivity to the needs of students with specific potentials and limitations (Pereira, 2020). Although human beings present singularities, distinct competencies, and difficulties, all have the right to access musical knowledge.

Those educators who "master instrumental technique and everything related to their instrument, but who do not necessarily master the art of teaching, much less understand learning processes, cognition, and human behavior" (Louro, 2015, p. 39), are not in alignment with the truth that music is for everyone, as advocated by music educator Shinichi Suzuki, thus missing the opportunity to implement a truly transformative music education (Suzuki, 1993).

Such individuals also fail to grasp the premise that, as art and music educators, we can help change a person's life – since all of us, as human beings, are musical beings who have lived musical experiences and who can also be encouraged to achieve positive and meaningful experiences within the world of sound and silence, since music is a universal right and a powerful instrument for change in people's lives (UNESCO, 2019).

2. BACKGROUND

Increasingly, music has been used as a complementary resource in the care and support of people with ASD. Many individuals on the spectrum demonstrate a natural predisposition and identification with certain instruments, such as the piano, and this preference can be used as a bridge for social and communicative interaction. Recent studies indicate that musical and music therapy interventions are associated with improvements in communication, social interaction, and behavior in autistic children (Geretsegger et al., 2022; Ke et al., 2022).

Alvin and Warwick (1991, p. 13) point out in their studies that children who fall within the autism spectrum tend to have a greater ability to establish interactions and reciprocal relationships with objects than with other individuals. In the context of music, they may develop a more substantial familiarity with a particular instrument for several reasons, including its physical form, and this object can be used as a supportive means to help autistic individuals build a bridge of interaction between their inner world and the environment in which they are situated. These same authors report that, from a pedagogical perspective, the piano offers particular characteristics that make it suitable for musical interventions with autistic individuals and, consequently, as an object, it can act positively and significantly as a supportive instrument for communication.

As reported by Neves, Parizzi, Freire, & Nunes (2022, p. 4), “Ockelford (2018) emphasized that children with ASD and severe learning difficulties are frequently fascinated and motivated by music and may demonstrate instrumental ability on the piano. In 2009, this same author suggested that the piano is often the first instrument of choice for children with this disorder—particularly those with absolute pitch...”. Furthermore, the authors highlight that the shape or design of the instrument allows children to engage in interactive experimentation with others (the foundation of group piano methodology).

Thus, the size and materiality of the piano promote interaction through shared attention activities. Another factor highlighted is that, because it has an organized system of keys, the instrument in itself offers a stimulus of interest to autistic individuals, who tend to have a natural affinity with organized series or patterns (Neves, Parizzi, Freire, & Nunes (2022).

As demonstrated in numerous studies, engaging with music—which involves not only sound but also silence—can be “the key to unlocking the door that may have kept the individual in silence” (Bauer, 2012).

Considering that ASD is frequently associated with various comorbidities such as anxiety, sensory processing disorders, motor difficulties, and deficits in socioemotional communication (APA, 2022), music can function as a relevant therapeutic and educational resource, optimizing the control and regulation of stress and anxiety (Anauate, 2025). However, its benefits are not limited to socioaffective dimensions. Recent evidence indicates that engagement with a musical instrument activates, develops, and stimulates the domains of motor skills, coordination, sensory processing, and cognition. Among these domains, fine and gross motor skills, motor coordination, sensory integration, and cognitive processes related to attention, memory, and planning stand out (Srinivasan et al., 2022; Wan & Schlaug, 2010).

Despite the challenges an autistic individual may face – considering not only the characteristics of the disorder itself but also the differences that shape human beings and make us unique in our capacities, potential, creativity, understanding of the world, and personal and artistic expression – we all occupy a sacred space in this earthly dimension. Nature, in its wisdom and perfection, has gifted many atypical individuals with a natural predisposition for absolute pitch. This means they have a developed internal ear capable of distinguishing one musical note from another without the aid of a reference instrument.

Another relevant dimension concerns auditory perception. Recent research indicates that individuals with ASD present differences in pitch perception and a higher prevalence of absolute pitch when compared to the general population (Wenhardt, Altenmüller, & Kopiez, 2019; Ong et al., 2024; Romani et al., 2021; Dohn et al., 2012; Wenhardt et al., 2019). Autistic individuals are approximately three times more likely to have absolute pitch than individuals considered typically developing, a fact observed in all the autistic individuals with whom we had the opportunity to work. Clearly, this characteristic can—and should—be taken into account so that autistic individuals can develop more effectively from multiple perspectives, achieving not only improvements in social and emotional skills, but also in abilities involving memory, attention, focus, sensory processing, and communication. However, the literature emphasizes individual variability, as not every individual with ASD possesses absolute pitch, and auditory abilities may vary widely. Issues related to sensory processing, as is well known, must be addressed with great sensitivity by the support team working with autistic individuals, since some are hyposensitive while others are hypersensitive. Many atypical individuals, for example, show aversion to high-volume sounds or to specific sound frequencies.

Thus, music presents itself as a comprehensive and potentially effective tool for enhancing quality of life and promoting the holistic development of individuals with ASD, especially in inclusive educational contexts.

2.1. Butterfly-Piano: A Creative and Inclusive Proposal

Considering all these factors as essential from a music educator's perspective – especially one seeking to offer autistic children an additional opportunity for recreation and stimulation through an adapted version of the group piano methodology – this article presents not only a new playful design proposal for the instrument, but also a practical functionality.

The proposal encompasses both a functional redesign of the instrument (facilitating reach, reducing unwanted auditory stimuli, and incorporating tactile markers) and adjustments to group dynamics (shared attention activities, predictable routines, and the use of visual and auditory references).

We know that creativity has always accompanied humankind. But it is often necessity that drives us to seek creative alternatives to meet certain needs. As a professor of group piano teaching methodology in the undergraduate music education program at the Federal University of Sergipe, in the northeastern region of Brazil, we face daily – within the university routine – an economic and social reality very different from that found in other Brazilian regions or more developed countries.

In general, in music degree programs in Brazil and the United States, regardless of whether students aim to become composers, conductors, or instrumentalists, non-pianist students are required to take piano courses. These classes support their studies in theory and structure and help improve ear training, since the piano is simultaneously percussive, harmonic, and melodic – in other words, complete.

Over fifteen years working in higher education with the group piano methodology (Logier, 1827), we have encountered a wide range of challenges. A significant portion of beginning students who entered the group piano lab during that time had special needs, in

addition to coming from socioeconomically disadvantaged backgrounds. While we had a program and schedule to follow during class, additional extra-class practice and dedication were essential for everyone to consolidate the material covered. Many students worked in various jobs during the day and attended our evening courses, commuting from rural towns without access to electricity or even running water. But how could they study piano or even acquire a small five-octave keyboard – sufficient for beginners – if they didn't even have access to basic sanitation or public health services?

Drawing inspiration from the silent pianos used by musical geniuses like Mozart and Beethoven during long carriage journeys on tour, we advised our students to build a small keyboard by drawing a few octaves onto a piece of cardboard. Instead of going to waste, that piece of cardboard was transformed into a true learning instrument.

Scientifically, it is known that “creative learning is an approach that transcends the mere assimilation of subjects and content, as it stimulates imagination, curiosity, and the ability to solve problems in original ways” (Tiburski, 2024). Alternative learning paths should always be sought by those who make education a vocation of the heart.

Naturally, building your own instrument and realizing that, by handling it, you can access a vast universe—through imagination or thought—makes the learning process more rewarding and pleasurable. The students do not see themselves as mere recipients of information, but rather as engaged and welcomed while building new knowledge and expanding their perception of the world.

The proposal of a soundless keyboard, inspired by the silent pianos of the past—which are still used today—offers the child the opportunity to work on cognitive interaction alongside finger dexterity. With this creative strategy, students are encouraged to develop their inner ear, since while imagining and attempting to trigger musical notes, as well as speaking or singing the sounds that make up a melody, they are optimizing the integration and progress of both cerebral hemispheres. Rhythm, in general, is controlled by the left side of the brain. However, speech and logical reasoning, once attributed solely to the left side, and image recognition and musical ability, once considered exclusive to the right side, are now proven to be functions of both hemispheres.

Therefore, the playful and silent piano proposed here will be highly useful in complementary and alternative therapies for individuals with autism, not only with the aim of helping them overcome their specific challenges, but also in fostering cerebral and cognitive interaction. It is worth remembering that Neves, Parizzi, Freire, & Nunes (2022, p. 3) advocate “the use of the piano... also as an exceptional tool for providing children with ASD a multisensory experience at the beginning of their musical development. In this context, the piano should also be used... percussively...”.

In the case of the Butterfly Piano, since it would have no sound – only a keyboard with the names of the notes from segments of universal songs, associated with the principles of chromotherapy – it is expected that some form of verbal communication will be initiated by autistic children, supported by other therapies. We have several neurodivergent students who did not speak until the ages of 4–6 and who, through the continuous listening of songs in various languages, began oral communication through singing. Naturally, over time, children can be encouraged to interact with conventional keyboards or pianos, actually performing what they had imagined and expressed in some way through frequent contact with the playful instrument in question.

3. OBJECTIVES

The objective of this research is to suggest new creative possibilities for using the piano—considered one of the most traditional musical instruments—for individuals with Autism Spectrum Disorder, based on the group piano methodology, aiming to promote a better quality of life for children with ASD, especially those who are nonverbal and have limited social interaction, the latter being the main learning goal of piano through the group methodology.

4. METHODOLOGY

The research is grounded in a qualitative approach, structured through a bibliographic investigation guided by the analysis and adaptation of the constitutive principles of the group piano methodology. After the selection of the theoretical corpus, an analysis of the references was carried out in order to identify convergences, gaps, and potentials within the fields investigated.

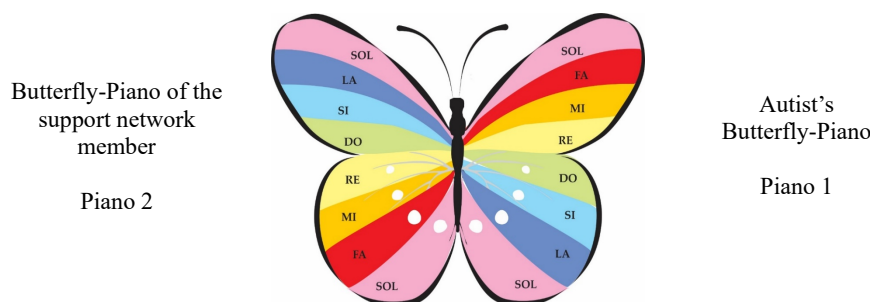
The foundations of the group piano methodology were established by Logier (1827) and, over the years, were systematized by American pedagogues such as Calvin Cady and Raymond Burrows to promote musical literacy among beginner students of all age groups (Peare, n.d.). Group piano methods, regardless of whether they are designed for children or adult beginners, encourage creativity, improvisation, and ensemble interaction. Having had the opportunity to work with Piano 101 and Alfred's Group Piano for Adults, which serve as the basis for the configuration of the butterfly piano scores, we can state that there is no more stimulating method for introducing both adults and children to the instrument than group piano, as it is grounded in social collaboration.

Thus, the adopted methodology made it possible not only to systematize the state of the art related to the topic, but also to propose creative and theoretically grounded possibilities for the use of the butterfly piano as a pedagogical, creative, and inclusive resource.

5. DESIGN

Regarding the design suggestion for the Butterfly Piano, which can be made of cardboard at home, it would be represented as follows.

*Figure 1.
Butterfly-Piano design.*



Many autistic children have particular interests. However, the choice of a playful symbol also needed to involve the union of at least two parts so that the traditional group piano methodology could be incorporated. Thus, the Butterfly Piano would serve as an initial exploration tool between an autistic child and a partner, whether from their family circle or not.

Since the adapted sheet music is part of a song repertoire passed down from generation to generation and also reproduced by various media, it is believed that it will generate a certain level of identification, familiarity, and affection from the autistic child.

Although fingering suggestions are provided – based on what is traditionally used in piano practice – the main goal of the proposed work is that, while the autistic child explores the keyboard (since the hands are essential in the production of knowledge), the vocalization of the lyrics should be encouraged. The suggested songs should be listened to repeatedly through available media, as recommended by violinist Shinichi Suzuki in his method for beginning string students.

In piano playing, both the right and left hands have their fingers numbered from 1 to 5, starting from the thumb. What is written in the treble clef is read with the right hand, while what is written in the bass clef is read with the left. Naturally, the time set aside in the autistic child's routine for exploring the Butterfly Piano should always be accompanied by an adult in the role of Piano 2, who will not only “play” their part on the silent keyboard but also sing the melody of the song suggested in the sheet music. In general, the melody will always be found in the Piano 1 part. While the adult encourages the child to “play” the Piano 1 notes, they sing the melody so that the child can mentally associate sounds and words, reinforced by the tactile and sensory engagement of their hands.

Music is divided into measures, each organizing what should be performed within that specific bar. Since these are universally known songs, the rhythm in the sheet music of these playful pianos does not follow formal notation. The colored notes in these arrangements occupy the same positions as those in a traditional score, but without the technical rhythmic symbols.

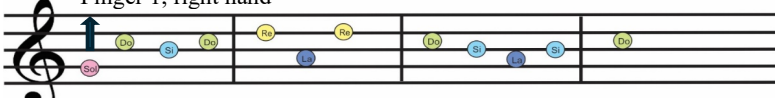
With repetition, it is expected that the autistic child, while listening to the song and mentally “playing” it on the silent keyboard, will gradually begin to verbalize the syllables of the lyrics along with the adult, which could significantly contribute to their oral expression and social interaction—the foundation of learning an instrument through the traditional group piano methodology.

The first suggested passage for exploration remains within the G major pentachord. The choice of pieces that work within pentachords is a highly effective strategy in beginner piano pedagogy, since only the first five notes—in this case, starting from G—are used to compose the musical phrase. This means the hand position remains fixed, with each finger resting on a specific note, making it easier for the student to understand the notes and their placement at this initial stage of study.

Considering chromotherapy, the G major pentachord would incorporate colors that, emotionally speaking, are generally significant for autistic individuals. While G, A, and B are associated with violet, indigo, and blue, C and D are associated with green and yellow. Another important aspect when teaching beginners is the choice of short pieces with longer note values, at a slower tempo. Both autistic and neurotypical individuals who are beginning musical literacy on the keyboard tend to struggle with long pieces, and at this early stage, the main goal is muscular, emotional, and physical relaxation.

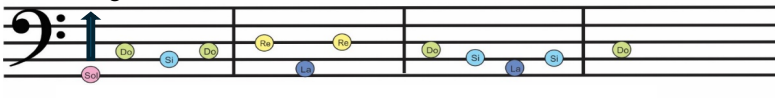
Figure 2.
Aura-Lee – arranged by Priscila Gambary – Piano 1 and 2.

Finger 1, right hand



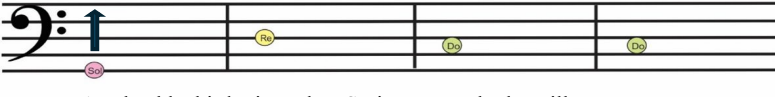
As the blue bird in the Spring neath the will-ow tree

Finger 5, left hand



Sat and piped I heard him sing prai-sing Au-ra Lee

Finger 5, left hand



As the bluebird in the Spring neath the willow tree



Sat and piped I heard him sing praising Aura Lee



do 1
mano destra



dito 5
mano sinistra



dito 5
mano sinistra

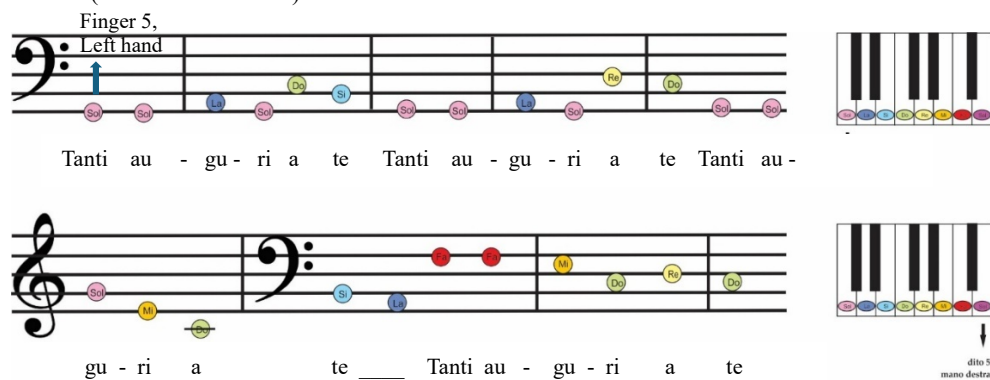
According to Rissato (2024), “bilingualism related to autism can enhance the ability to adapt to different situations... in addition to providing cognitive stimulation, improving communication... and fostering social and cultural inclusion...”.

All the “works” listed here feature melodies that are universally recognized across various cultures. The languages adopted do not prevent the “performer” from translating them into their native language, although many begin vocalizing in different languages.

Figure 3.
Tanti auguri – Mildred Hill/ Patty Hill/ Arranged by Priscila Gambary.

Piano 1 (treble and bass clefs)

Finger 5,
Left hand



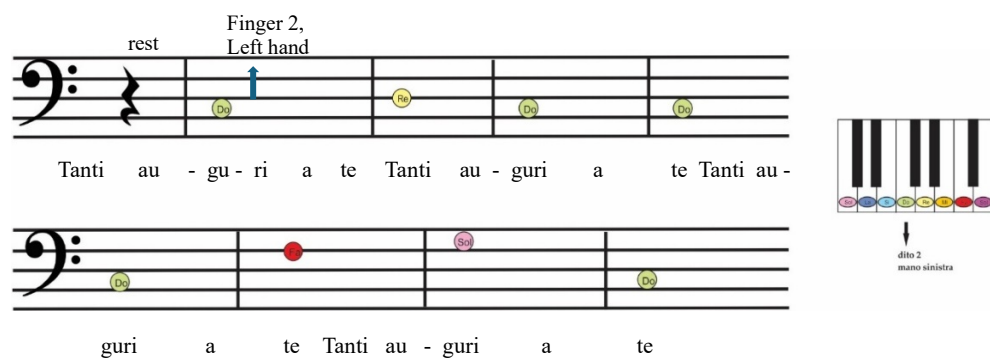
Tanti au - gu - ri a te Tanti au - gu - ri a te Tanti au -

gu - ri a te Tanti au - gu - ri a te

↓
dito 5
mano destra

Piano 2 (bass clef)

rest Finger 2,
Left hand



Tanti au - gu - ri a te Tanti au - guri a te Tanti au -

guri a te Tanti au - guri a te

↓
dito 2
mano sinistra

Figure 4.
Brilla, brilla una stellina – arranged by Priscila Gambary – Piano 1 e 2.

The figure displays a musical score for the song "Brilla, brilla una stellina" with piano accompaniment. The score is organized into three systems, each with a vocal line and a piano accompaniment line. The piano accompaniment is written in bass clef. The first system includes fingerings: "Finger 2, right hand" and "Finger 5, left hand". The second system includes the lyrics "Bri - lla bri - lla u - na ste - lli - na su nel cie - lo pic - co - li - na". The third system includes the lyrics "Bri - lla bri - lla so - pra noi, Mi do - man - do di chi sei". The fourth system includes the lyrics "Bri - lla bri - lla u - na ste - lli - na, Ora tu sei più vi - ci - na". The fifth system includes the lyrics "Brill brilla u - na stellina su nel cielo piccolina". The sixth system includes the lyrics "Brilla brilla sopra noi, Mi domando di chi sei". The seventh system includes the lyrics "Brilla brilla u - na stellina, Ora tu sei più vicina.".

Diagram illustrating the fingerings for the piano accompaniment:

- Hand 1 (Left): Finger 5 (dita 5 mano sinistra)
- Hand 2 (Right): Finger 2 (dita 2 mano destra)

For many educators, affection is an essential component for the development of intelligence and for fostering the interest and motivation of any individual, whether neurodivergent or not (Wadsworth, 1997; Macedo, 2021).

If the person performing the Piano 2 part – written in the bass clef – is part of the autistic individual's network of affection, the expected results may be achieved faster than one might imagine. Suzuki argued that, within the scope of music pedagogy, children are educated primarily through example. According to him, the main teaching tool, in all its dimensions, is affection.

6. FUTURE RESEARCH DIRECTIONS

As previously mentioned, the foundation for the construction of these pianos is the group piano methodology (Logier, 1827). Therefore, the child would not unleash their imagination without the presence of an adult mediator—without the need for prior musical knowledge—who could be the father, mother, sibling, grandparents, therapists, or anyone within their support circle. This would contribute to strengthening even further the social and emotional bonds between individuals.

There is a technologically developed physical structure when we think of the traditional conception of the American group piano methodology. Each student occupies a digital piano, and we have seen teachers working with 22 students at the same time in a single class, with the help of an assistant. Just as a beginner learning to read and write needs their own materials, in the group piano methodology, the process is no different: each student must have their own textbook and a piano available to them. Regarding the textbook, it is worth noting that, for this methodology, there are several books written that do not work well for conservatory-style or individual piano lessons, and vice-versa, for example Piano 101 (Lancaster, Renfrow, 1999) and Alfred's Group Piano for Adults (Lancaster, Renfrow, 1996). Group piano methods, in addition to repertoire, regardless of whether they were designed for children or adult beginners, stimulate creation, creativity, composition, improvisation, practice, and ensemble interaction. Having had the opportunity to work with both methodologies, we can say there is no more stimulating method for introducing adults and children to the instrument than group piano. There are methods created for use in music universities with students who do not have piano as their main instrument – who need contact with the instrument for complementary training – as well as methods for children, which encourage imagination and music-making in a playful way, with a slower, step-by-step approach, respecting the developmental stages of a specific age group and with attractive, colorful visual elements. Books designed for adult beginners, who wish to learn piano as a hobby or for leisure, present musical content and graphic design in a different way.

The author of this research began introducing teenagers, young adults, and seniors to piano in 2009 through a university Community outreach and social inclusion project at the Federal University of Bahia, as an assistant professor and doctoral student in piano. There were nearly 150 students distributed across 20 classes, with eight digital pianos available.

Naturally, extra-class study is necessary because it is through repetition that we expand our work memory and transform it into learning, consolidating new knowledge. In 2013, when we took over group piano classes at the Federal University of Sergipe, our physical structure was more modest, with keyboards of limited range—which are sufficient at the beginning. As already mentioned, students also had greater restrictions on extra-class practice. It was from this need for daily practice that we began providing cardboard pianos. We can say, without hesitation, that the students who adopted and embraced this strategy achieved the best results in the course.

It was with the intention of adapting this idea, along with the foundation of the group piano methodology, that the creation of the Butterfly Piano for autistic children emerged. The association of the instrument with a butterfly was not made by chance – symbols have always been essential to the process of human development.

It is known that, in general, autistic individuals have difficulty imitating what they hear or see (Kerches, 2019). For this reason, many are unable to begin verbal communication at the age when it is expected for a typical child to start babbling their first words. But even if the individual cannot express themselves verbally, everyone in their family and support network should continuously encourage dialogue. The fact that a child does not speak does not mean they do not listen. Some autistic children may not respond with words, but just as one can feel welcomed through a hug, a gesture, or a simple look, it is possible to attempt interaction or self-expression in response to external stimuli without the need for oral communication.

When we engage in the challenging process of self-awareness and self-acceptance, we are able to accept life as it is, and we are able to accept others as they are. When we understand that there is an infinite world of possibilities to be discovered within ourselves, we are able to see—and help others see—that they also possess this creative world that allows us to build, deconstruct, and reconstruct knowledge daily. When we speak of an atmosphere that involves play, there should not—or should never—exist a balance that tips between “right” and “wrong,” because mistakes should always be seen as possibilities or pathways for development and learning, not for judgment.

Thus, as Vygotsky stated – cited by Rodrigues and Angotti (2023, p. 5) – symbols “are psychological instruments that represent the real world within our mental universe, expanding our ability to communicate what we understand.”

The main goal is that the autistic child will, in their own time, be able to reproduce short phrases from popular songs, considering the predisposition many have toward absolute pitch, while exploring their silent keyboard. As chromotherapy has shown positive results not only in complementary treatments for autistic individuals but also for neurotypical ones, we believe that this suggested relationship between colors and musical notes can be effective.

“Those with absolute pitch can identify musical pitches without needing to compare them to an external reference. This means they have an internal memory for exact pitches” (Sacks, 2007, p. 90). It is also important to note, according to the same author, that those with absolute pitch often have high abilities and may associate sounds with colors.

Regardless of whether we think of an autistic or non-autistic individual, the fact is that colors – like sounds – can evoke sensations and emotions that do not have the same meaning for everyone, as each of us has a personal life repertoire and history that changes according to our experiences. However, some colors and sound textures generally evoke specific feelings in human beings. For example, “the color blue is associated with joy and with influencing verbalization in people. In autism, blue stimulates feelings of calm and greater balance... Orange and yellow, being very close in the spectrum, can help in the social stimulation of children” (Brites, 2025).

The understanding of colors and their gradients is taught in the various therapies that a neurodivergent child should have access to after diagnosis and determination of the necessary level of support. Therefore, the objective here would be to reinforce or complement what is already being worked on by their support network. It is known that chromotherapy may not work for everyone, but it has produced good results in many neurodivergent individuals. What matters most is that everyone can develop their creativity, as long as they are encouraged and inspired to live life with curiosity.

Among the various definitions of creativity, we highlight that of Ghiselin (1952, p. 21): “Creativity is the process of change, of development, of evolution in the organization of subjective life. Without questioning, without experimentation, observation, and an interest in seeking connections, we cannot keep the flame of creativity alive. And it is through it that we are able to build a life of purpose and fulfillment.”

We must not forget that the brain that thinks and processes information is also a repository of emotions. According to Comoli (2021), “when an experience is strong enough to consolidate information, a process begins to form synapses and neural circuits that did not exist before, and the brain changes physically. Because of the physical emotions of memories, there is no single brain identical to another – the memory gives us identity. And creating identity – or rather, contributing so that each individual builds and lives their own – is what should truly drive us as mediators of content and knowledge.”

7. CONCLUSION

Based on the premise of the group piano methodology – which is grounded in collaboration, positive reinforcement, interaction, and the creation of a genuine support network that makes learning as engaging and human as possible – we present this new proposal for creating playful pianos adapted to the needs of autistic individuals. These pianos, whose notes are associated with the principles of chromotherapy, produce no sound, respecting an important aspect when considering the sensory experience of the spectrum; they are inspired by silent pianos.

Before speaking of welcoming and inclusion, the first thing we must understand is that diversity is what makes life more interesting and richer to experience and live.

Contrary to today’s world, in the traditional group piano methodology there is no room for competition with others, but rather for fostering a sense of solidarity and affection. We conclude this proposal – focused on embracing diverse individuals – by affirming that it is possible to create a learning environment and an exchange of experiences that are more sensitive and cooperative if we truly understand that being different is what is normal. And that, for the other to be well, we must be well with ourselves so that, together, we can find a way to resonate beauty, love, and compassion into the world.

Contemporary music education demands an ethical, empathetic, and creative teaching approach. The Butterfly-Piano proposal therefore seeks to bring piano teaching closer to an inclusive perspective, one that is sensitive to the cognitive, emotional, and sensory needs of children with ASD. Beyond fostering musical development, it is also essential to contribute to the creation of experiences that reinforce everyone’s right to music.

REFERENCES

- Alvin, J., & Warwick, A. (1991). *Musical therapy for the autistic child*. New York: Oxford University Press.
- American Psychiatric Association. (2022). *Diagnostic and statistical manual of mental disorders* (5th ed., text rev.). APA. Retrieved from <https://psycnet.apa.org/record/2013-14907-000>
- Anauate, N. (2025, August 21). *A relação entre música e regulação emocional* [The relationship between music and emotional regulation]. Message posted to <https://www.psicologasvilaoimpia.com.br/blog/relacao-entre-musica-e-regulacao-emocional/>
- Bauer, B. (2012). Ten Characteristics for Teaching Students with Special Needs. *Piano Pedagogy Forum*, 14 (1).

- Brites, L. (2025). *Como é a classificação de cores no autismo* [Color classification in autism]. Retrieved from <https://institutoneurosaber.com.br/artigos/como-e-classificacao-de-cores-no-autismo/>
- Comoli, E. (2021). *Emoções facilitam o armazenamento de memórias duradouras* [Emotions facilitate the storage of long-lasting memories]. Retrieved from <https://www.comciencia.br/memorias-ligadas-ao-medo-sao-mais-fortes-que-as-prazerosas/>
- Dohn, A., Garza-Villarreal, E. A., Heaton, P., & Vuust, P. (2012). Do musicians with perfect pitch have more autism traits than musicians without perfect pitch? An empirical study. *PLoS One*, 7(5), e37961. doi: 10.1371/journal.pone.0037961
- Geretsegger, M., Elephant, C., Mössler, K. A., & Gold, C. (2022). Music therapy for autistic people. *Cochrane Database of Systematic Reviews*. doi: 10.1002/14651858.CD004381.pub4
- Ghiselin, B. (1952). *The creative process*. Berkeley: University of California Press.
- Ke, X., Zhang, H., Li, M., et al. (2022). Effectiveness of music therapy in children with autism: A meta-analysis. *Frontiers in Psychiatry*, 13. doi: 10.3389/fpsyt.2022.894276
- Kerches, D. (2019). *Imitação no autismo* [Imitation in autism]. Retrieved from <https://www.deborahkerches.com.br>
- Logier, J. B. (1827). *System of the Science of Music and Practical Composition*. Londres: R. Hunter.
- Louro, V. (2015). Educação Musical Inclusiva: desafios e reflexões [Inclusive Music Education: challenges and reflections]. In H. L. Silva & J. A. Zille (Orgs.), *Música e Educação – Série Diálogos com o som* (pp. 33-50). Barbacena: Editora da Universidade do Estado de Minas Gerais.
- Macedo, M. (2021). *O papel do afeto no desenvolvimento do autista* [The role of affection in the development of autistic individuals]. Ponta Grossa: Atena Editora.
- Neves, M., Parizzi, B., Freire, M., & Nunes, N. (2022). Tocando do jeito delas: o piano como instrumento musicalizador de crianças com transtorno do espectro do autismo [Playing in their own way: the piano as a music education instrument for children with autism spectrum disorder]. *Anais 8º Nas Nuvens – Congresso de Música*.
- Pearce, C. (n. d.). *The history of group piano classes*. Retrieved from <https://www.hunterdonacademyofthearts.com/music-and-art-for-all/music-and-art-for-all/bid/53935/>
- Pereira, E. (2020). Concepções pedagógicas da educação musical brasileira: relações com os campos da Educação e da arte-educação [Pedagogical conceptions of Brazilian music education: relationships with the fields of education and art education]. *Revista Eletrônica da Associação Nacional de Pesquisa e Pós-graduação em Música*, 26(1).
- Rissato, H. (2024). *Bilinguismo no autismo: conheça os benefícios em aprender uma língua no TEA* [Bilingualism in autism: learn about the benefits of acquiring a language in ASD]. Retrieved from www.genialcare.com.br
- Rodrigues, A., & Angotti, E. (2023). O papel dos instrumentos e signos culturais no desenvolvimento do pensamento: contribuições para a educação [The role of instruments and cultural signs in the development of thought: contributions to education]. *Cadernos da Fucamp*, 22(55), 70-86.
- Romani, M., Martucci, M., Castellano, M., Prono, F., Valente, D., & Sogos, C. (2021). *What if sharing music as a language is the key to meeting halfway? Absolute pitch, pitch discrimination and Autism Spectrum Disorder*. *La Clinica Terapeutica*, 172(6), 577-590. doi: 10.7417/CT.2021.2381
- Sacks, O. (2007). *Alucinações musicais: relatos sobre a música e o cérebro* [Musical hallucinations: accounts of music and the brain]. São Paulo: Companhia das Letras.
- Srinivasan, S. M., Eigsti, I.-M., Gifford, T., & Bhat, A. N. (2022). The effects of rhythm and music on motor coordination in autism: A systematic review. *Frontiers in Psychology*, 13, 834079.
- Suzuki, S. (1993). *Educação é amor: um novo método de educação musical* [Education is Love: A new method of music education]. São Paulo: Edusp.
- Tiburski, R. (2024). *Aprendizagem criativa* [Creative learning]. Retrieved from www.diarioescolar.com.br
- UNESCO. (2019). *The Universality of Music and Human Rights*. Paris: International Music Council. Retrieved from <https://www.scena.org/lsm/sm10-2/universalite-musique-en.htm>
- Ong, J. H., Tan, Y. Q., Lee, W. et al. (2024). The relationship between autism and pitch perception is complex: Evidence from a large sample. *Journal of Autism and Developmental Disorders*. doi: 10.1007/s10803-024-06283-4

P. Gambary

- Wadsworth, B. J. (1997). *Inteligência e afetividade da criança na Teoria de Piaget: Fundamentos do Construtivismo* [Child intelligence and affectivity in Piaget's Theory: Foundations of Constructivism]. Castro: Pioneira.
- Wan, C. Y., & Schlaug, G. (2010). Music making as a tool for promoting brain plasticity across the life span. *The Neuroscientist*, 16(5), 566-577.
- Wenhart, T., Altenmüller, E., & Kopiez, R. (2019). Autistic traits, resting-state connectivity, and absolute pitch in musicians. *Molecular Autism*, 10(17). doi: 10.1186/s13229-019-0260-7

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Chapter # 7

HACKATHONS IN THE ERA OF GRAND CHALLENGES: A tool fit for management education objectives?

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ABSTRACT

In management education, hackathons have become a popular tool, originally designed to foster technology prototyping. This study examines their suitability for tackling grand challenges like climate change, poverty, inequality, and environmental sustainability. It focuses on hackathons for sustainable development held at a business school since 2016. Adopting a multi-stakeholder approach, the research includes data from students, professors, programme management, and external stakeholders via questionnaires and interviews to analyse one specific hackathon. The findings reveal that each group attributes different value to the hackathon experience, leading to significant tensions. The study, therefore, advises caution in adopting hackathons as a one-size-fits-all solution for teaching complex grand challenges. Ultimately, the research suggests that hackathons fail to satisfy all stakeholders simultaneously. This highlights the need to adapt the hackathon format to specific contexts to maintain its pedagogical integrity. These insights are crucial, given the growing emphasis on multi-stakeholder approaches in sustainable development education and the widespread use of hackathons in higher education.

Keywords: hackathons, grand challenges, practice-based tools, management education.

1. INTRODUCTION

The nature and purpose of management education, as well as the future of business schools, are ongoing debates (Thomas & Ambrosini, 2021), particularly regarding their practical relevance (Ferlie et al., 2010; Schoemaker, 2008). This debate has intensified with the focus on grand challenges (Howard-Grenville et al., 2014; Ferraro et al., 2015) and how well management education prepares students for complex sustainability issues (Nonet et al., 2016; Arevalo et al., 2020). Montiel et al. (2020a) call for new pedagogical practices, but their popularity does not always ensure effectiveness.

One such practice is the hackathon, originally from the IT sector (Briscoe & Mulligan, 2014; Komssi et al., 2015; Macedo Guimarães et al., 2021), now adapted by corporations to include marketing, design, sales, and even customers (Canopé, 2017; Aillerie, 2020). In management education, hackathons are used to teach innovation and entrepreneurship (Suominen et al., 2018; Porras et al., 2019; Page et al., 2016), and to promote responsible management through “green hackathons” (Zapico et al., 2013). However, critiques remain in both industry and academia (Fabbri et al., 2018; Endrissat, 2019). This study examines whether hackathons are fit for purpose in management education, particularly in addressing grand challenges. Considering the multiple actors involved (Cavallone et al., 2021), we ask whose purposes hackathons serve. We analyse six hackathons run in a French business school since 2016 on sustainable development, with an in-depth focus on one event. Data include surveys from 260 students and 13 interviews with programme managers, stakeholders, and faculty.

Findings reveal tensions between stakeholder expectations and perceived value. Without adapting hackathons to academic aims, they risk failing to meet diverse needs. Our multi-stakeholder approach highlights these tensions and offers recommendations to “hack” the hackathon for educational value. More broadly, we contribute to sustainability competence development and propose adjustments to better align hackathons with educational goals.

2. BACKGROUND

To set our empirical study within the wider discussion on the nature and role of management education, we begin by highlighting the current debates around management education and practice, before analysing hackathons in greater detail.

2.1. The Gap Between Management Education and Reality in the Context of Grand Challenges

Business schools have faced criticism (Ferlie et al., 2010), particularly regarding a perceived disconnect between academic theory and practical business needs (Schoemaker, 2008). As companies are increasingly reluctant to provide on-the-job training (Puri, 2018), students must acquire practical skills. Responses include designing curriculums with professionals (Bruno et al., 2021) and promoting experiential learning to develop essential competencies (Dean et al., 2020). Another critique concerns business schools' ability to prepare ethical leaders, a discussion sparked by scandals like Enron (Beggs & Dean, 2007; Hibbert & Cunliffe, 2015; Nonet et al., 2016). The UN's Principles for Responsible Management Education (PRME) were launched in 2007, coinciding with growing research on sustainability education (Starik et al., 2010). However, the impact of these efforts on practice remains uncertain a decade later (Hibbert & Cunliffe, 2015; Montiel et al., 2020b). The more recent appearance of “grand challenges” (e.g., poverty, climate change) has revitalized these debates. These complex problems (Eisenhardt et al., 2016; Ferraro et al., 2015) require comprehensive, coordinated solutions (George et al., 2016). In 2022, the European Commission published the GreenComp framework (Bianchi et al., 2022), which promotes skills like systems thinking and collective action, and encourages active, experiential learning. While broad recommendations exist (Montiel et al., 2020a), there are limited empirical examples of how to effectively implement these methods. To address this gap, we explore the use of hackathons as an educational tool in this context.

2.2. Hackathons: A Practice-Based Tool

Blending “hack” and “marathon,” hackathons emerged about two decades ago (Macedo Guimarães et al., 2021) as an intensive event where computer developers created prototypes over short periods (Briscoe & Mulligan, 2014; Raatikainen et al., 2013). Once loosely structured, large corporations have since adopted hackathons as “accelerated innovation processes” (Lifshitz-Assaf et al., 2021, p. 684). Firms have expanded the model to include non-IT specialists and potential customers (Briscoe & Mulligan, 2014; Canopé, 2017; Aillerie, 2020). However, critics note that hackathons can lack inclusivity, produce quick fixes rather than genuine innovations, and blur boundaries between work and leisure (Endrissat, 2019). Ethical questions have been raised about unpaid labour and “forced” collaboration.

Hackathons have nonetheless been widely adopted in higher education as active learning formats for addressing real-world problems (Gréselle-Zaïbet et al., 2018; Silver et al., 2016; Suominen et al., 2018; Porras et al., 2019). This student-centred approach positions professors as facilitators (Greenwood Dictionary of Education, 2003; Canopé, 2017). Companies often sponsor these events, proposing challenges and offering prizes or internships (Page et al., 2016). The resulting “coopetition”—simultaneous collaboration and competition—is viewed as an effective way to foster innovation in university–industry partnerships (Suominen et al., 2018). Despite their appeal, hackathons demand substantial resources, suitable collaborative spaces, strong pedagogical design, and institutional support (Canopé, 2017; Page et al., 2016). Further research is needed to determine their long-term educational and organisational value.

2.3. Addressing Grand Challenges Through Hackathons

The real-world nature of hackathons has intuitively lent itself to the development of “green hackathons” (Zapico et al., 2013) which aim to provide answers to pressing social and environmental issues. Hackathons favour diversity and interdisciplinary expertise which is needed to respond to grand challenges (George et al., 2016) and offer an experiential pedagogical approach, which is complementary to more traditional theoretical contributions and act as devices for “learning by doing” and “doing it together” (Canopé 2017, p. 15). The teaching of sustainable development encourages the use of less top-down pedagogical methods and the confrontation of ideas and situational problem-solving. These methods bring not only meaningful learning, but also enhance skills’ anchoring, as developed through constructivism theories (Doychinova, 2023). Thus, as the demand for competences to address sustainability and grand challenges grows and the practice of educational hackathons becomes more widespread, we might expect a convergence giving rise to more educational hackathons on sustainability (Saukkonen et al., 2020).

On the other hand, the time constrained nature of hackathons may encourage quick fixes and short pitches and which destroy differences of opinion (Endrissat, 2019). The hackathon tool, which evolved in practice to offer a highly efficient innovation process (Lifshitz-Assaf et al., 2021), may not then be appropriate for the complexity inherent in grand challenges and sustainability issues (Ferraro et al., 2015; George et al., 2016). Moreover, hackathons can easily be diverted from their original objectives, which were to find viable solutions for the community rather than for a handful of elected representatives or private actors.

Hackathons seem to hold the potential to be a relevant tool for teaching the skills required to address grand challenges. However, their objectives may vary significantly between different stakeholders: pedagogical objectives can differ while institutional, professional and student participants may all have quite different aims. Students may be stimulated by the final prize or more interested in the convivial aspect, the concrete character of the project or the contact with companies (Page et al., 2016). The companies themselves want new ideas, to understand the aspirations of the new generation, to improve their employer image, and to identify future recruits. The motivation to address grand challenges cannot be assumed to be the driving motive for all stakeholders.

2.4. Experiential and Self-Determined Learning: The Ambiguity of the Hackathon Format

Experiential learning (Kolb, 1984) has long sought to bridge theory and practice through cycles of action and reflection, with hackathons in business schools exemplifying this approach by promoting engagement and practical competencies. Yet, when implemented

in overly instrumental or decontextualised ways, experiential learning can overlook the social, institutional, and power dynamics that shape learning processes (Beard & Wilson, 2018). These concerns are especially relevant to grand challenges, which demand engagement with complex socio-ecological systems and sufficient time for structured reflection beyond mere “doing” to critically examine assumptions and trade-offs (Kayes, 2002; Sutherland & Crowther, 2006).

In hackathons, students may also engage in *heutagogy* or self-determined learning (Blaschke, 2012; Kenyon & Hase, 2010), as they must work autonomously, mobilize their skills, and build their own solutions. While heutagogy is valued for preparing graduates for uncertain and evolving contexts (Moore, 2020), research identifies persistent challenges in higher education, including uneven learner autonomy, tensions with assessment systems, and the need for scaffolding to prevent inequities (Blaschke & Hase, 2016; Moore, 2020).

Educational hackathons thus sit at the intersection of experiential and self-directed learning, fostering autonomy and active participation. However, their accelerated, time-compressed format amplifies the limitations of these pedagogies by constraining opportunities for deep reflection, critical dialogue, and the development of the systemic, long-term thinking required to address grand challenges (Lifshitz-Assaf et al., 2021).

3. METHOD

To understand the effectiveness and purpose of educational hackathons in management education, particularly in the context of sustainable development, this study has been conducted in two steps.

At first, the researchers gathered preliminary information from five different hackathons they organised at a French business school since 2016 (see Table 1 for details). These hackathons focused on sustainability themes and involved a variety of stakeholders, including educators, students, programme managers and external partners. Common reflections indicated dissatisfaction with the achievement of educational goals, mainly due to institutional constraints and misaligned stakeholders’ expectations.

In a second step, these reflections and insights were then further explored through an in-depth study conducted on the Critical Marketing Hackathon (Table 1) at the same institution. Part of a Master’s Marketing Major, this hackathon was held twice yearly. Over two days, student teams developed innovative marketing proposals addressing environmental and social issues related to packaging and waste. This hackathon capped a module on SDGs, stakeholder engagement, and carbon footprint assessment. Three external experts—from business, the public sector, and an NGO—participated as consultants and provided feedback during final pitches.

Table 1.
Summary presentation of the hackathons studied.

Name	General Theme	Methodology	Participants	Ext* Part	Organising Team	Dur *	Rec*
LSP® Workshop	Defining growth through cross-functional approaches (management, technology, construction and urban planning)	Workshops based on the LEGO® SERIOUS PLAY® methodology	40 postgraduate students (management, engineering and architecture schools)	No	1 lecturer specialised in economics; 1 instructional designer specialised in CSR	2 days	None
Urban Lab	Addressing global challenges related to the city of tomorrow	Design thinking methodology	110 Master's level (M2) students (management, engineering and architecture)	Yes	5 programme coordinators; 1 institutional representative ; 1 instructional designer	3 days	Since 2016
CSR Challenge	Working on a CSR issue linked to one of the Sustainable Development Goals (SDGs)	Ideation process combining phases of divergence and convergence	120 to 156 students enrolled in specialised Master's programmes in management	Yes	1 lecturer specialised in CSR; 1 instructional designer specialised in CSR	2 days	Annual since 2017
Plastic Forum	Understanding major environmental challenges and related CSR strategies	Role-playing activities, short lectures, discussions and team work	105 to 130 students from the International Master in Management	No	2 lecturers specialised in CSR	1.5 day	Annual since 2017
LID	Prototyping a collective urban henhouse	Learning-by-doing approach with immersion in a fablab	30 undergraduate students (management, engineering and architecture)	Yes	2 lecturers specialised in maker culture and design; partnership with a fablab	2 days	Not renewed for this theme
Critical Marketing Hackathon	Redesigning product market positioning to integrate environmental and social issues	Role-playing, expert talks, short lectures and team work	73 Master's level students majoring in marketing	No	4 lecturers; 1 instructional designer	2 days	Twice yearly since 2020

**Ext.Part: External Partner; Dur: Duration ; Rec: Recurrence*

Data was collected via student surveys, before and after the event, (260 responses), which included open and closed questions about their expectations, perceptions of the hackathon's relevance, and its value as a teaching tool. Additionally, 13 semi-structured interviews were conducted with educators, program directors, and external stakeholders. Interviews, lasting 17 to 62 minutes, were transcribed and thematically analysed using Nvivo software, with a final list of 16 themes agreed upon by the authors.

4. RESULTS

The benefits of the hackathon were recognised by students, experts, and school management. However, its specific format also generated some frustration. For teachers and managers, another major problem was highlighted: logistical tasks. The hackathon's organisation required a lot of time and energy, which also created some frustration among teachers, who felt they had less time to devote to instructional design.

4.1. Benefits of the Hackathon

Hackathons introduced something new to the curriculum, offering students a practical way to engage with critical marketing. Students said they were *"Pleasantly surprised; two very well organised days."* (Student G), that the hackathon was *"a playful way of discovering a teamwork topic"* (Student H), and *"I learned a lot and found the format very interesting."* (Student A). The format was seen as concrete, immersive and stimulating, giving *"a better understanding of the role and place of marketing in the integration of social and environmental issues"* (Student D). It also encouraged perspective-taking: *"It was very interesting to put ourselves in the place of the different stakeholders [...] and why the solutions are not so simple."* (Student B).

Experts agreed it raised awareness of sustainability: *"I think it is a good challenge [...] going forward it should be the job of a marketer to learn sustainable products. [...] This format is a very good exercise, because they have to adapt [...] with people that have different points of view, different perspectives, different objectives."* (NGO).

For directors, the main goal was to test innovative teaching and foster interdisciplinarity: *"It's difficult to get disciplines to talk to each other [...] when you look at the environment, you look at it from the point of view of strategy, marketing and so on."* (DIR 2). Another benefit was shared learning across backgrounds: *"So the idea [of hackathons] is really to have a time when all the students could get together and share a common learning experience."* (DIR 3). Hackathons also enabled teachers to innovate: *"So that teachers can [...] explore new subjects. I'd also say open up the teachers' chakras."* (DIR 3).

Educators highlighted fruitful collaboration across expertise: *"It's interesting: there's a bit of a skills transfer between us. [...] We support each other well, there's a good chemistry."* (Prof 2). However, participants' experiences also exposed notable points of frustration.

4.2. Frustrations Linked to the Hackathon Format

Students felt that the hackathon format was inappropriate for developing new solutions. Many of them would have liked to continue the project and engage more extensively with stakeholders and companies: *"It was exciting, and it would be great to continue, by trying to explore our ideas in more depth and contacting the right stakeholders who could be involved in the project."* (Student F). The students found the experience very demanding and intense; this was exacerbated by its programming just before the final exam period of the semester. *"I found this experience tiring, short and uninteresting. I can explain: working from 9 a.m. to 6 p.m. is not the problem, the problem is rather having precise and consistent expectations in a short space of time and not having to take a break (one 50-minute session in the afternoon)."* (Student J) and suggested to *"Leave 1 hour more for producing the poster, because that's what we'll be graded on."* (Student K). Other comments indicated the event had been too long suggesting: *"Slightly less time, segment the work into even more precise points"*. (Student L).

The graded output of the hackathon was a poster expected at the end day two which created a certain amount of stress for some students. *"I was very stressed on the first day, partly because the event took place within 2 days of the finals, partly because, apart from the academic aspect of the Hackathon, it represented 50% of the score for 4 credits [...]"* (Student N).

However, the teaching team recognised that this could be taken further. Students remained at the ideation stage and were unable to move on to prototyping: *"The problem was that the [...] format prevented us from going as far as we wanted. Today, it's about ideation, not prototyping."* (Prof 3).

Experts regret not having enough time to discuss matters with all the different teams and to give them feedback. *"If I [...] had more time, I could have maybe given a debrief to all the groups or even when the groups are brainstorming, I could potentially challenge them to push them further. I could try to do if there would be some time for that [...]"* (NGO)

4.3. No Common Objective Shared by the Different Stakeholders

One of the organisers' regrets was being too focused on the hackathon process, to the detriment of the content even though this point underlines how educators behave to ensure a student-centred approach as recommended in the field of constructivism. Students build their own knowledge through experience. *"On this hackathon, I worked a lot with [Prof 1] on the way the hackathon was going to be run, we worked a lot on the way we wanted the activities to be carried out, on the proposed missions we could carry out and the objectives. [...] But I think we could go further... [...] so that students can test their solutions in the field. A bit more than that. Because, in the end, they're ideas but they're a bit out of touch with the ground."* (ING) But by doing so, the hackathon seemed too structured for the person from the company, who considered that it doesn't allow highly original proposals to emerge. When comparing the Critical Marketing Hackathon to another hackathon he had attended in a different business school he noted: *"I believe yours is more framed. So I mean it is very squared, the students are quite consistent in the mission and the global level is homogeneous so from year to year I think [there is] good work and relevant insights because the angle is quite narrow.... in [the other school] the angle is not narrow enough [...] but at the end some of the projects are really useful, really insightful and they help to have a new perspective on my mission, even if 80 % of the products, it's fantasy [...]"* (Company)

In conclusion, the hackathon was well received by the students and the objective of raising awareness of sustainability in marketing was largely achieved. The inclusion of different stakeholder views was particularly appreciated. However, some aspects didn't seem to work so well, such as the expected outcomes, and there were disagreements about logistical aspects (limited timetable, advice given to students). Some students' experience of 'knowing that' and 'knowing how' might have been frustrating. The processes are not the same and the sustainability hackathon focuses more on procedural knowledge. Another problem was that in contrast to the original hackathons, the educational hackathons observed were highly structured. In fact, some students had not yet sufficiently acquired the skills of autonomy. In order to manage a variety of demands and challenges, the educators had to adapt the hackathon. Hacking the hackathon in this way created a lot of work for them, and in the end meant that the format no longer precisely fitted the definition of a hackathon.

5. DISCUSSION AND CONCLUSION

Our findings suggest that hackathons create value for different categories of stakeholders and therefore could form part of a forward-looking business school strategy of co-creation with stakeholders (Cavallone et al., 2021; Thomas & Ambrosini, 2021). However, to ensure that this practice-based tool can be used effectively as an educational tool in the context of grand challenges, some critical points should be considered.

5.1. Hacking the Hackathon: From Accelerated Innovation to Critical Experiential Learning

Our empirical results suggest that the diverse types of value generated by hackathons must be carefully balanced, as they differ from traditional teaching formats. Their visible event status can add value for programme managers, students, and external experts, but this must not compromise pedagogical integrity. A key aspect in using hackathons as pedagogical tools is to align objectives and expected outputs. Hackathons as practice-based tools focus on “answers” (Zapico et al., 2013), “innovative quick fixes” (Komssi et al., 2015; Macedo Guimarães et al 2021; Page et al., 2016) or “fast-paced innovative solutions” (Komssi et al., 2015; Macedo Guimarães et al., 2021; Page et al., 2016). However, our findings indicate that in the context of grand challenges, hackathons are more effective at creating awareness of complexity and fostering dialogue among diverse perspectives than at producing innovative solutions. Thus, evaluation design becomes critical: emphasizing final outputs within a short timeframe risk reducing complexity and undermining learning objectives. The focus on a final pitch or poster tends to push students toward simplified, incremental ideas and consensus over contestation, limiting their potential for transformative impact (Endrissat, 2019).

How hackathons are embedded within the wider curriculum matters too. Beyond logistical considerations, connecting them to pre- and post-event courses enhances pedagogical value, drawing on prior knowledge and extending learning toward action, innovation, and scenario-building. This integration could also reconcile external experts’ preference for company-specific outcomes with educators’ aim for broader applicability through subsequent critical analysis in other contexts.

Finally, the positioning of hackathons within programmes matters for skills development. While they support more self-directed or self-determined learning (Blaschke, 2012), such autonomy is most effective when scaffolded through earlier learning experiences. Educators therefore need familiarity with heutagogical principles and an awareness of students’ varying needs for guidance (Kenyon & Hase, 2010).

In conclusion, our findings call for caution and a clear pedagogical roadmap to ensure that hackathons retain educational integrity while preserving their appeal. This is especially relevant given the growing emphasis on multi-stakeholder sustainability education, the development of “green” competences in future leaders, and the rising popularity of hackathons in higher education.

5.2. A Conceptual Framework for Adapting Hackathons to Management Education

We propose a conceptual framework for using hackathons as pedagogical tools in management education that aligns with the long-term, systemic nature of grand challenges. The framework combines two perspectives—experiential-critical learning and

self-determined (heutagogical) learning—across three phases: before, during, and after the hackathon.

In the pre-event phase, emphasis is placed on preparing students and stakeholders by embedding the hackathon within a broader sustainability curriculum, providing tools for systems thinking and stakeholder analysis, and explicitly addressing the limits of accelerated innovation formats.

During the event, the framework advocates slowing down elements of the process to preserve pedagogical integrity. This involves creating structured opportunities for reflection and contestation, encouraging teams to engage with tensions and trade-offs rather than premature consensus, and valuing process outputs (e.g. stakeholder maps or scenarios) alongside solution pitches.

In the post-event phase, the hackathon serves as a springboard rather than an endpoint. Follow-up courses and projects extend selected ideas, critically examine implementation conditions, and revisit the hackathon itself as an object of analysis. This approach supports the development of sustainability-related competences—such as systems thinking, anticipatory and collaborative skills—while mitigating risks of superficial engagement.

Future research should further explore ethical and inclusion issues in pedagogical hackathons, particularly regarding workload intensity, accessibility, and value capture, to ensure coherence with sustainability values.

REFERENCES

- Aillerie, C. (2020). Quelles Potentialités Pédagogiques du Hackathon? *Reseau Canopé* Retrieved from: <https://www.reseau-canope.fr/agence-des-usages/quelles-potentialites-pedagogiques-du-hackathon>
- Arevalo, J. A., Mitchell, S. F., Rands, G., & Starik, M. (2020). Guest editors' introduction to the special issue: Sustainability in management education. *Journal of Management Education*, 44(6), 683-698. <https://doi.org/10.1177/1052562920962832>
- Beard, C., & Wilson, J. P. (2018). *Experiential learning: A handbook for education, training and coaching* (3rd ed.). Kogan Page.
- Beggs, J., & Dean, K. (2007). Legislated ethics or ethics education? Faculty views in the post-Enron era. *Journal of Business Ethics*, 73(4), 381-396. <https://doi.org/10.1007/s10551-006-9123-4>
- Bianchi, G., Pisiotis, U., & Cabrera Giraldez, M. (2022). *GreenComp: The European sustainability competence framework*. Luxembourg: Publications Office of the European Union. <https://doi.org/10.2760/13286>
- Blaschke, L.M. (2012). Heutagogy and lifelong learning: A review of heutagogical practice and self-determined learning. *The International Review of Research in Open and Distributed Learning*, 13(1), 56-71. <https://doi.org/10.19173/irrodl.v13i1.1076>
- Blaschke, L. M., & Hase, S. (2016). Heutagogy: A holistic framework for creating twenty-first-century self-determined learners. In B. Gros, K. Kinshuk, & M. Maina (Eds.), *The future of ubiquitous learning* (pp. 25-40). Springer. https://doi.org/10.1007/978-3-662-47724-3_2
- Briscoe, G., & Mulligan, C. (2014). Digital innovation: The hackathon phenomenon. *MIS Quarterly Executive*, 13(2), 67-76. Retrieved from: <http://www.creativeworkslondon.org.uk/wp-content/uploads/2013/11/Digital-Innovation-The-Hackathon-Phenomenon.pdf>
- Bruno, A., Diglio, A., Kalinowski, T. B., Piccolo, C., & Rippa, P. (2021). University-Business Cooperation to design a transnational curriculum for energy efficiency operations. *Studies in Higher Education*, 46(4), 763-781. <https://doi.org/10.1080/03075079.2019.1652810>
- Canopé, A. (2017). *Hackathons – organiser des défis pédagogiques*. Editions Canopé Retrieved from: <https://www.reseau-canope.fr/notice/hackathons-organiser-des-defis-pedagogiques.html>

- Cavallone, M., Ciasullo, M. V., Douglas, J., & Palumbo, R. (2021). Framing higher education quality from a business perspective: setting the conditions for value co-creation. *Studies in Higher Education*, 46(6), 1099-1111. <https://doi.org/10.1080/03075079.2019.1672644>
- Dean, K. L., Wright, S., & Forray, J. M. (2020). Experiential learning and the moral duty of business schools. *Academy of Management Learning & Education*, 19(4), 569-583. <https://doi.org/10.5465/amle.2018.0335>
- Doychinova, K. (2023). Teaching methods based on constructivism in environmental education. *Sciend*, 10(2), 97-108. <https://doi.org/10.2478/asn-2023-0017>
- Eisenhardt, K., Graebner, M. E., & Sonenshein, S. (2016). Grand Challenges and Inductive Methods: Rigor without Rigor Mortis. *Academy of Management Journal*, 59, 1113-1123. <https://doi.org/10.5465/amj.2016.4004>
- Endrissat, N. (2019). Hackathons: A field of dreams for 'collaborative innovation'? A review of recent studies. *Entreprendre & Innover*, 38(3), 69-75. <https://doi.org/10.5465/amj.2015.4004>
- Fabbri, J., Toutain O., & Glaser A. (2018). Hackathons & Co : entre fascination et rejet. *Entreprendre & Innover*, 38(3), 5-8. <https://doi.org/10.3917/entin.038.0005>
- Ferraro, F., Etzion, D., & Gehman, J. (2015). Tackling Grand Challenges Pragmatically: Robust Action Revisited. *Organization Studies*, 36, 363-390. <https://doi.org/10.1177/0170840614564593>
- Ferlie, E., et al. (2010) Developing a Public Interest School of Management. *British Journal of Management*. 21(1), 60-70. <https://doi.org/10.5465/amle.2010.51428567>
- George, G., Howard-Grenville, J., Joshi, A., & Tihanyi, L. (2016). Understanding and tackling societal grand challenges. *Academy of Management Journal*, 59(6), 1880-1903. <https://doi.org/10.5465/amj.2016.4007>
- Gréselle-Zaïbet, O., Kleber, A., & Dejoux, C. (2018). Le Hackathon en mode Design Thinking ou quelles modalités pour former à des compétences méthodologiques et comportementales ? *Management & Avenir*, 6(104), 149-171. <https://doi.org/10.3917/mav.104.0149>
- Hibbert, P., & Cunliffe, A. (2015) *Responsible management education*. *Academy of Management Learning & Education*, 14(2), 171-188. <https://doi.org/10.5465/amle.2013.0304>
- Howard-Grenville, J., Buckle, S. J., Hoskins, B. J., & George, G. (2014). Climate change and management. *Academy of Management Journal*, 57(3), 615-623. <https://doi.org/10.5465/amj.2013.0183>
- Kayes, D. C. (2002). Experiential learning and its critics: Preserving the role of experience in management learning and education. *Academy of Management Learning & Education*, 1(2), 137-149. <https://doi.org/10.5465/amle.2002.8509336>
- Kenyon, C., & Hase, S. (2010). Andragogy and heutagogy in postgraduate work. In T. Kerry (Ed.), *Meeting the challenges of change in postgraduate education*. London: Continuum Press.
- Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice Hall.
- Komssi, M., Pichlis, D., Raatikainen, M., Kindstrom, K., & Jarvinen, J. (2015). What are Hackathons for? *IEEE software*, 32(5), 60-67. <https://doi.org/10.1109/MS.2015.119>
- Lifshitz-Assaf, H., Lebovitz, S., & Zalmanson, L. (2021). Minimal and adaptive coordination: How hackathons' projects accelerate innovation without killing it. *Academy of Management Journal*, 64(3), 684-715. <https://doi.org/10.5465/amj.2018.1470>
- Macedo Guimarães, L. B. D., Bitencourt, R. S., Chrusciak, C. B., Derenevich, M. G., Poncini, C. R., Okumura, M. L. M., & Junior, O. C. (2021). Sustainability Hackathon: Integrating Academia and Companies for Finding Solutions for Socio-environmental Problems. In Leal Filho, W., Tortato, U., Frankenberger, F. (Eds), *Integrating Social Responsibility and Sustainable Development* (pp. 591-607). Springer, Cham. https://doi.org/10.1007/978-3-030-59975-1_40
- Montiel, I., Delgado-Ceballos, J., Ortiz-de-Mandojana, N., & Antolin-Lopez, R. (2020a). New ways of teaching: using technology and mobile apps to educate on societal grand challenges. *Journal of Business Ethics*, 161, 243-251. <https://doi.org/10.1007/s10551-019-04360-7>

- Montiel, I., Gallo, P. J., & Antolin-Lopez, R. (2020b). What on Earth should managers learn about corporate sustainability? A threshold concept approach. *Journal of Business Ethics*, 162, 857-880. <https://doi.org/10.1007/s10551-019-04260-5>
- Moore, R. L. (2020). Developing lifelong learning with heutagogy: contexts, critiques, and challenges. *Distance Education*, 41(3), 381-401. <https://doi.org/10.1080/01587919.2020.1766949>
- Nonet, G., Kassel, K., & Meijs, L. (2016). Understanding responsible management: Emerging themes and variations from European business school programs. *Journal of business ethics*, 139, 717-736. <https://doi.org/10.1007/s10551-016-3149-z>
- Page, F., Sweeney, S., Bruce, F., & Baxter, S. (2016). *The Use of the "Hackathon" In Design Education: An Opportunistic Exploration*. Paper presented at the 18th International Conference on Engineering and Product Design Education. Retrieved from: https://www.designsociety.org/publication/39074/the_use_of_the_%E2%80%99Hackathon%E2%80%9D_in_design_education_an_opportunistic_exploration
- Porras, J., Knutas, A., Ikonen, J., Happonen, A., Khakurel, J., & Herala, A. (2019). *Code camps and hackathons in education-literature review and lessons learned*. Paper presented at the 52nd Hawaii International Conference on System Sciences. Abstract retrieved from: https://www.researchgate.net/publication/330219800_Code_camps_and_hackathons_in_education_-_literature_review_and_lessons_learned
- Raatikainen, M., Komssi, M., dal Bianco, V., & Kindstom, K. (2013). *Industrial Experiences of Organizing a Hackathon to Assess a Device-centric Cloud Ecosystem*. Paper presented at the International Computer Software and Applications Conference. Retrieved from: https://www.researchgate.net/publication/261527272_Industrial_Experiences_of_Organizing_a_Hackathon_to_Assess_a_Device-Centric_Cloud_Ecosystem
- Schoemaker, P. J. (2008). The future challenges of business: Rethinking management education. *California Management Review*, 50(3), 119-139. <https://doi.org/10.2307/41166448>
- Silver, J. K., Binder, D. S., Zubcevik, N., & Zafonte, R. D. (2016). Healthcare hackathons provide educational and innovation opportunities: a case study and best practice recommendations. *Journal of medical systems*, 40, 1-7. <https://doi.org/10.1007/s10916-016-0532-3>
- Starik, M., Rands, G., Marcus, A. A., & Clark, T. S. (2010). From the guest editors: In search of sustainability in management education. *Academy of Management Learning & Education*, 9(3), 377-383. <https://doi.org/10.5465/amle.9.3.zqr377>
- Suominen, A. H., Jussila, J., Lundell, T., Mikkola, M., & Aramo-Immonen, H. (2018). *Educational hackathon: innovation contest for innovation pedagogy*. In *LUT Scientific and Expertise Publications*, Reports (No. 78). Lappeenranta University of Technology, ISPIM. Retrieved from: https://jyx.jyu.fi/jyx/Record/jyx_123456789_62595#
- Thomas, L., & Ambrosini, V. (2021). The future role of the business school: A value cocreation perspective. *Academy of Management Learning & Education*, 20(2), 249-269. <https://doi.org/10.5465/amle.2019.0239>
- Zapico, J. L., Pargman, D., Ebner, H. & Eriksson, E. (2013). *Hacking sustainability: Broadening participation through green Hackathons*. Paper presented at the Fourth International Symposium on End-User Development. Retrieved from: <https://www.diva-portal.org/smash/get/diva2:635996/FULLTEXT01.pdf>

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Chapter # 8

BECOMING A STEM FOCUSED SCHOOL: INITIAL PRIORITIES FOR SCHOOL TRANSFORMATION

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ABSTRACT

The global importance of science, technology, engineering, and mathematics (STEM) education is growing, prompting schools and policymakers to seek more effective ways to implement STEM instruction. Ministries of education are responding by creating specialized STEM-focused schools, which aim to cultivate critical thinking, experiential learning, and innovative problem-solving through an integrated, interdisciplinary curriculum. These schools often use project-based learning to connect with real-world applications and prepare a diverse student body, particularly those from underrepresented populations, for STEM careers. However, the implementation of such programs presents challenges. These obstacles can be better overcome with a purposeful pre-implementation framework that addresses key structures and conditions before significant changes are made. This chapter will review existing literature on STEM-focused schools and propose a research-based framework for initial priorities for the transformation to becoming a STEM focused school. This framework will provide teachers, administrators, and policymakers with a clear roadmap for successful school-wide STEM transformation.

Keywords: STEM, STEM education, integrated STEM, project-based learning, school change.

1. INTRODUCTION

STEM focused schools are those designed to prioritize science, technology, engineering, and mathematics as central components of their instructional mission. In the United States as well as across Europe, interest in schools that focus in STEM learning has grown over the past decades (Costello et al., 2020; Eisenhart et al., 2015) driven by repeated calls to strengthen STEM education and by heightened recognition that many future careers depend on continued innovation in science and engineering (National Academies of Sciences, 2024). In the United States, early efforts to define and structure such schools were led by the National Research Council (2011). Several models of STEM focused schools were identified, including inclusive, selective, and Career and technical education-focused schools; each with specific criteria aimed at advancing STEM learning (National Research Council, 2011). Additionally, STEM focused schools are found at all levels of the K-12 system, which means unique affordances can be leveraged to increase the successes of the school but also unique challenges may be present that inhibit their progress as well.

For most schools, transitioning from a traditional school, with traditional blocks of time for each content area, to a STEM focused school is a significant undertaking filled with many questions, uncertainties, and varied infrastructure challenges (Weiselmann et al., 2021). This means that for STEM focused schools to reach the level of quality and success they intend, several criteria must be in place. Some of the more critical criteria include implementing rigorous, integrated STEM curricula, fostering external partnerships with various industry

partners in the community, connecting and leveraging expertise from institutions of higher education, and prompting the didactical innovation and critical thinking necessary to support learning across content disciplines. In some contexts and regions in the United States, formal criteria have been developed to formally recognize these STEM focused schools, sometimes referring to them as STEM Designated Schools (Almus, Sahin, & Almus, 2016). Schools that successfully receive this designation typically undergo a thorough and demanding review process that requires the school to demonstrate how it meets the standards and expectations for schools of this nature.

For schools that wish to become a high-quality STEM focused school, even without the formal review process, often involves a substantial and difficult whole-school shift in what they have done before, how they have structured the learning during the day, and the ways in which teachers and teacher leaders collaborate to effectively make this change process viable. Without the foundational knowledge of what the priorities are for implementing this change, especially at the early stages of planning, schools can easily falter. If they are not adequately prepared through the development of essential structures, mindsets, and setting the conditions for change their unintentional lack of understanding can inhibit their progress. That is, if schools fail to understand the broader landscape of becoming a STEM focused school, they will likely fail in their efforts to become such a school. As such, a clearly defined plan of priorities can help school leaders navigate these challenges and better position themselves for the complexity involved. This chapter will detail the initial priorities beginning with the early planning stages and then continuing into the first years of the transition to a STEM focused school.

1.1. Conceptual Framework

Several conceptual frameworks for STEM education (Jackson et al., 2021; Kelley & Knowles, 2016; Roehrig et al., 2021) provide valuable perspectives on how schools might implement integrated STEM. Bybee's (2010) early model outlines a comprehensive ten-year framework for adopting, sustaining, and evaluating integrated STEM education reform through a series of broad, strategic phases. This study specifically pulls from the first two phases: the initial two-year period dedicated to infrastructure, hiring, and curriculum design, followed by a six-year period of active implementation. The core components of Phase I include unit development, strategic implementation (selecting specific school district so begin the rollout), and systemic buy-in. Phase II is a six-year scaling period focused on turning initial models into a widespread, permanent standard, including data-driven refinement, policy and standards alignment, curricular shifts, and continuous support. During these stages, the reform relies on continuous reflection and iterative changes to school policy and programming to address emerging challenges. His framework and timeline do not explicitly outline the implementation practices and structures needed to become a STEM focused school. Other scholars have examined particular aspects of STEM implementation or identified individual practices, but their work is not comprehensive in describing the full process or the foundational structures required prior to, and during, the early years of the transition (Slavit et al., 2016; Wieselmann et al., 2021). While existing frameworks provide valuable guidance and insight, a significant gap remains between the general concept of "implementing STEM" and the systematic, structured approach to transitioning from a non-STEM school to a STEM focused institution.

To address this gap, we draw on a broader framework of general school change, Ramhurry's (2024) process and framework for system-wide change in education. We take her description and literature review of the systemic nature of school change, and apply the principles to the context of STEM focused school transformation. Ramhurry describes

sustainable system-wide reform as an ongoing, cyclical process categorized into five distinct phases. In Phase One the reform facilitator assesses their preparedness, establishing rapport with leadership to build a foundation. Phase Two is where a core team of influential stakeholders is assembled to develop a shared vision, manage change-related resources, and identify obstacles. In Phase Three, the core team expands into multiple design and decision-making teams, fostering a wider culture of expertise and community liaison. Phase Four is where stakeholders discard outdated practices to design an ideal educational system centered on shared values and administrative support. It is not until Phase Five that the new system is gradually implemented and continually refined through formative assessments and feedback loops. This framework prioritizes a systems-level perspective and rigorous pre-implementation planning. The systems view recognizes that education change must be comprehensive, affecting all interconnected parts of the structure rather than being applied piecemeal. The importance of the multiple pre-implementation steps highlights that foundational phases, such as assessing readiness and assembling core teams are vital because systematic effectiveness depends on having a clear conceptual guide and checklist before execution.

2. BACKGROUND

The concept of a STEM focused school is a relatively recent educational model, gaining initial momentum following the call for improved K-12 STEM education models (National Research Council, 2011). These initial models were broadly categorized as inclusive, selective or technical and career-oriented. The landscape of these schools has since expanded, with various models emerging at all grade levels, including high school (Eisenhart et al., 2015; Erdogan & Stuessy, 2015; Scott, 2012), middle schools (Slavit et al., 2016) and primary schools (House et al., 2020). While these various models share common features, such as an interdisciplinary and real-world focused curriculum, they also exhibit distinct characteristics. These can include the criteria for admission, the use of a makerspace, or a strong focus on Career and Technical Education.

One particularly formalized version of a STEM focused school is the STEM designated school, which is a STEM focused school that has received official recognition after successfully meeting a set of rigorous criteria typically established by a state department of education or an accrediting body. This designation has been officially adopted by a growing number of states in the United States (Öner & Caparo, 2016). As such, this chapter will focus on these officially recognized STEM focused schools.

A review of current research identifies several key characteristics that are essential for the success of a STEM focused school. Wieselmann and colleagues (2021) created a synthesis of critical components adapted from other major studies and their findings towards critical components (Lynch et al., 2018; Peters-Burton et al., 2014; Peters-Burton et al., 2019). While the specific number and range of these features may vary, there is broad agreement on five common components: leadership, curriculum, teaching practices, partnerships, and school culture.

For a STEM focused school to thrive, a supportive administrative team with a clear mission and vision is essential (Wieselmann et al., 2021). Effective leaders are deeply committed to inclusive STEM education and recognize its long-term benefits. These leaders must be prepared to manage the tension, confusion, and other challenges that can arise during a transition to a new school model (Lesseig et al., 2019; Slavit et al., 2016). To address this, they must foster a culture of collaboration, open communication, and mutual respect. Leaders, including teacher leaders (Yow et al., 2021) in successful schools also play a crucial

role in enabling teacher autonomy. They proactively consider the needs of teachers, students, and the community through innovative solutions and uplifting leadership. However, Sikma and Osborne (2014) detail some of the conflicts that occur when a top-down mandate for change from the district leadership is taken. Their findings highlighted that a lack of clarity and buy-in among teachers about the purpose of a STEM focused school during the early stages created significant problems, especially in the curriculum design process. Likewise, Trott (2021) found that principals and other stakeholders reported that it took time and professional development to ensure that all members of the school community understood the objectives related to becoming a STEM focused school. For a STEM school to achieve its innovative goals, its leadership needs the autonomy to operate independently from other district mandates.

STEM focused schools typically implement an integrated curriculum, blending science, engineering and mathematics, often in the form of project or problem-based learning. Although the exact definitions and actual implementation of integration can vary (Lesseig et al., 2019), an operational definition that centers on learning that cannot be achieved in a single discipline alone is strongly encouraged (Bennett & Ruchti, 2022). While some schools use professionally developed materials, many create their own (Dallavis, 2023). The quality of these homegrown curricula can vary greatly, which in turn affects the implementation of effective teaching practices. A successful teacher-created integrated curriculum requires teachers to have a deep understanding of science, engineering, and mathematics standards, as well as the pedagogical knowledge to connect these disciplines (Bennett & Ruchti, 2022).

Furthermore, effective STEM focused schools are characterized by instructional practices that are active, research-backed, and designed to immerse students in STEM content, process and habits of mind. Project and problem-based learning, which is typically situated in an authentic context, and emphasizes deeper learning is a key pedagogical approach in STEM Focused schools. For these practices to be successful, teachers must be highly qualified and possess advanced pedagogical content knowledge in STEM and/or practical experience in STEM careers. To support this, teachers in successful STEM schools are provided with opportunities for online professional learning, collaboration, and interactions with STEM education experts and professionals. In addition, these schools use data-driven decision making for continuous improvement. Assessment and data systems are used to inform and refine teaching strategies, student supports, professional learning and the allocation of resources.

Additionally, external partnerships are important for increasing the school's capacity for STEM programming and preparing students for college and career readiness. High-functioning STEM focused schools understand the importance of connecting students with their future careers, building these connections which should be a focus from the primary grades through graduation (Dare et al., 2021). External STEM partnerships with universities, businesses, and industry leaders provide critical support. These connections offer students real-world opportunities and valuable insights into emerging technologies and industry trends, which prepares them for the dynamic demands of STEM careers (Detgen et al., 2021). Additionally, successful STEM schools make sure that the families and community have a voice in the decisions and are included in the school's activities. By establishing and maintaining a strong community presence, emerging STEM schools ensure their initiatives are well-supported and relevant.

Moreover, and of substantial importance, a STEM focused school has a collective school culture that fosters a sense of personal, intellectual, and social-emotional safety. The environment must be built on mutual trust and respect, and maintain high expectations for both students and staff. In this culture, students are given agency and choice in their

learning, empowering them to take ownership of their education. Similarly, teachers are granted professional autonomy, allowing them to make choices in their teaching that best serve their students. This balance of high expectations and shared trust creates an environment where students and educators can succeed.

3. CONTEXT AND DESIGN

In this study we wanted to investigate the perceived priorities of educational leaders from STEM-Designated schools regarding the structural, pedagogical, and cultural implementation elements required to transform a traditional school into a STEM-Designated School. The participants in this study were ten educational leaders from STEM-Designated schools from the Mountain-West area of the United States. The educational leaders came from schools with different grade level structures; five of these leaders were from kindergarten through grade six primary schools, two from kindergarten through grade eight schools and two from high schools with the typical grades nine through twelve. All participants had successfully guided their schools through their state's STEM designation process within the past four years. The participants were also members of an established professional leadership group with knowledge of the process. This professional leadership group provided networking opportunities and access to a shared context for on-going professional learning and peer-peer informal mentoring experiences.

An online survey was created and distributed to the participants to gather their perspectives on the implementation priorities for becoming a STEM-Designated School. This survey was developed around multiple research-based sources and other STEM learning outcomes from leading STEM organizations including state standards for STEM designation, core integrated practices from EL Education (2023) and Weiselman's (2021) synthesis of the critical characteristics of STEM focused schools which is grounded in the work of prominent STEM education research (Crotty, 2018; Peters Burton et al., 2020; Peters Burton et al., 2014). The survey was divided into three main sections each addressing a larger element of the change process. Specifically, these elements were centered on school structures and other organizational aspects, pedagogy and active learning, and the overall culture of the school. Each of these sections addresses a critical aspect of becoming a STEM designated school and allows the research team to better capture participants' priorities for a five-year transformation from a traditional school into a STEM focused school. Appendix A outlines the three sections and the specific elements of each section.

In the first section, participants ranked a series of structural and organizational elements according to when each element should become a focus in the transformation process (e.g., in place before beginning the process, Year 1, Year 2, Year 3, Year 4, Year 5, or not important). Broadly speaking, the elements for the first section addressed organizational structures and leadership practices, as well as processes such as scheduling and the curriculum design process. The second section centered on instructional practices. Participants evaluated the importance of various pedagogical goals, including fostering student engagement in problem-solving and project-based learning, promoting cross-curricular integration, incorporating performance-based assessments, and providing professional learning opportunities for staff. The final section asked participants to rank priorities related to school culture, focusing on goals such as family and community engagement, college and career readiness, and technology integration in the classroom. In each section, participants were also invited to provide qualitative comments to further explain their rankings and share additional insights.

4. RESULTS

The results presented in this chapter focus on the initial priorities identified by participants. Specifically, only those priorities considered as the most important either prior to beginning the transformation from a traditional school to a STEM focused school or during the first year of the transformation are discussed below.

With respect to the first element, School Structural and Organizational Elements, the school leaders all indicated three of the sub-elements as being critical. These dealt with having evidence of teacher buy-in, evidence of school leadership buy-in and support, and evidence of district leadership buy-in and support. A fourth, the creation of a STEM leadership team, had strong support with at least seven of the ten agreeing it was a critical early element for success. This suggests that the collective commitments of key stakeholders are necessary from the beginning. Particular importance was given to the buy-in from various stakeholders. Participants highlighted in their comments that a successful transformation from a traditional school to a STEM focus school requires buy-in from teachers, school leadership and district leadership. For example, one leader noted that

“teachers need to understand what they are getting into, that they will be required to change how they teach, as well as what management looks like when kids are more autonomous; they have to buy into that and leaders need to help them feel supported.”

This buy-in cannot be a given; it must be cultivated and supported by leaders and willfully adopted by the teachers and other stakeholders. Overall, the comments suggest that when teachers and school leaders feel supported in the transition, they are more likely to embrace the new model.

With respect to the second element, Pedagogy and Active Learning, there was generally strong support for five of the sub-elements, with common team time and identifying basic evidence of the ideal or intended instructional strategies having the greatest support. Specifically, the qualitative comments highlighted the importance for dedicated and structured time for common planning. The leaders emphasized that this planning time should be established early in the process, ideally before the initiative officially begins. One leader commented,

“Common planning for both school-wide and grade level is just so much easier to build if done at the earliest stages, even before seeking designation so that you are not trying to face those hurdles with everything else going on. Schedule changes are logistical nightmares.”

Whereas another leader stated,

“When becoming a STEM school, time to develop and coordinate curriculum and instruction is crucial. It is when teachers can collaboratively plan lessons, create assessments and how we ensure consistency across classrooms and grade levels. Without time set aside to do this work, it just cannot get done.”

These comments made it clear that without this protected time, the transformation from a traditional school to a STEM focused school may be unsuccessful from the beginning. However, the emphasis on common team and planning, highlights a potential concern. While understanding standards or learning outcomes in mathematics and science was considered important, it was less important than the previous three. This is of particular interest as the three identified as being of slightly greater importance, including the common team and planning time, all rely on a solid understanding of the learning outcomes in order for them to

be successful. That is, without a robust knowledge of specific learning outcomes, such as the science and mathematics standards, teams may not be aligned in what they want students to know and be able to do and thus cannot meaningfully discuss how best to support student learning. And while the difference between understanding the standards and the others may be small, the substantial importance of understanding standards and learning outcomes, both at an individual teacher level and at a collective team level, cannot be understated. In fact, one education leader stated,

“Our professional development wasn’t very focused or effective at first. Some teachers understood the science standards, but others didn’t, so they couldn’t have conversations about the nuances in their planning and curriculum development without having to go back and reteach. I’d make sure all teachers had at least some basic understanding before starting the process.”

Also related to the second element, another important priority among leaders was ensuring teachers possess foundational instructional skills and at least a basic understanding of how to create learning experiences aligned to the science and mathematics standards. One leader emphasized that “without the basics, teachers can get overwhelmed in the shift to project-based learning when they don’t even have a basic understanding of active learning strategies or the standards that we are building on.” Collectively, these perspectives highlight school leaders’ priorities in establishing a baseline of instructional strategies and STEM teaching competencies early in the transformation process and how even though some elements and sub-elements may be priorities to the educational leaders, moving on without a team cohesiveness and collective understanding further restricts the school’s progress.

Lastly, and with respect to the third element, Culture and Character, which centers on building a strong school culture both within the building and beyond with the greater community, at most, four of the ten participants believed any one sub-element was important. In fact, the highest scoring sub-element was family communication and no more than four participants viewed this as important during either the pre-planning stage or in the initial implementation phase. The overall lack of attention to developing a strong culture around becoming a STEM focused school is perhaps one of the more surprising findings in this study. The research literature is unequivocally clear on the importance of a unified and strong school culture and the role educational leaders play in creating this culture.

5. FUTURE RESEARCH DIRECTIONS

Future research should continue to explore the complexities of successful and unsuccessful school transformations. While we know that the essential role of school and teacher leadership has been established, there is a need to identify the specific leadership practices that are most effective, including a closer examination of how school and district leaders cultivate a culture of innovation, manage resistance to change, and ensure the sustainability of the STEM identity over time, particularly in the face of staff turnover, and shifting resource availability as well as policy and political change.

In addition, research can focus on the specific hurdles schools face after the initial decision to change has been made. For example, a deeper understanding is needed of the most common challenges in defining and integrating the four STEM disciplines and how schools overcome logistical problems, especially in creating schedules that support common planning time. A key area for future inquiry is understanding the specific and critical features of an integrated STEM curriculum and pedagogy that lead to improved student learning outcomes and yet is able to be created and adopted by teachers.

Finally, the role and structure of professional learning in the STEM focused school needs further examination. Instead of simply knowing that it must exist, future studies should explore multiple professional learning models and measure their impact on teacher practice, confidence, professional identity, and student outcomes.

6. DISCUSSION AND CONCLUSION

To begin, school leadership needs to establish a culture and structures conducive to change (Beare et al., 2018; Leithwood et al., 2020; Turan & Bektas, 2013). This includes deliberate attention to common beliefs within the leadership team, consistent and frequent communication around the vision for the school and purpose for change, collaboration with multiple internal and external stakeholders, and an accountability to professional learning. Each of these will be discussed in further detail below.

To successfully transform into a STEM focused school from the beginning of the transformation process, leaders must first establish a culture and structure that is conducive to change. Our findings indicate that educational leaders heavily prioritize this process; securing buy-in from teachers, school leadership, and district leadership from the very beginning matters. This includes creating a clear, comprehensive vision for STEM education that is communicated to and understood by all stakeholders. A clear vision for change is not only necessary, but the first element to clearly define and establish. A comprehensive vision highlighting the benefits of STEM education for students, teachers, and the broader community must be accessible and understandable to all (Grant, 2023). Within that vision and the long-term plan for achieving that vision, measures of success, and how success will be evaluated, including ensuring students from underrepresented populations have equal access should be clearly described. The leadership team should also consider other school initiatives that may not fit the new STEM education vision, and may take away from the vision as this may lead to confusion around purpose and intended outcomes. A critical next step is to form a dedicated STEM Leadership Team composed of teachers and administrators to guide the vision's development and ensure a phased approach to implementation.

Next, the STEM leadership team will need to engage a variety of stakeholders early in the planning process. Building relationships, as well as maintaining open and regular communications, with a variety of stakeholders is critical anytime a major initiative begins (Crotty, 2018). Parents and families are a natural group to include but the STEM leadership team should make deliberate efforts to include community leaders, industry partners, and aligned community organizations from the planning phase onward. These stakeholders bring insights and perspectives not often found within the internal school community and the leadership team should be prepared to leverage these partnerships to enhance learning opportunities, mentorship programs, and access to real-world STEM applications. Additionally, the STEM leadership team should host regular outreach and educational events, such as STEM “Open Houses” to showcase student work and STEM Family Nights to provide hands-on STEM experiences for families, fostering transparency and buy-in. In doing so, informal opportunities to continually educate these external stakeholders are created.

Simultaneously, some internal structures must be adapted or adopted to support the long-term intended change. For example, schools must create schedules to ensure teachers have sufficient common planning time, both within their subject areas and across interdisciplinary teams. Ideally, teams would adopt the Professional Learning Communities structures, as established by DuFour and colleagues (2024), wherein the intentionality of the team is on creating a shared and clear understanding of what they want students to know and

be able to do, developing assessment practices to know if this learning occurred, and then how best to support students who did not learn it or how to challenge those who did. Additionally, time should be built into the schedule for regular whole-school professional learning sessions to enhance teacher expertise and promote collaboration (Ruchti et al., 2018). In time, this will lead to teacher-driven professional learning, which further builds the internal professional capacity of the teachers and teacher leaders. Furthermore, schools should consider ways to create flexibility in the daily schedule in order to support interdisciplinary curriculum and instruction, allowing time for collaboration, exploration, reflection, and targeted support. It is worth considering options such as block scheduling, interdisciplinary periods, or advisory time for collaboration and for exhibition days when students showcase their work.

In this study, none of the educational leaders indicated that considering potential financial obligations should be examined in the planning stages, prior to implementation. This is of substantial concern but may be rooted in a belief that expenditures will be similar after the transition. However, the STEM leadership team needs to be clear on the potential financial implications associated with the transition. This includes considering what additional STEM-aligned curricular resources will be needed and when, technology resources, maintenance of the technology, and additional training or professional learning opportunities for teachers and support staff, to instructionally leverage the technologies. Likewise, the team needs to inventory their current technology resources as they may need to invest in, or update, additional classroom technologies such as laptops, tablets, and interactive whiteboards or data collection probes and software. For some schools, it is worth considering whether a dedicated STEM lab or “Makerspace” is needed; each space may need to be designed and equipped for hands-on experimentation and prototyping. Lastly, the STEM leadership team needs to understand the school’s internet capacity. In some situations, or geographical locations, the current bandwidth and internet speeds will not support digital tools and online learning. Finally, given the potential initial investment in resources, the STEM leadership team should have a plan for any shifts in resource allocation. That is, by prioritizing technology needs, the leadership team will be better positioned to reallocate financial resources appropriately if or when the situation arises to do so.

Lastly, the STEM leadership team needs to understand how they are going to assess their progress by developing and using appropriate evaluation and continuous improvement tools. To begin, they should define clear measures of success and establish data collection processes to evaluate progress; leveraging the expertise of external stakeholders, such as higher education experts or STEM consultants, is often needed. The STEM leadership team should use this data to inform ongoing adjustments and ensure continuous improvement of STEM initiatives as would be done in a professional learning community (DuFour et al., 2024). However, the team should also use multiple other measures of effectiveness outside of student achievement tests. For example, one common measure of success or goal of STEM focused education is expanding the number of students who pursue advanced degrees and careers in STEM, in particular for women and other underrepresented groups (National Research Council, 2011). Regardless of which measures of success and instruments used to assess this success are used, the intentionality in developing these are necessary.

Although the discussion of this study is on educational leaders’ perceived priorities around this pre-implementation framework for becoming a STEM focused school, it is important to remember that this change involves not only curricular modifications and resources. Shifting from a traditional school to a STEM focused school also necessitates a fundamental shift in school culture and operations. One of the foundational considerations is understanding and honoring the unique characteristics of a school and its community; each

school operates within a distinct ecosystem of traditions, values, and expectations. Therefore, as schools move forward with this transformation, it must be a dynamic, adaptive process shaped by the unique contexts, histories, and relationships within each school community. Change is never a static event, but is a continuous evolution influenced by real-time interactions and negotiations among stakeholders, including faculty, staff, administrators, and the broader community. Most often, schools must respect and integrate existing traditions while simultaneously fostering innovation. Prioritizing the school's current social and cultural context ensures that implementation is meaningful and sustainable, and also allows for the evolution of practices and the incorporation of community values. By embracing this adaptive and flexible approach, schools can foster a systematic, equitable, and lasting shift toward high-quality STEM education.

REFERENCES

- Almus, K., Sahin, A., & Almus, M. (2016). *Does STEM designation matter? A longitudinal analysis of T-STEM academies' performance in mathematics*. Paper presented at the National Council of Teachers of Mathematics Research Conference, San Francisco, CA.
- Beare, H., Caldwell, B. J., & Millikan, R. H. (2018). *Creating an excellent school: Some new management techniques*. Routledge.
- Bennett, C. A., & Ruchti, W. (2022). Designing intentional STEM connections: An initial case study in an American curriculum school. *Proceedings of the Twelfth Congress of the European Society for Research in Mathematics Education (CERME12)*. <https://hal.science/hal-03745356v1>
- Bybee, R. W. (2010). Advancing STEM education: A 2020 vision. *Technology and engineering teacher*, 70(1), 30-35.
- Costello, E., Girmé, P., McKnight, M., Brown, M., McLoughlin, E., & Kaya, S. (2020). Government responses to the challenge of STEM education: case studies from Europe (ATS STEM Report #2). <http://dx.doi.org/10.5281/zenodo.3673600>
- Crotty, E. A. (2018). *Understanding the Ways in Which Teacher Leadership Teams Influence STEM Integration in Emerging STEM Schools* (Order No. 10838553). Available from ProQuest Dissertations & Theses Global. (2108990126). <https://www.proquest.com/dissertations-theses/understanding-ways-which-teacher-leadership-teams/docview/2108990126/se-2>
- Dallavis, J. W. (2023). Becoming a STEM-Focused Catholic school: Insights into adopting a curricular specialization. *Journal of Catholic Education*, 26(2), 85-107.
- Dare, E. A., Keratithamkul, K., Hiwatig, B. M., & Li, F. (2021). Beyond content: The role of STEM disciplines, real-world problems, 21st century skills, and STEM careers within science teachers' conceptions of integrated STEM education. *Education Sciences*, 11(11), 737.
- Detgen, A., Fernandez, F., McMahon, A., Johnson, L., & Dailey, C. R. (2021). Efficacy of a college and career readiness program: Bridge to employment. *The Career Development Quarterly*, 69(3), 231-247.
- DuFour, R., Dufour, R., Eaker, R. Many, T. W., Mattos, M. & Muhammad, A. (2024). *Learning by doing. A handbook for Professional Learning Communities at Work* (4th ed.). Solution Tree.
- Eisenhart, M., Weis, L., Allen, C. D., Cipollone, K., Stich, A., & Dominguez, R. (2015). High school opportunities for STEM: Comparing inclusive STEM-focused and comprehensive high schools in two US cities. *Journal of Research in Science Teaching*, 52(6), 763-789. <https://doi.org/10.1002/tea.21213>
- Erdogan, N., & Stuessy, C. L. (2015). Modeling successful STEM high schools in the United States: An ecology framework. *International Journal of Education in Mathematics, Science and Technology (IJEMST)*, 3(1), 77-92.
- EL Education (2023). *Core Practices: A Vision for Improving Schools*. Retrieved from <https://www.eleducation.org/resources/core-practices-updated/>

- Grant, L. E. (2023). *STEM Elementary Schools: Teacher and Administrator Perceptions and Concerns* (Order No. 30314175). Available from ProQuest Dissertations & Theses Global. (2836683616). <https://www.proquest.com/dissertations-theses/stem-elementary-schools-teacher-administrator/docview/2836683616/se-2>
- House, A., Peters-Burton, E. E., Hinton, V. P., Remold, J., & Levin-Güracar, E. (2020). Critical components of STEM-Focused elementary schools. *Journal of Higher Education Theory & Practice*, 20(8).
- Jackson, C., Mohr-Schroeder, M. J., Bush, S. B., Maiorca, C., Roberts, T., Yost, C., & Fowler, A. (2021). Equity-oriented conceptual framework for K-12 STEM literacy. *International Journal of STEM education*, 8, 1-16.
- Kelley, T. R., & Knowles, J. G. (2016). A conceptual framework for integrated STEM education. *International Journal of STEM Education*, 3, 1-11.
- Leithwood, K., Harris, A., & Hopkins, D. (2020). Seven strong claims about successful school leadership revisited. *School Leadership & Management*, 40(1), 5-22. doi: 10.1080/13632434.2019.1596077
- Lesseig, K., Firestone, J., Morrison, J., Slavitt, D., & Holmlund, T. (2019). An analysis of cultural influences on STEM schools: Similarities and differences across K-12 contexts. *International Journal of Science and Mathematics Education*, 17, 449-466.
- Lynch, S. J., Burton, E. P., Behrend, T., House, A., Ford, M., Spillane, N., Matray, S., Han, E., & Means, B. (2018). Understanding inclusive STEM high schools as opportunity structures for underrepresented students: Critical components. *Journal of Research in Science Teaching*, 55(5), 712-748.
- National Academies of Sciences, Engineering, and Medicine. (2025). *Scaling and Sustaining Pre-K-12 STEM Education Innovations: Systemic Challenges, Systemic Responses*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/27950>
- National Research Council. (2011). *Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/13158>
- Öner, A., & Capraro, R. (2016). Is STEM academy designation synonymous with higher student achievement?. *Education and Science*, 41(185).
- Peters-Burton, E. E., Lynch, S. J., Behrend, T. S., & Means, B. B. (2014). Inclusive STEM high school design: 10 critical components. *Theory Into Practice*, 53(1), 64-71.
- Peters-Burton, E. E., House, A., Peters, V., & Remold, J. (2019). Understanding STEM-focused elementary schools: Case study of Walter Bracken STEAM Academy. *School Science and Mathematics*, 119(8), 446-456.
- Ramhurry, C. (2024). Comprehensive process and framework for sustainable system-wide change in education: A literature review. *Journal of Public Administration, Finance & Law*, (32).
- Roehrig, G. H., Dare, E. A., Ellis, J. A., & Ring-Whalen, E. (2021). Beyond the basics: A detailed conceptual framework of integrated STEM. *Disciplinary and Interdisciplinary Science Education Research*, 3, 1-18.
- Ruchti, W., Bennett, C. A., & Dunstan, M. (2018). Understanding quality work in mathematics: Supporting teachers in leading professional development. *Journal of Interdisciplinary Teacher Leadership*, 2(1), 19-28.
- Scott, C. E. (2012). An investigation of science, technology, engineering and mathematics (STEM) focused high schools in the US. *Journal of STEM education: Innovations and Research*, 13(5).
- Sikma, L., & Osborne, M. (2014). Conflicts in developing an elementary STEM magnet school. *Theory Into Practice*, 53(1), 4-10.
- Slavitt, D., Nelson, T. H., & Lesseig, K. (2016). The teachers' role in developing, opening, and nurturing an inclusive STEM-focused school. *International Journal of STEM education*, 3, 1-17.
- Trott, C. A. (2021). *Catholic Schools and STEM (Science, Technology, Engineering, and Mathematics): An Exploration of Stakeholders' Interest and Perceptions of STEM Programs in Elementary Schools*. Available from ProQuest Dissertations & Theses Global. (2646960841). Retrieved from <https://www.proquest.com/dissertations-theses/catholic-schools-stem-science-technology/docview/2646960841/se-2>

- Turan, S., & Bektas, F. (2013). The relationship between school culture and leadership practices. *Eurasian Journal of Educational Research*, 13(52), 155-168.
- Wieselmann, J. R., Roehrig, G. H., Ring-Whalen, E. A., & Meagher, T. (2021). Becoming a STEM-focused school district: Administrators' roles and experiences. *Education Sciences*, 11(12), 805.
- Yow, J. A., Lotter, C., & Criswell, B. (2021). The need for STEM teacher leadership. *School Science and Mathematics*, 121(3).

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APPENDIX A. Selection of Elements and Sub-elements for Prioritization

School Structural and Organizational Elements
Evidence of teacher buy-in (willingness to take risks, expand content and pedagogical K, etc.)
Evidence of school leadership buy-in and support
Evidence of district leadership buy-in and support
Evidence of parent/guardian buy-in and support
STEM Leadership Team
Project-Based Learning school schedule (adequate time for deeper learning)
Common school-wide teacher planning/development time
Common grade-level/departmental/interdisciplinary team planning time
School-based makerspace
Student-led conferences
Portfolio assessment
Advisories or Homeroom in middle and high school
Standards based grading
Financial resources for PBLs
School STEM Coordinator
Pedagogy and Active Learning Elements
Planning school-wide PBL
Revising school-wide PBL
Documenting school-wide PBL
Teaching and facilitating PBL
Understanding and teaching Idaho Science standards
Understanding and teaching Idaho Mathematics Standards
Curriculum Mapping school-wide PBLs (scope and sequence)
Performance Based Assessments of PBLs or other effective assessment practices
Integrating Engineering into projects, implementing EDP Schoolwide
Integrating reading, writing, and/or arts into projects
incorporating fieldwork, local expertise, partnerships into PBLs
Using sources of data to improve student achievement
Basic evidence based instructional strategies
Classroom management for PBLs
Culture and Character Elements
Defining and implementing a set of character traits (e.g. 4Cs, 21st Century, PBIS,)
Physical environment reflecting STEM focus (e.g. documentation panels, displaying student work)
Family communication and participation in school
Community communication and participation in the school
Systematic College and Career exposure, exploration and advising
Using sources of data to improve student achievement
Instructional coaching allowing for risk-taking
Systematic integration of Engineering Design Process schoolwide
Student mastery of learning shown in portfolios or other non-graded methods
Onboarding teachers new to school
Mentoring teachers new to school

Chapter #9

NAVIGATING CONTRADICTING EXPECTATIONS:

Study demands and resources in European games, animation and VFX education

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ABSTRACT

The games, animation, and visual effects (VFX) creative industries are characterised by high-pressure team projects and oversaturated job markets, leading to contradictory demands for students to become both humble team players and highly competitive self-promoters. Using qualitative semi-structured interviews and focus groups, this study examined the study demands and resources experienced by 50 participants across 12 European countries: educators (n = 28), students (n = 14), and recent graduates (n = 8). Drawing on Study Demands-Resources (SD-R) theory, which emphasises the importance of educational institutions balancing study demands and resources to support student well-being, this study demonstrates how curriculum reforms, faculty guidance, and peer networks (factors that should function as study resources) can instead transform into demands for students in these specific contexts. The findings also reveal adaptive strategies students developed in response to these conditions. This study extends SD-R theory by demonstrating conditions under which traditional resource-demand relationships operate differently than established patterns, contributing to theoretical understanding of student well-being in creative industries in higher education.

Keywords: games, animation and VFX industry, student well-being, study demands, study demands-resource theory, educational stress.

1. INTRODUCTION

Educational institutions increasingly recognise their responsibility to assess drivers of student burnout and engagement, and to initiate interventions at both individual and program levels (Bannigan et al., 2025). This requires coordinated institutional efforts: student counsellors need tools to identify early warning signs and intervene before students reach crisis points; lecturers need guidance for designing courses that balance learning objectives with sustainable workloads; and administrators need frameworks for evaluating which institutional structures support versus undermine student well-being. Effective, context-appropriate interventions depend on deep understanding of how demands and resources function within specific educational settings. Bakker and Mostert (2024) emphasise that rigorous sector-specific qualitative research is essential to explore how students perceive study demands and resources in relation to the systems around them, including the modulating influence of educators and the overall institutional climate.

The Study Demands-Resources (SD-R) framework (Bakker & Mostert, 2024) provides a systematic approach for this exploration by categorising study characteristics into demands and resources. In this framework, demands include study facets that impact physical, emotional, and mental well-being, such as high workloads (Travis et al., 2020), time

constraints (Lesener et al., 2019, 2020), and conflicting deadlines (Martin et al., 2021). In contrast, resources include factors such as lecturer and peer support (Cilliers et al., 2018) and developmental opportunities (Bakker et al., 2014), which can buffer the effects of study demands and contribute to student well-being (Bakker & Mostert, 2024). This study examines how sector-specific conditions shape study demands and resource dynamics within European games, animation, and visual effects (VFX) educational contexts.

The video games, animation, and visual effects (VFX) sectors are rapidly expanding industries characterised by high-pressure work environments demanding high-quality outputs under tight deadlines (Bourscheid et al., 2025; Horo et al., 2025; Wilkes et al., 2020) and oversaturated job markets with limited positions attracting large numbers of graduate applicants (Carey et al., 2024; GDC, 2025). These conditions make individual portfolio excellence the primary hiring criterion, not because studios undervalue collaboration but because market conditions make portfolio quality the most practical screening mechanism when hundreds of applicants compete for limited positions. Simultaneously, there is increased recognition of the importance of soft skills within the labour market (Poláková et al., 2023) and more specifically within the creative industries (Dooley et al., 2024; Munro, 2017). Educational institutions are increasingly responding to such industry needs by reforming curricula, shifting from modular learning emphasising individual technical skills toward collaborative, project-based and problem-based learning emphasising process over product (Hassreiter et al., 2024). Consequently, students in these programs face conflicting demands: becoming a competitive self-promoter while also becoming a humble team player (Hassreiter et al., 2024). Navigating these conflicting demands compounds the usual demands of higher education, including lectures, group projects, and assignments, placing students in these sectors under considerable strain.

This study applies the Study Demands-Resource (SD-R) theory to examine the specific demands and resources experienced by students in the high-pressure games, animation, and VFX industries, along with their coping strategies. It offers in-depth and nuanced insights into the dynamic interplay between demands and resources, providing valuable guidance for educational institutions aiming to enhance student well-being, support faculty, and promote sustainable preparation for highly competitive creative industries. Additionally, this research advances SD-R literature by extending its application in high-pressure educational environments beyond medical education (National Academies of Sciences Engineering and Medicine, 2019; Scheepers et al., 2024) to the creative media sector, addressing the tension between educational emphases on collaboration (which align with industry ideals) and hiring practices that prioritise individual portfolios (reflecting market realities). It also contributes to the growing body of work on media professionals' mental health and working conditions (Bourscheid et al., 2025; Bourscheid & Steil, 2024; Cote & Harris, 2021; Deuze, 2025) by shifting attention to students preparing to enter these fields, uniquely examining how contradictions between industry-valued principles and actual hiring practices manifest during educational experiences through an SD-R lens.

2. METHODOLOGY

2.1. Sample Characteristics and Data-Collection Procedure

This study is part of a larger project (PANEURAMA: <https://www.paneurama.eu/>). The findings reported here comprise semi-structured interviews conducted with 50 participants (n = 50): educators (n = 28), students (n = 14), and recent graduates (n = 8) in the European games, animation, and VFX industries (see Figure 1). Educators comprised full-time and part-time lecturers (also working in the industry), and project supervisors. All

students were in their final-year, which allowed them to reflect effectively on their educational structures. Recent graduates were junior professionals (< 2 years post-graduation), able to reflect on both educational structures, application and early career experiences within their sector.

Interviews focused on understanding how students experienced industry demands and job market pressures, and how their universities' educational offerings responded to these demands and pressures. Interviews lasted approximately 60 minutes and were conducted online between January and September 2024. Participants represented 12 European countries (see Figure 2) and recruitment followed purposive and snowball sampling methods. All participants provided written informed consent prior to participation. While gender-related demographic information was collected, such an analysis falls beyond this study's scope. However, the authors recognise that examining gender dynamics, particularly regarding how contradictory demands may differentially impact students of different genders, warrants future research.

Figure 1.
Distribution of participants by role across industry sectors.

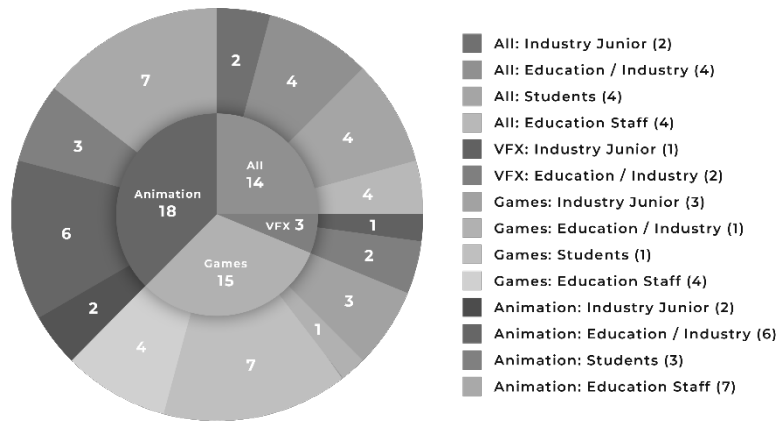
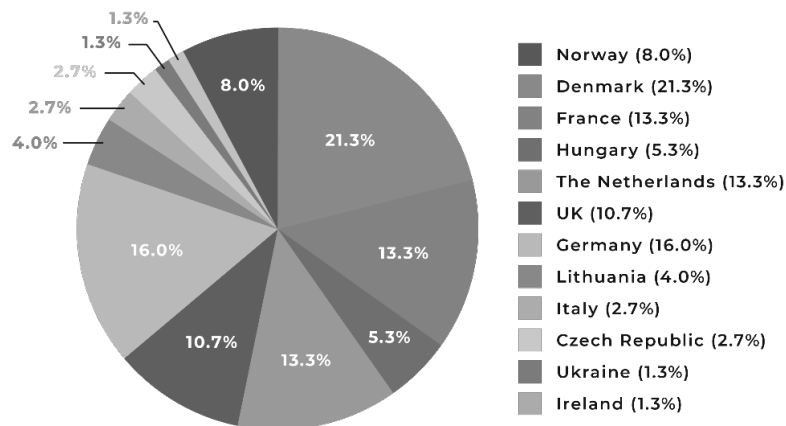


Figure 2.
Distribution of participants by country.



2.2. Data Analysis

Interviews were transcribed verbatim using Notta.ai and uploaded to ATLAS.ti for analysis. Transcripts were analysed using thematic analysis and informed by the Study Demands-Resource (SD-R) theoretical framework (Bakker & Mostert, 2024). While the SD-R theory provided a sensitising lens for understanding the relationship between study-demands and resources in educational contexts, the analysis remained inductive (Atkinson & Delamont, 2010), allowing key patterns and themes to emerge from participant narratives rather than imposing predetermined categories. Data were open coded by the first author, which involved allocating a short phrase to data segments which addressed the study objectives. Subsequently, the first and second authors met to discuss the codes and inform the development of preliminary themes by grouping codes with similar meanings addressing the research objective. These findings were finally discussed with the research team, incorporating their expert insights relating to both the industry landscape and educational practices in the games, animation, and VFX sectors.

Preliminary findings of the project were also presented at three industry conferences: FMX (Film & Media Exchange Conference) 2024 in Stuttgart, Germany; the International Animation Film Festival in Annecy, France; and the Viborg Animation Festival in Denmark. Through engaging in panel discussions and informal conversations with educators, students, junior and senior professionals, these conferences further reinforced the findings of this study concerning the demands experienced by students navigating these industries and their coping strategies. This checking process supports both the validity of our findings and their significance for educational practice, while also providing additional contextual depth to our understanding of these paradoxical dynamics.

3. FINDINGS

Our thematic analysis revealed five themes outlined below. These themes emerged as interconnected and compounding factors, creating a chain of escalating circumstances that demonstrated how well-intentioned educational resources such as curricula updates aligning with industry demands, well-meant advice intended at improving employability and student well-being, and peer relationships may transform into demands for students within games, animation, and VFX.

3.1. Curriculum Reforms: Discipline-Specific Resource-To-Demand Transformations

Bakker and Mostert (2024) noted that studying is a social activity where collaboration provides opportunities for enjoyable and fulfilling experiences through peer learning and shared work, but may also involve interpersonal conflicts, for example, because of unequal contributions to groupwork. Our findings confirm these dynamics: students reported having to engage in group projects requiring extensive coordination, generating conflicts over quality expectations, working styles, and uneven contributions across members. Crucially, however, our data identified asymmetries across these resource-demand dynamics within disciplines. Among art and animation students, group work was experienced as the primary time demand competing with portfolio work. Conversely, game design, directing, and programming students experienced groupwork primarily as a means of coordination that led to emotional demands when teammates' disengagement undermined their ability to demonstrate collaborative skills.

Among the art and animation students, group projects presented a complex challenge. Students in our study recognised collaborative learning as essential preparation for industry work, articulating that working together in educational settings was necessary to learn how to function in collaborative production teams later. However, they simultaneously acknowledged fundamental challenges: first, securing employment requires an exceptional individual portfolio. As one student explained the tension:

I think they [the university] put a lot of emphasis on learning how to work together and in a team, but it's a bit difficult portfolio wise and applying for studios because there is nothing I can show really to prove my soft skills on my portfolio, right? OK, they will see a group project and if the art is aligned, they will probably see: OK, multiple artists worked on this, they are able to work together and create something cohesive.

Secondly, using the same group projects in individual portfolios creates problems because portfolios from one university would look too similar, risking student potential to stand out with differentiated work. This represents a compounding stressor encountered by these students where collaborative skills matter for professional success once employed, yet remain largely invisible during hiring. Moreover, even attempting to demonstrate collaboration through shared projects in portfolios risks appearing generic rather than exceptional. As a result, students invest substantial educational time developing competencies they valued and recognised as important, which provide limited tangible career advantage at the critical juncture of securing initial employment.

[Group work] is cool, but it felt sometimes like a waste of time. [...] I was all the time working. I made my portfolio after school hours. The first entire half year of year three I just spent animating all the time. Making sure that I create a portfolio according to skills that companies want to see more. Catching up with the skills I lack. School work I rarely use in my portfolio. I think maybe one or two pieces out of the six, so it's mainly self-study work that I put in.

Several participants described experiencing a “double workload”. Here, learning time was spent on collaborative assignments to meet institutional deadlines that yield minimal portfolio utility. Consequently, additional hours (outside of a typical working day) are spent on developing individual pieces that would differentiate their portfolios from peers.

Students in game design, directing, and programming programmes within our sample reported different challenges within the same structures. Their work gained meaning through integration with others' contributions, making collaborative projects essential for demonstrating competencies. However, these participants encountered significant difficulties when teammates faced the double workload and portfolio differentiation pressures described above. As one game design student explained:

An example that really, really frustrates me, but I totally understand, is that many of the art students did not give a shit about group projects because they didn't need to. Their individual art pieces were actually more valuable for building a successful portfolio... The designer is heavily reliant on being able to work in a group context and produce work that is reflective of their design skill because a lot of design is foundational. So if there's nobody to build on top of your work like a programmer or an artist, then it doesn't exist. It doesn't come to life.

This participant's acknowledgment, “I totally understand,” reveals an awareness that their teammates' behaviour reflected a rational career strategy given portfolio requirements and differentiation needs. Yet, this understanding did not alleviate the demand. Instead, these

students reported investing substantially more time in coordination compared to collaborative and discipline specific skill development, thus compensating for limited engagement by their peers. They either take on additional work themselves, or accept lower quality group outputs which for them and unlike their teammates, served as primary demonstrations of their capabilities

3.2. Faculty Guidance: Resource-to-Demand Transformation Through Contradictory Messages

According to SD-R theory, faculty support and guidance represent key study resources that buffer demands and promote engagement (Bakker et al., 2015, as cited in Bakker & Mostert, 2024). However, students in our study reported experiencing faculty guidance as a source of stress and confusion when teachers provided conflicting messages about what to prioritise. While individual teachers were valued as mentors, students described the faculty as a whole creating additional demands through divergent expectations, they felt compelled to meet simultaneously. Educators confirmed this lack of pedagogical consensus, and validated students' experiences of contradictory guidance.

The differing educator-guidance experienced by students included, some educators emphasising collaborative work, group projects, and soft skills as being essential for evolving workplace cultures, and others prioritising the development of technical excellence and portfolio development for securing future employment. This conflicting educator advice within programmes was confirmed by an educator who explained:

The tricky thing is that even within our degree programs, we don't have consensus on this [teaching approach], because there are still industry veterans that say no, this is how the industry works [they need individual excellence]. [...] More people are talking about healthy, sane working practices. But that's not a universal message yet, and I don't think we can get away with a universal message yet.

Students are consequently left to reconcile these conflicting messages, as they may need to satisfy both sets of expectations to pass courses, and maintain relationships with all faculty. Crucially, this pedagogical divergence is not hidden or subtle, as another participant noted:

We have a hierarchy problem. Most teachers that come from the industry and teach are seniors, but they rather talk about past experiences in the industry and perpetuate. The ones that talk new practices are the ones that are juniors. That makes it difficult to change overall approaches in Universities due to hierarchy issues.

Educators further described the contextual factors creating these divergent approaches. As one explained, they cannot emphasise only collaboration because industry partners would criticise graduates for lacking technical skills. Yet focusing only on technical excellence perpetuates unsustainable practices. One educator explicitly articulated the conflict students must navigate:

That leaves us as an education in an incredibly tricky situation. Do we teach right now for the skills they need to get a job today, or do we teach what the industry should be according to a little more liberal interpretation of what a healthy workforce is? And there is a direct conflict with that.

As such, the contradictory educator guidance, represent systemic tensions rather than simple miscommunication from educators.

3.3. Wellness Initiatives as Performative Demand: When Balance Becomes Unachievable

Our study revealed a phenomenon not yet examined in SD-R research - institutional wellness messaging and faculty emphasis on work-life balance. Though well-intentioned and often expressed out of genuine concern for students, such messages can paradoxically transform into additional demands for students within the context of their heavy workloads, portfolio pressures and contradictory messages from educators. Amid such demands, a work-life balance is practically unachievable, causing such messaging to be perceived as a source of stress, compounding demands experienced by students. Specifically, while student participants in this study appreciated these messages and supported the principle of work-life balance, they noted feeling pressured to visibly demonstrate positive well-being and work-life balance, transforming wellness messages into a performative practice, and an additional task rather than serving as supportive resources.

“Every time a teacher enters the room, I feel like I have to strike a yoga pose.” This quote captures the performative aspect that well-being messaging takes, when students feel they must prove they are following institutional guidance about self-care while simultaneously managing the impossible workload created by competing demands. Within SD-R theory, this represents a particularly insidious form of demand escalation: the institutional resource intended to buffer stress, which instead becomes an additional performance expectation that students must manage alongside their already unsustainable workload.

Students find themselves caught between genuinely wanting to maintain healthy practices and feeling pressured to demonstrate their compliance with institutional wellness expectations. The transformation of well-being from a natural state into a performance requirement illustrates how even the most positive institutional intentions can become additional sources of stress when they exist alongside contradictory structural demands. Students cannot genuinely achieve work-life balance when structural conditions require them to invest full effort in both collaborative work and individual portfolios simultaneously. Yet they must perform balance for institutional audiences, adding the emotional labour of appearing well to the already excessive workload of their studies.

3.4. The ‘Newly Found Family’ that Becomes a Demanding Community

According to SD-R theory, peer support represents a crucial study resource that buffers demands, promotes engagement, and protects against burnout (Bakker et al., 2015 as cited in Bakker & Mostert, 2024). Social connections provide emotional support, practical assistance, and a sense of belonging that help students navigate academic challenges. Our data confirmed that peer networks function as major resources, yet also revealed how these same networks can transform into demanding communities that intensify pressure and create additional stressors.

Despite recognising that peers will be future sources of competition, students identified peers as their greatest resource during their studies. They valued peer networks for motivating each other as they complete educational tasks, sharing resources relating to the industry landscape, keeping each other updated on sought-after skills, and identifying potential employment opportunities. As one participant explained:

For sure, you kind of still want to be the best. But you also want your friends to succeed as well, right? So, we are really pushing each other. We motivate each other. I would not have managed to get where I am right now without my friends and that is really

important to me personally. They helped me continue. I helped them push. We all push each other and make sure that we did our best.

This mutual support and motivation exemplify how peer networks should function as study resources within SD-R theory, providing both emotional encouragement and practical assistance that buffer academic demands and promote sustained engagement.

However, while peers function as strong resources in academic and later work contexts, an overly deep sense of belonging can transform peer networks into stressors. Participants reported that students in these fields often experienced exclusion in previous educational settings for being different. When entering university, they frequently meet like-minded peers for the first time and experience deep friendship, which can lead students to push themselves to stay within their peer group and environment, even when they lack the skill level or mental and emotional capacity to remain in education and later in the industry sustainably. As one participant explained:

They [peers at educational institution] were my people and it was the first time I felt like I was part of a collective. I've never had that before. [...]. I think it's the people that were a bit ostracised by society because they are nerds, gamers. This even goes with the artists. They were probably doodling in their sketchbooks in high school, and then other people were like: 'Oh, look at that nerd just drawing'. Then you come all of a sudden to this place [university], where everyone has been ostracised at some point and you're like: 'Oh, we've all been going through the same for being different.'

An educator further explained this dynamic and its risks:

Often, these students have dealt with loneliness and exclusion, perhaps as loners in school. They weren't on the sports team, they weren't the centre of attention, they've been more in the background. Now, with this education, it is their chance to be seen, heard, and admired. And it's very dangerous [that they push themselves too hard].

This intense drive to prove themselves and belong can lead to unhealthy work-life balance, as the desire for validation from peers becomes a significant demand. Students may feel compelled to maintain their position within these high-performing communities, even when they lack the capacity to do so sustainably. In this way, the peer network that should buffer other demands instead amplifies them, students must not only meet institutional requirements but also maintain performance levels that preserve their valued social belonging.

3.5. When Multiple Demands Converge: Student Adaptive Responses

The contradictory demands from inside and outside the university create a confluence of stressors that fundamentally reshape the student experience. According to SD-R theory, when faced with high demands, individuals develop coping strategies that influence both well-being and performance outcomes (Bakker et al., 2015 as cited in Bakker & Mostert, 2024). Our data reveal diverse adaptive responses students develop to navigate the impossible workload created by structural contradictions. These adaptive strategies carry significant implications for both immediate well-being and long-term career sustainability.

The three primary adaptive responses we identified emerged inductively from student narratives about how they balanced competing demands. These were not predetermined constructs but patterns we identified through our analysis of how students described their study strategies and work ethics in response to contradictory institutional and industry pressures.

3.5.1. The Individual Excellence Approach

Some students prioritise standing out and dedicate significant time to mastering technical skills and building exceptional portfolios. This approach clashes with present curricula emphasising collaboration and creates tension between personal goals and the team-oriented structure of projects. As one student described the extreme workload this strategy requires:

In uni, I think my standard week was like 80 hours and then it would jump up to 110 at times. So eventually I also took a break for a year like between my 3rd and 4th year. [Then] I felt I lost time. I worked hard again and made up for putting a gap year in.

According to the participant, these students run the risk of overworking to create exceptional portfolios and gain visibility, fostering unsustainable work habits during university years. Despite their potential to gain a competitive edge in the job market through portfolio excellence, they might struggle with transitioning toward collaborative production teams when they secure employment in the industry.

3.5.2. The Self-Preservation Approach

Other students prioritise personal well-being while developing a solid foundation in both technical and soft skills. The curriculum's emphasis on group work aligns with their approach, allowing them to develop collaborative skills and share responsibilities in ways that support their balanced lifestyle. As one student explained:

If I think about it too much, then it gets stressful. Then I'm like, oh shit, maybe I also need to do that [work as hard as them], but I know for myself, I'm not even able to do that kind of stuff, like work so many afterhours and stuff. So for me, I'm kind of accepting it. Like we'll see where I land and I'm not trying to worry about other people.

Some students following this approach face difficulties securing employment despite having solid portfolios. As a result, they either consider working in other industries or adopt a competitive improvement approach (see below) during master's studies, using this time alongside full-time study to create stronger portfolios without creating gaps in their CVs. However, some teachers expressed concern about this trend, fearing this focus on work-life balance might lead students to self-limit and choose different career paths too early, potentially missing opportunities to reach their full potential.

3.5.3. The Competitive Improvement Approach

A third group focuses on individual excellence and creating exceptional portfolios alongside developing soft skills, actively engaging in peer networking and extracurricular activities for experience and insights, all while fulfilling educational tasks requiring participation in group work. This mindset attempts to meet all demands simultaneously. As one student described:

Game education is something that you have to sacrifice things for. It takes time, not just a regular nine to five. [...] You will do more outside of it because you will want to learn different things. You'll want to make a portfolio, so you gotta put in those hours. You gotta do your research for that in order to get to where you want to go. [...] Talk to those people, make connections right away. [...]. Be friendly, be flexible. [...]. You just need to work hard and be nice to get in.

As a result, these students often exceed 40-hour study weeks and sacrifice leisure time to meet their goals. Educational experts expressed concern about the potential negative impact of this approach on student well-being. One young professional who adopted this approach compared their study time to working in the highly demanding games, animation, and VFX industry: “Compared to the stress levels during my studies, a job in the industry feels like a walk in the park.”

When discussing these findings with teachers, the educators found it striking to gain such detailed insights into students’ perspectives and coping mechanisms, as they had not previously been aware of them to this extent. Recognising the potential impact on student well-being and learning outcomes, they indicated they would bring these findings to the wider faculty to discuss how teaching approaches and support structures might be adjusted in response.

4. CONCLUSION

This study points to a recurring pattern within the games, animation, and VFX programmes we examined: several well-intentioned educational resources can become experienced as demands when they are embedded in contradictory expectations. In our sample, curriculum elements designed to promote collaboration (Section 3.1), faculty support structures (Section 3.2), wellness initiatives (Section 3.3), and peer communities (Section 3.4) were often described by students as turning into demands. This shift occurred particularly when students felt they had to excel in both group projects and individual portfolios, navigate inconsistent or conflicting guidance from staff, “perform” wellness while facing high workloads, or maintain a sense of belonging within competitive peer groups.

Our findings contribute to SD-R theory by showing how resource–demand conversions can arise from structural contradictions in addition to individual or interpersonal mechanisms. In the contexts we studied, tensions between programme design (informed by industry-articulated ideals such as collaboration) and actual hiring practices (influenced by competitive market realities) appeared to create conditions where intended resources could no longer operate as SD-R theory predicts. In other words, resources were not “failing” due to student dispositions but because contradictions built into the institutional environment amplified the processes through which resources became demands.

4.1. Study Limitations and Future Research

Participants in this study were predominantly based in Northern and Central Europe, with limited representation from Southern and Eastern European regions, despite recruitment efforts. Therefore, the findings should be interpreted with important caveats concerning their generalisability across European educational systems with substantially different pedagogical structures, industry relationships, or labour market conditions. While our use of a snowball sampling method may have reinforced these effects, it provided access to participants with relevant experiences who could offer valuable insights.

This study captured participant experiences at a single point in time rather than tracking individual trajectories. Using longitudinal designs, future research could examine how students’ adaptive strategies evolve across their academic careers, and into early professional practice. Comparative studies across diverse geographic, cultural, and institutional contexts would also strengthen our understanding of how different educational models and industry relationships shape student experiences. Longitudinal, comparative, and mixed-methods research would help clarify which patterns are context-specific versus widespread, how adaptive strategies impact long-term well-being and career trajectories, and which

programmatic changes most effectively transform resources into genuine support rather than additional demands. Research should also consider gender differences, as Deuze (2025) notes persistent variations in experiences and outcomes across genders in media education and work, to ensure that interventions support all students equitably.

REFERENCES

- Atkinson, P., & Delamont, S. (2010). *SAGE Qualitative Research Methods*. <https://doi.org/10.4135/9780857028211>
- Bakker, A. B., & Mostert, K. (2024). Study Demands–Resources Theory: Understanding Student Well-Being in Higher Education. *Educational Psychology Review*, 36(3), 36-92. <https://doi.org/10.1007/s10648-024-09940-8>
- Bakker, A. B., Sanz Vergel, A. I., & Kuntze, J. (2014). Student engagement and performance: A weekly diary study on the role of openness. *Motivation and Emotion*, 39, 49-62. <https://doi.org/10.1007/S11031-014-9422-5>
- Bannigan, G., McGrath, D., & Matthews, J. (2025). Whole-university approaches to embedding well-being in the curriculum: a scoping review. *Frontiers in Education*, 10, 1534244. <https://doi.org/10.3389/FEDUC.2025.1534244>
- Bourscheid, D., & Steil, A. (2024). Crunch on the playground: long hours of work in game development. *Abstract Proceedings of DiGRA 2024 Conference: Playgrounds*. <https://doi.org/10.17605/OSF.IO/RC4M3>
- Bourscheid, D., Steil, V., & da Silva Paixão, E. (2025). Crunch on video game production: practices to avoid for healthier workplaces in Game Development. *Proceedings of the 20th International Conference on the Foundations of Digital Games*, FDG 2025. <https://doi.org/10.1145/3723498.3723730>
- Carey, H., Giles, L., Wilks, D., & Hickman, B. (2024). *Skills for Success in the UK Screen Industries*. WorldSkillsUK.
- Cilliers, J. R., Mostert, K., & Nel, J. A. (2018). Study demands, study resources and the role of personality characteristics in predicting the engagement of first-year university students. *South African Journal of Higher Education*, 32(1), 49-70. <https://doi.org/10.20853/32-1-1575>
- Cote, A. C., & Harris, B. C. (2021). ‘Weekends became something other people did’: Understanding and intervening in the habitus of video game crunch. *Convergence: The International Journal of Research into New Media Technologies*, 27(1), 161-176. <https://doi.org/10.1177/1354856520913865>
- Deuze, M. (2025). *Well-Being and Creative Careers*. Intellect Books.
- Dooley, K., Peng, F., Neville, S., & McKibbin, J. (2024). Mind the gap: A scoping review of skills gaps for graduates in the creative industries. *Arts and Humanities in Higher Education*, 23(4), 330-349. <https://doi.org/10.1177/14740222241276166>
- GDC. (2025). *2025 State of the Games Industry*. Retrieved from <https://investgame.net/news/pdf/2025-state-of-the-game-industry-report/>
- Hassreiter, S., Haggis-Burridge, M., Clavero, T., & Bouwels, L. (2024). *Work Environment Dynamics and Soft Skills in Animation, Games, and VFX industries*. Retrieved from <https://www.paneurama.eu/research/>
- Horo, A., Choure, R., Mehta, K., & Patil, A. (2025). Effects of short deadlines on VFX Artists. *International Journal of Research Publication and Reviews Journal*, 6, 17356-17360. <https://doi.org/10.55248/gengpi.6.0525.19117>
- Lesener, T., Gusy, B., & Wolter, C. (2019). The job demands-resources model: A meta-analytic review of longitudinal studies. *Work and Stress*, 33(1), 76-103. <https://doi.org/10.1080/02678373.2018.1529065>
- Lesener, T., Pleiss, L. S., Gusy, B., & Wolter, C. (2020). The Study Demands-Resources Framework: An Empirical Introduction. *International Journal of Environmental Research and Public Health*, 17(14), 5183. <https://doi.org/10.3390/IJERPH17145183>

- Martin, A. J., Collie, R. J., & Nagy, R. P. (2021). Adaptability and High School Students' Online Learning During COVID-19: A Job Demands-Resources Perspective. *Frontiers in Psychology*, 12, 702163. <https://doi.org/10.3389/FPSYG.2021.702163>
- Munro, E. (2017). Building soft skills in the creative economy: Creative intermediaries, business support and the 'soft skills gap'. *Poetics*, 64, 14-25. <https://doi.org/10.1016/J.POETIC.2017.07.002>
- National Academies of Sciences Engineering and Medicine. (2019). Student and Trainee Burnout and Professional Well-Being. In *Taking Action Against Clinician Burnout*. National Academies Press. <https://doi.org/10.17226/25521>
- Poláková, M., Suleimanová, J. H., Madzik, P., Copuš, L., Molnárová, I., & Polednová, J. (2023). Soft skills and their importance in the labour market under the conditions of Industry 5.0. *Heliyon*, 9(8), e18670. <https://doi.org/10.1016/j.heliyon.2023.e18670>
- Scheepers, R. A., Hilverda, F., & Vollmann, M. (2024). Study demands and resources affect academic well-being and life satisfaction of undergraduate medical students in the Netherlands. *Medical Education*, 58, 1097-1106. <https://doi.org/10.1111/MEDU.15456>
- Travis, J., Kaszycki, A., Geden, M., & Bunde, J. (2020). Some stress is good stress: The challenge-hindrance framework, academic self-efficacy, and academic outcomes. *Journal of Educational Psychology*, 112, 1632-1643. <https://doi.org/10.1037/EDU0000478>
- Wilkes, M., Carey, H., & Florisson, R. (2020). *The Looking Glass: Mental health in the UK film, TV and cinema industry*. Film and TV Charity.

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Chapter # 10

FUTURE EDUCATORS' PERCEPTIONS OF VICARIANCE AS A DESIGN TOOL IN EARLY CHILDHOOD EDUCATION SERVICES IN THE PRESENCE OF VISUALLY IMPAIRED CHILDREN

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ABSTRACT

Neuroscience highlights the body's central role in cognition, showing the close link between perception, action, and thought. Vicariance is a creative capacity of the brain that enables humans to devise alternative solutions to the complexity and unpredictability of reality. It thus represents an adaptive resource that fosters flexibility and responsiveness, both essential for survival. In the case of visual impairment, vicariance allows the body to compensate for the lack of sight by enhancing other senses and supporting movement. This concept is highly relevant to education, where biological and cultural dimensions intersect. In the learning processes of visually impaired children, vicariance can be understood in two ways. On the one hand, it reflects the child's ability to develop strategies that compensate for the absence of vision. On the other hand, it refers to the educator's role in designing flexible responses tailored to specific educational needs, within an Adaptive Decision-Making perspective. On these grounds, a questionnaire was administered to students in the Educational Sciences degree program at the University of Salerno during the course "Inclusive Design of Early Childhood Services." The aim was to explore future educators' perceptions of designing activities for early childhood contexts with children with visual impairments, and to assess how they envision using vicariance as a creative tool to foster inclusive education for all.

Keywords: visual impairment, early childhood education services, vicariance, educational design, inclusion.

1. INTRODUCTION

Pedagogical design in early childhood education services represents a fundamental element in constructing quality educational contexts, promoting the well-being, development and learning of children in the 0-3 age group (Bianquin & Bulgarelli, 2022). It is a reflexive, intentional and dynamic process that orients everyday educational practices and ensures consistency with a shared pedagogical vision. Far from being a mere programming of activities, pedagogical design takes on a deeper meaning, expressing a particular image of the child, education, and society. The idea behind the pedagogical work in the nurseries is that of considering the child as a competent person, active in the construction of his or her knowledge, the bearer of rights and the protagonist of his or her growth path, promoting constant exploration and social interaction and encouraging his or her full autonomy (Aiello, 2023). Therefore, the focus is on each child's specific characteristics to create an environment that promotes the well-being of the individual and the group (Montessori, 1999). The relationships with adults and peers are central to design, as learning and personal development are nurtured through interaction. For this reason, pedagogical design is an

essential tool for creating spaces that foster the development of meaningful relationships, which, in turn, encourage exchanges between peers in a climate of positive affectivity, thereby promoting social responsibility processes (Amadoro et al., 2024b). Furthermore, in the project action, great importance is given to constructing a stimulating environment that supports exploration, learning and growth through numerous activities and play opportunities. For this reason, it is necessary to devote particular care to the arrangement of spaces and furnishings, the selection of materials, the organisation of time, and the design of educational experiences that can effectively accommodate the various changes the child will undergo as he or she grows. According to Montessori, the richness of the environment, understood as the presence of stimuli organised according to reasoned educational reflection, is directly proportional to the child's cognitive development. The importance of perception within cognitive processes, now confirmed by neuroscience research, has long been emphasised in education. Indeed, sensory education represents a fundamental cognitive experience that precedes higher intellectual activities in children aged 0-6 (Montecchiani & Paolini, 2011). It appears to be further enhanced in the presence of visual disabilities, as in this case stimulation of the senses is necessary to compensate for the absence of sight, allowing the child with this type of disability to form mental images through which to construct their knowledge of the world.

The concept of vicariance, whose etymological origins refer to the Latin term *vicarius* – meaning “one who acts in place of another”, “who takes the place of another” – has crossed a multitude of epistemic domains over time, gradually acquiring specific meanings and distinct connotations. Despite its semantic diversification, the conceptual core of vicariance remains constant: it denotes a substitutive, compensatory, and generative function that can activate alternative means of pursuing a goal in the presence of obstacles, constraints, or discontinuities (Di Gennaro et al., 2018).

In psychology, particularly in differential psychology, vicariance refers to the ability of different individuals to solve the same problem using heterogeneous intellectual and perceptual strategies (Lautrey, 2003). Cognitive performance is therefore not an expression of a single, standardised process, but rather the result of multiple mental pathways, adapted to individual profiles and contextual conditions (Gardner, 1983). From this perspective, vicariance highlights the irreducibility of the human mind to linear models, emphasising instead its flexible, situated and variable nature. In the field of biological sciences, the concept takes on further implications, linking to von Uexküll's (2010) theory of the *Umwelt*. According to this view, every living organism interacts with the environment through a subjective representation that selectively orients its possibilities for action and perception. Vicariance, in this sense, manifests itself as the ability of organisms to adapt their behaviour in diverse and creative ways, modulating the use of available resources according to their own perceptual and motor structure. It is, therefore, a form of functional plasticity, which expresses the possibility of redefining the relationship between organism and environment based on different perceptual configurations (Clark, 1997). In the medical and neurological fields, vicariance has been described as an expression of cerebral neuroplasticity, i.e., the ability of healthy brain regions to assume, in the event of damage, the functions previously performed by the damaged regions (Mounier, 1982). This phenomenon is particularly evident among individuals with sensory disabilities, who frequently develop complex and innovative neurocognitive adaptations to compensate for functional losses by reactivating other sensory or motor channels. In this sense, vicariance is an endogenous mechanism of biological resilience that can preserve or restructure functional balance under conditions of impairment (Bavelier & Neville, 2002).

A significant reworking in educational terms is offered by Lev S. Vygotskij, who, in his theory of compensation, states that every deficiency is accompanied by creative, infinitely varied and original forms of development (Vygotskij, 2007). According to this approach, the deficit is not conceived as a static limitation but as a dynamic, generative condition from which a reorganisation of functions and skills can arise. Vicariance, in this context, is a transformative process that allows the individual to develop new, creative and adaptive responses to a limitation, thus orienting their development towards non-predetermined trajectories. In line with this view, Alain Berthoz (2015) offered a refined neuroscientific and philosophical interpretation of the concept, arguing that vicariance is not limited to a simple capacity for functional substitution but manifests as a creative and anticipatory act grounded in the possibility of inventing possible worlds (*id.*). According to Berthoz, the human brain does not merely reproduce learned models; it selectively acts on incoming information, modifying its action patterns in relation to context to develop new strategies for achieving a goal. This conception emphasises the design dimension of vicariance, which is not limited to compensating for deficits, but activates processes of restructuring, discovery and construction of new possibilities of meaning.

The pedagogical outcome of these reflections is the formulation of a vicarious teaching approach aimed at overcoming the logic of ex post adaptation and promoting an idea of intrinsically differentiated educational planning (Sibilio, 2014). From this perspective, teaching does not aim to standardise pathways but to expand access, expression, and participation through multiple languages, devices, and environments. Vicariance thus emerges as the founding principle of an inclusive, dynamic and creative pedagogy, which recognises human variability not as an obstacle, but as an epistemological resource from which to rethink the forms of teaching and learning. In the context of visual impairment, vicariance refers to the extraordinary ability of the human brain to adapt and reorganise its functions when one sense is impaired or absent. When one sense, such as sight, is no longer available, the other senses (touch, hearing, smell, taste) play a more critical role in perceiving the environment and gathering information. The deprivation of sight necessarily entails a functional reorganisation expressed through the strategic use of the other senses and specific cognitive functions. Sensory vicariance determines how pupils with visual impairment interact with the world, learn and develop cognitively. Touch becomes the primary sense used to explore the environment and learn concepts (Caldin & Polato, 2023).

In educational contexts, particularly those involving children with visual impairments, vicariance has a dual meaning. On the one hand, it reflects the natural predisposition of the blind child's body to develop alternative mechanisms that compensate for the loss of visual function. On the other hand, it is reflected in the educational professional's ability to define solutions and design interventions tailored to the child's educational needs, implementing an *Adaptive Decision Making* strategy (Caldin & Polato, 2023). Through the activation of differentiated strategies and nonlinear paths, vicariance enables us to identify and legitimise the teaching strategies necessary to address the complexity of educational processes, particularly in contexts characterised by special educational needs. In such a theoretical framework, there is a need to configure educational environments with high perceptual density, in which cognitive experience can develop through sensory modalities alternative to vision, safeguarding the symbolic, relational and cognitive dimensions of the educational process. Adopting this approach helps avoid implicit exclusion or educational simplification, thereby restoring centrality to the subjective dimension of learning and the right to full participation in education. In this way, it allows the overcoming of methodological rigidity and the identification of educational deviations, thereby addressing the complexity of teaching and learning (Sibilio, 2017).

On this basis, the study aimed to explore future educators' perceptions of educational design in early childhood contexts that include children with visual impairments. In particular, a questionnaire including open-ended and closed-ended questions was administered to a group of students enrolled in the third year of the degree course in Educational Sciences, specialising in "Educators in early childhood services", at the University of Salerno (Italy), who attended the course "Inclusive design of early childhood services". The sample was asked to imagine designing an educational activity in a context in which at least one child with a visual impairment was present. The study aimed to identify recurring elements of educational design by analyzing participants' responses. Specifically, the research investigated how future educators imagine and conceptualise the design of educational activities when visual impairment is present, and whether the elements emerging from their representations are consistent with the scientific literature on vicariance as a central biological and pedagogical principle in inclusive education. Within this framework, vicariance is understood in its dual meaning: on the one hand, as an intentional design competence of the educator, and on the other, as a biologically inherent capacity of every child that supports development through adaptive and alternative pathways.

2. METHODOLOGY

2.1. Objective

The present study aimed to analyse the perceptions of future educators in early childhood services regarding the design of educational activities in contexts that include children with visual impairments. In particular, it sought to identify recurring elements of educational design emerging from participants' representations and to examine their consistency with the scientific literature on vicariance as a key principle in inclusive educational design.

2.2. Sample

The sample analysed consisted of 43 students enrolled in the third year of the degree course in Educational Sciences, specialising in 'Educators in Early Childhood Services', at the University of Salerno (Italy). They attended the course 'Inclusive Design of Early Childhood Services' during the first semester of the 2024-2025 academic year.

2.3. Survey Tool and Process

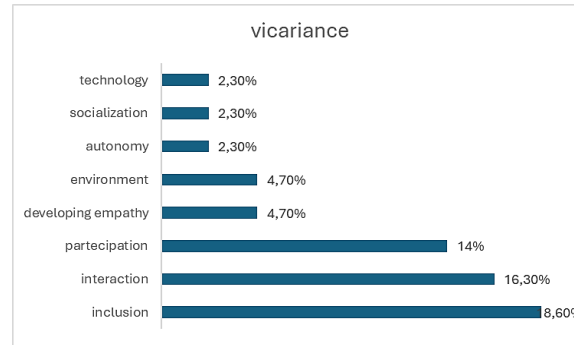
The survey instrument was a qualitative-quantitative questionnaire comprising eighteen questions, divided into three sections. Section no. 1 (items 1 - 7) was dedicated to gathering socio-demographic information, relating to age, gender, place of origin and course of study. Section 2 (items 8-16) collected information on traineeship experience (an activity included in the study pathway). They were asked to indicate the type of facility dedicated to early childhood services where the experience took place (item 9), whether there were children with disabilities (item 12) and, if so, to specify the type of disability (item 13). Item 12 ("Were there children with disabilities in the educational setting?") refers exclusively to participants' previous traineeship experience, and not to the imagined scenario proposed in item 18. This distinction was intentional, as the study sought to differentiate representations grounded in direct educational experience from those grounded in hypothetical design reasoning. The imagined presence of a visually impaired child was therefore introduced only in the final section of the questionnaire. Finally, it was asked whether the activities designed in contexts where children with disabilities were present had favoured the process of their inclusion in

the educational context (item 15). Section no. 3 (items 17 - 18) aimed at gathering information on the perceptions of future educators regarding the design of activities in educational contexts where there were children with disabilities (item 17) and with visual disabilities (item 18). More specifically, they were asked to imagine and describe the educational activities designed in the specific contexts outlined above. The questionnaire was administered during the first lesson, so the sample's answers were not influenced by the knowledge gained from attending the course. Still, it expressed personal impressions derived from direct field experience and sensitivity. The objective of the research was to answer the question. 18 ("If in the imagined educational context there was the presence of one or more visually impaired children, what activities would you plan to respond to their specific educational needs and favour their inclusion process within the educational context?"), for which a thematic type of analysis was chosen. It involved highlighting the key terms, which were then subdivided by frequency index and, finally, grouped into macro-categories. Although the core of the study is qualitative, a limited quantitative component was included by calculating frequency indices for recurring terms and thematic categories. These frequencies were not intended for inferential purposes; instead, they were used descriptively to support the qualitative thematic analysis and to highlight the relative salience of emerging design elements.

2.4. Data Analysis and Discussion

The presentation of findings is organised in relation to the research objective, focusing on how future educators conceptualise inclusive educational design through vicariance. In particular, the analysis highlights recurring design elements and examines how these align with existing theoretical and empirical literature. Regarding the first section of the questionnaire on socio-demographic data, the analysis of the collected data shows that the entire sample originates from Campania, the region in southern Italy where the university is located. Most of the sample (72%) comes from Salerno and its province. In comparison, a fair percentage (16%) comes from the city of Naples, the regional capital, and its province. Finally, the remainder of the sample came from the other provinces of the region and their respective provinces (5% from Avellino and Benevento, and 2% from the city of Caserta and its province). Most of the sample (98%) is female, while 2% identify as male. Most of the sample (92%) were between 21 and 25 years old; 6% were under 20, and only 2% were over 25. The second section of the questionnaire, which referred to the training experience carried out (as provided for in the study plan), most of the sample (91%) stated that it took place in nurseries, 7% in pre-schools and 2% in other facilities. To the question concerning the presence of children with disabilities in the facilities where this activity is carried out (item 12), only 16% of the sample answered in the affirmative, and, from the answers given to the next question (item 13), this presence is concentrated exclusively in nurseries. In the third section, which investigates how future educators envision designing activities in early childhood contexts for children with visual disabilities, the sample identifies vicariance as a key element of the design process. The term "vicariance" is associated with "inclusion" (18.6%), "interaction" (16.3%), "participation" (14%), and "motor, cognitive, and social development" (9.3%). Further associations emerge with the terms "development of empathy" and "environment" (both 4.7%); "socialisation", "autonomy" and "technology" (2.3%) (Figure 1).

Figure 1.



Through thematic analysis of the responses, it emerged that the entire sample envisions designing educational activities in early childhood contexts for children with visual impairments, using vicariance through sensory education. However, most of the sample treats touch and hearing as vicarious senses of sight, and only a minority explicitly identifies taste and smell as well. No one, on the other hand, takes haptic perception, considered the sixth sense and fundamental for people with visual disabilities, into account. A further interesting observation concerns the percentage of the sample that is convinced that educational design centred on vicariance promotes the development of empathy. This idea seems justified by the fact that the vicarious use of the other senses in place of sight would allow children without visual impairment to experience a "change of perspective," bringing them closer to the condition of their peers with this type of disability. Therefore, sharing the same condition would be beneficial to understanding it, thus facilitating the deconstruction of prejudice against the different. Moreover, sharing the same condition would seem to favour recognition of and attention to the other's needs. In this sense, this would favour collaboration among peers and the active participation of the visually impaired child, thereby improving the general class's inclusion. According to the sample's responses, sensory education would also benefit the child's motor, social, and cognitive development. This finding is noteworthy because it reveals a holistic approach to a dimension of the person that aligns closely with the biopsychosocial perspective on which the ICF-CY is based. Still, it identifies its justification in the embodied dimension of knowledge. It would be sensory education realised through the senses, thereby favouring the contextual development of the three dimensions of the person: physical, relational, and intellectual. This would confirm the recognition of the centrality of the body (albeit deprived of a sense and the so-called 'sense of distance' in favor of the senses considered 'of proximity' - touch, hearing, taste, and smell) within the person's development process. Part of the sample also recognizes a central role for the environment, understood as a multifaceted element comprising both physical and relational aspects, and considers it fundamental to the realization of a design aimed at enhancing sensory education by effectively responding to the educational needs of children and children with visual disabilities. Finally, the data on the use of technology as a tool for designing educational activities, which focuses on the functional use of sensory vicariance, leaves one somewhat perplexed. The low percentage shown in the figure appears inconsistent with the sample's average age, which places it in the digital-native generation. This contradiction could be justified by a lack of knowledge about the educational potential of technologies, which, by contrast, according to evidence in the scientific literature, constitute concrete tools for designing personalized educational paths. For this reason, they would be well-positioned to

address everyone's educational needs and, therefore, highly inclusive. Considering these results, it is possible to affirm that the participants' responses reflect a basic awareness of the value of vicariance in inclusive educational design, although some conceptual limitations remain. None of the participants explicitly referred to haptic perception, defined as active tactile exploration that integrates sensory and motor processes. This omission may reflect a tendency to subsume haptics under the broader category of touch. In line with Lederman and Klatzky (2009), haptic perception is not conceived here as an additional sense, but as a functional perceptual system resulting from the integration of tactile input and purposeful movement.

Likewise, the reduced emphasis on olfactory and gustatory senses indicates a partial view of multisensory learning. Educational literature increasingly highlights the benefits of integrating all senses in early childhood education to foster deeper cognitive and emotional engagement (Shams & Seitz, 2008).

Furthermore, the low level of awareness regarding the potential of digital tools for inclusive sensory-based education suggests the need to strengthen technological literacy among future educators. Digital applications, such as tactile tablets, sound-based learning tools, and virtual simulations designed for visually impaired learners, have shown promising results in enhancing access to multisensory experiences (Al-Azawei et al., 2016; Amadoro & Di Gennaro, 2024a). Therefore, targeted training in inclusive technologies could be a strategic lever for advancing educational design toward greater equity and creativity.

Another critical aspect concerns the respondents' intuitive reference to empathy as a by-product of vicariant activities. This insight aligns with current research in affective neuroscience, which shows that shared sensorimotor experiences can foster interpersonal understanding and emotional resonance (Gallese, 2007). The idea of using vicariant educational strategies to promote empathy and peer cooperation could thus represent a valuable direction for inclusive pedagogy. A deeper theoretical integration with existing inclusive education models, such as the Universal Design for Learning (UDL), could further strengthen future educators' capacity to structure learning environments that are accessible, flexible and emotionally responsive (CAST, 2018).

3. CONCLUSIONS

The research data appear to corroborate the scientific literature on the centrality of vicariance as an indispensable tool for designing educational activities in early childhood contexts that include children with visual disabilities. The most frequent terminological connection is precisely "vicariance-inclusion". However, the concept of vicariance can be understood in ambivalent terms, concerning both the child's organic faculty and educators' capacity to identify solutions that meet children's specific educational needs (Caldin & Polato, 2023). In the first case, designing educational activities that stimulate the development of vicariance, understood as the biological faculty of the human being, would foster divergent thinking and creativity in children (Zollo et al., 2015). This would also be consistent with what is indicated by recent European legislation on the subject and, in particular, the *Council Conclusions on the role of early childhood education and primary education in promoting creativity, innovation and digital competence*, which established the importance of fostering creativity from early childhood onwards by making explicit reference to the need for 'modernisation of pedagogical approaches, teaching resources and the learning environment' (2015/C 172/05). In the educational sphere, the acquisition of creative thinking skills can be a valid strategy for promoting educational interventions that decipher complexity and address its pitfalls (Zollo et al., 2015; Amadoro et al., 2024b). In the specific

case of children with visual disabilities, the design of educational activities that tend to enhance this ability would have the twofold objective of responding to a particular need of the child with this type of disability, since he or she needs to *train* the other senses to compensate for the absence of sight and, at the same time, would respond to the need shared with his or her peers to foster the development of creative ability. Furthermore, designing educational activities centered on vicariance would more generally respond to the common need of children in the 0-6 age group to use sensorial exploration as the primary vehicle for knowledge of reality, as affirmed by Montessori's pedagogy (Montessori, 1938).

In conclusion, vicariance, understood as a central component of educational design in early childhood services, particularly in contexts where children with visual impairments are present, is doubly linked to the theme of inclusion. Responding to needs shared by all and specific to some, vicariant-based educational experiences enable the development of skills that are fundamental in early childhood. From a pedagogical point of view, these results highlight the importance of rethinking training pathways for future educators, ensuring they are equipped with interdisciplinary knowledge that connects neuroscience, special pedagogy and didactic innovation. Integrating theoretical models, such as "embodied cognition" and "multisensory learning," into university curricula could enhance professional practices grounded in awareness and scientific rigor (Wilson, 2002). Moreover, it is essential to consolidate reflective practice within educational contexts, fostering a design mindset that is not only responsive but also anticipatory of children's diverse needs. As suggested by Sibilio (2017), embracing vicariance as a pedagogical tool means adopting a dynamic approach to teaching, one that values flexibility, creativity, and situated decision-making.

Finally, further research should explore the long-term effects of vicariant-based educational interventions on the development of autonomy, self-regulation and social integration among children with visual impairments. Building evidence-based models to guide inclusive design strategies could significantly enhance educational quality and equity from the earliest years of life.

REFERENCES

- Aiello, P. (Ed.). (2023). *Pedagogia speciale, infanzia e servizi educativi inclusivi* [Special education, childhood and inclusive educational services]. FrancoAngeli.
- Al-Azawei, A., Serenelli, F., & Lundqvist, K. (2016). Universal Design for Learning (UDL): A content analysis of peer-reviewed journal papers from 2012 to 2015. *Journal of the Scholarship of Teaching and Learning*, 16(3), 39–56. <https://doi.org/10.14434/josotl.v16i3.19295>
- Amadoro, A., & Di Gennaro, D. C. (2024a). Artificial intelligence and virtual learning environments: Limits and opportunities for blind students. *Giornale Italiano di Educazione alla Salute, Sport e Didattica Inclusiva*, 8(2).
- Amadoro, A., Veneruso, U., & Di Gennaro, D. C. (2024b). Designing childhood inclusive educational spaces to foster the development of creativity in visually impaired children. In *ICERI2024 Proceedings* (pp. 7435–7442).
- Bavelier, D., & Neville, H. J. (2002). Cross-modal plasticity: Where and how? *Nature Reviews Neuroscience*, 3(6), 443–452. <https://doi.org/10.1038/nrn848>
- Berthoz, A. (2015). *La vicarianza: Il nostro cervello creatore di mondi* [Vicariance: Our brain as a world-maker]. Codice Edizioni.
- Bianquin, N., & Bulgarelli, D. (2022). *Nido d'infanzia e progettazione educativa individualizzata: Progettare l'inclusione attraverso il PEI su base ICF* [Early childhood services and individualized educational planning: Designing inclusion through the ICF-based IEP]. Erickson.

- Caldin, R., & Polato, E. (2023). Touching, knowing, representing. From touch to tactile images: The thinking of Montessori, Munari, Romagnoli, Ceppi. *Italian Journal of Special Education for Inclusion*, 11(1), 93–102. <https://doi.org/10.7346/sipes-01-2023-09>
- CAST. (2018). *Universal Design for Learning guidelines version 2.2*. CAST. <https://udlguidelines.cast.org>
- Clark, A. (1997). *Being there: Putting brain, body, and world together again*. MIT Press.
- Council of the European Union. (2015). Council conclusions on the role of early childhood education and primary education in fostering creativity, innovation and digital competence (2015/C 172/05). *Official Journal of the European Union*, C 172, 17–21.
- Di Gennaro, D. C., Aiello, P., Zollo, I., & Sibilio, M. (2018). Agire didattico inclusivo: Una questione di stile? [Inclusive teaching action: A matter of style?]. *Pedagogia più Didattica*, 4(1).
- Gallese, V. (2007). Before and below “theory of mind”: Embodied simulation and the neural correlates of social cognition. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 362(1480), 659–669. <https://doi.org/10.1098/rstb.2006.2002>
- Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences*. Basic Books.
- Lautrey, J. (2003). A pluralistic approach to cognitive differentiation and development. In R. J. Sternberg, J. Lautrey, & T. I. Lubart (Eds.), *Models of intelligence: International perspectives* (pp. 117–131). American Psychological Association.
- Lederman, S. J., & Klatzky, R. L. (2009). Haptic perception: A tutorial. *Attention, Perception, & Psychophysics*, 71(7), 1439–1459. <https://doi.org/10.3758/APP.71.7.1439>
- Ministero dell'Istruzione. (2021). *Orientamenti per i servizi educativi per l'infanzia* [Guidelines for early childhood education services]. <https://www.miur.gov.it/documents/20182/6735034>
- Montecchiani, M., & Polini, S. (2011). Il metodo Montessori e la disabilità visiva nella scuola dell'infanzia [The Montessori method and visual impairment in early childhood education]. *Tiflologia per l'integrazione*, 2, 98–118.
- Montessori, M. (1938). *Il segreto dell'infanzia* [The secret of childhood]. Istituto Editoriale Ticinese.
- Montessori, M. (1999). *La scoperta del bambino* [The discovery of the child]. Garzanti.
- Mounier, J. (1982). *Trattato di neurologia clinica* [Treatise of clinical neurology]. Masson.
- Shams, L., & Seitz, A. R. (2008). Benefits of multisensory learning. *Trends in Cognitive Sciences*, 12(11), 411–417. <https://doi.org/10.1016/j.tics.2008.07.006>
- Sibilio, M. (2014). *La didattica semplessa* [Simplex didactics]. Liguori.
- Sibilio, M. (2017). *Vicarianza e didattica: Corpo, cognizione e insegnamento* [Vicariance and didactics: Body, cognition and teaching]. La Scuola.
- von Uexküll, J. (2010). *Ambienti animali e ambienti umani* [Animal environments and human environments] (M. Mazzeo, Ed.; G. Kriszat, Ill.). Quodlibet.
- Vygotskij, L. S. (2007). *Pensiero e linguaggio* [Thought and language]. Giunti Editore.
- Wilson, M. (2002). Six views of embodied cognition. *Psychonomic Bulletin & Review*, 9(4), 625–636. <https://doi.org/10.3758/BF03196322>
- Zollo, I., Kourkoutas, E., & Sibilio, M. (2015). Creatività, pensiero divergente e pensiero laterale per una didattica semplessa [Creativity, divergent thinking and lateral thinking for complex didactics]. *Educational Reflective Practices*, 1, 5–17.

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Chapter # 11

“YOU CAN BRING YOURSELF INTO YOUR PIECE.” YOUNG WOMEN’S AGENCY IN MAKING

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ABSTRACT

While many makerspaces are created by and cater to middle-aged males, our research has found that young women enjoy engaging in a multitude of making disciplines, including those traditionally thought of as masculine such as woodworking. In the AAMASE project, we worked with participants and program staff to co-design an eight-week program focusing on introducing several making disciplines with a set of principles, activities, and tools to support youths' agency in a community-based makerspace in the mid-Atlantic region of the United States. Most participants were African American high-school-aged young women from two out-of-school learning organizations and a private school. Making projects ranged from single-day projects, such as creating resin art pieces, to longer multi-session projects, such as making a laser engraved cutting board. We found that projects supported participants' agency as assessed through a framework we developed consisting of five criteria (self-efficacy, personalization, connection, planfulness, and iteration) consistent with the research literature on agency. Our research found that single-day projects supported participants' self-efficacy, personalization, and connection, and longer final projects supported their planfulness and iteration. The paper also briefly describes the researchers' use of artifact elicitation and provides recommendations for future research on agency and for practices that support agency.

Keywords: making, STEM, youth development, agency, design principles.

1. INTRODUCTION

African American Young Women in Making to Engage in STEM and Entrepreneurship (AAMASE) was an NSF ITEST Developing and Testing Innovations project aimed at serving 13–18-year-old young women in Greensboro, North Carolina, USA from 2022-2025. The project was a collaboration between TERC, a STEM education research and development organization, and the Forge Greensboro, a nonprofit community makerspace. Through participatory design research (PDR; Coenraad et al., 2019), AAMASE engaged youth in making and entrepreneurship activities emphasizing STEM disciplinary practices to amplify their agency while building their engagement and skills in STEM and their awareness of STEM career pathways. Youth participants learned how to design, build, and pitch a product with guidance from adult designers, makers, and entrepreneurs. Activities were designed based on the youth's interests with the goal of supporting their agency development. Activities included short, one-session projects to explore specific making disciplines and final projects where youth chose one of the making disciplines to develop a product that would address a problem from a pre-selected set of profiles, each with a design challenge that could be solved by youth in an open-ended way. For example, one of the profiles was about a young woman who needed a system to organize her school locker. AAMASE participants who chose this profile then selected one of the making disciplines they learned

earlier in the program to address the design challenge. The research included multiple data collection methods (e.g., surveys, interviews with partners and program staff, observations, artifact elicitation) to gain a holistic understanding of the PDR process from the perspective of all involved as well as the learning and changes that participating youth experienced. This paper focuses on youths' agency and experience throughout the program, integrating data from artifact elicitation interviews and observations.

2. LITERATURE REVIEW

2.1. Makerspaces as STEM Learning and Agency Developing Environments

Research has shown that makerspaces are often not supportive environments for non-dominant youth or women (Calabrese Barton & Tan, 2018). AAMASE aimed to address this challenge by situating its approach to making as a community-centered, culturally embedded practice. Making and design projects bring together tools and communities to provide both motivation and a context for developing STEM practices (Gravel et al., 2018; Martin, 2015) that are aligned with the Next Generation Science Standards (NGSS) (NGSS Lead States, 2013). We see NGSS practices and concepts (e.g., defining problems, designing solutions, patterns, cause and effect) as highly aligned with making practices when STEM content becomes part of the making. In fact, programs like AAMASE can support improved agency in implementing making practices and STEM content that results in new visions of STEM that invite broader participation (Calabrese Barton, Tan, & Greenberg, 2017).

In the making and makerspaces literature, different types of agency are described, such as individual agency, collective agency, and transformative agency. Schouweiler & Heredia (2021) defined individual agency as “the ability for youth to make meaningful decisions in how they engage with a learning setting” (p. 1). Marsh and colleagues (2018) found that implementation of a project focused on maker literacies and citizenship fostered collective agency, which often led to a strong sense of social inclusion and the development of communal cultures to address community issues. Kajamaa and Kumpulainen (2019) defined transformative agency “as a cognitive transformation and reframing process evidenced in young people’s initiative and commitment to transform the context(s) of their activity for personal, academic, working life, and/or civic ends” (p. 266). Though they describe different types of agency, these three definitions converge on autonomous decision making, addressing issues of interest (individual or communal), and engaging in transformation. At the same time, the literature lacks a structured understanding of the different components of agency or how to measure it with participants in makerspaces.

2.2. Young African American Women as Makers and Entrepreneurs

Makerspaces have the potential of responding to young women’s interests to build on their strengths, like overcoming obstacles and seizing opportunities (Stevens, 2002). Creating more supportive environments for making and learning requires “learning designers to consider who a maker is (and who can be a maker); what a maker does; for whom a maker makes ... [and] who a maker can become in, and through, the act of making” (Castek et al., 2019, p. 5). Importantly, design principles for fostering more equitable making environments call for incorporating STEM practices as a meaningful part of the making activity (Vossoughi et al., 2013). Research into entrepreneurship education has shown that learner agency can be supported by increasing self-efficacy, perceived behavioral control, and intentional action, particularly through experiential, action-oriented pedagogies that require learners to set goals, make consequential decisions, and adapt under uncertainty (Fayolle & Gailly, 2015;

Martin, McNally, & Kay, 2013; Nabi et al., 2017). Some research, however, has suggested that entrepreneurship education outcomes can differ by gender (J. Weiss et al., 2023). To better support young women, AAMASE centered their making interests and experiences to subvert the inequities often found in making culture and actualized culturally sustaining and youth-centered pedagogy by amplifying participants’ voices (Champion et al., 2020).

2.3. Engaging Young African American Women through PDR

Too often, while non-dominant youth are the intended audience for STEM programs, they are denied influence on the programs’ designs. In fact, youth more broadly aren’t often considered stakeholders of programs for which they are the targeted audience. For example, the design principles in Kennedy and Odell’s (2014) overview of high-quality STEM programs left youth out of the stakeholders included in the design of such programs. Ignoring youth results in missed opportunities for helping minoritized youth learn STEM practices in a way that influences their views of their STEM futures (Tan et al., 2013). PDR offers an alternative: “Participatory design is an essential design strategy for creating artifacts and experiences that reflect the voices of the population being designed for and with” (Coenraad et al., 2019, p. 185). In AAMASE, three factors contributed to the program reflecting the youths’ STEM and making-related interests: (1) youth were told at the beginning of the program that it was a research project and that their voices were essential for the field to learn from their experiences; (2) the AAMASE program staff and design researchers asked the participants (a majority of whom were young women of color) what they wanted to create and learn and then observed participants’ engagement throughout up through reflections on completed build cycles; and (3) perhaps most critically, when youth asked for different resources or learnings, program facilitators worked diligently to provide the experience that the youth were seeking. Youths’ involvement in the PDR process supported the development of their agency as a group because they experienced a program where their experiences, opinions, and interests were centered and meaningfully attended to.

3. THEORETICAL FRAMEWORK

This work is framed by a values-based theory of change centered around agency. Theory of change (C. Weiss, 1995) is a theory of how and why an initiative works. It makes clear what assumptions are being made in an intervention, and the desired outcomes. A values-based theory of change starts with a value or values for learning and engagement (Wardrip, Evancho, & McNamara, 2018). For this project, agency was a central value. We propose a definition of agency as follows: a person’s or group’s ability, inclination, and sensitivity to conceptualize and pursue the making of an object (physical, psychological, and/or social) to address a need or desire given a set of appropriate physical and/or social resources. This working definition allows the scaling of our unit of analysis between individual and group as appropriate as well as recognizing the salient resource features of an environment. In their review of the agency literature, Cavazzoni, Fiorini, & Veronese (2022) defined agency loosely as “people’s ability to exert control over one’s life and [to] pursue goals” (p. 1126) and found that studies used agency along two main conceptual pathways: (1) how an individual engages in agentic actions across their social environments; and (2) how an individual engages in agentic action in a more constrained realm of action. Our working definition of agency is aligned with the more constrained perspective as we aim to support and develop agency in participants in making and STEAM-focused learning environments.

Cavazzoni and colleagues wrote, "There is still little agreement on how this construct [of agency] should be understood and defined. ... Indeed, no current consensus or standardized methodology exists to assess agency" (2022, p. 1125). So, even though there are several validated instruments to measure agency or similar constructs, each one measures different dimensions of the phenomenon. Given this lack of consensus and based on the agency literature and Cavazzoni and colleagues' literature review, the AAMASE team proposes the following five-criteria framework for assessing agency among non-dominant youth in a makerspace. The purpose of this five-criteria framework is to translate the current research on agency that has been conducted outside of makerspaces to make it applicable to the specific conditions of makerspaces and non-dominant youth:

- (1) Self-efficacy. There is evidence that participants perceive that their effort influences their success (Bandura et al., 2001). This criterion incorporates elements of perceived competence, responsibility, confidence, and an internal locus of control (i.e., participants believe that they are in charge of their own successes and failures).
- (2) Personalization. The products/processes that participants create/articulate show attempts to make them more relevant or useful to specific people in participants' lives. This criterion incorporates elements of freedom, autonomy, and voice. The notion of personalization here aligns with "voice" and "decision-making" addressed by Zimmerman and colleagues (2019) related to participants' ability to articulate choices and opinions without the need to seek outside approval.
- (3) Connection. The products/processes that participants create/articulate show connections to and empathy for self and/or others. This criterion incorporates elements of participation in a community, such as through service, and critical consciousness. These elements are related to Bentley-Edwards' (2016) work on racial agency, which engages notions of group cohesion and the sense of being able to enact change in the world.
- (4) Planfulness. The products/processes that participants create/articulate show evidence that they were pursued based on some plan or design. This criterion incorporates elements of fact gathering and problem solving (Hitlin & Elder, 2006) in decision-making processes.
- (5) Iteration. The products/processes that participants create/articulate show evidence that they were improved upon. This criterion incorporates elements of resilience (Lautamo et al., 2020) and the flexibility to adapt in the face of difficulties or changes.

We developed these five criteria for assessing agency focused on non-dominant youth in makerspaces; so, they are not meant to be exhaustive or applicable to all educational settings or all youth. We based the selection of these criteria on being immersed in the data collected as part of our research in making and makerspaces in this project, which allowed us to identify the most salient due to their strong alignment with the PDR framework we employed in the design and implementation of the project. In addition, these build on our previous work on identity development through making (Knudsen, Jaumot-Pascual & Levin Güracar, 2025).

4. RESEARCH DESIGN AND METHODS

4.1. Research Design

AAMASE conducted PDR (Coenraad et al., 2019) where curriculum was designed, tested, and modified with the population for which it was being designed in an iterative

process where the research data informed curriculum development. The research used a mixed methods design (Creswell, 2021) that included surveys, artifact elicitation interviews with youth, interviews with facilitators, session recordings and observations, and document analysis. The purpose of this mixed methods design was to get a broad view of how the program worked for the youth and others involved, to understand youths' experiences in the program and what they learned, and to learn how the PDR process worked for all involved. The multiple data collection methods were designed to provide information about the study’s phenomena from multiple perspectives to allow for triangulation of findings (Greene, 2007).

4.2. Data Collection Methods

A major element of data collection was artifact elicitation (Douglas et al., 2015; Levin-Güracar et al., 2024), wherein the interviewee brings an artifact that they made in the program with them into the interview to spark a conversation about their experiences and what they learned. Since the objects were created by the youth, they embody their knowledge, skills, and attitudes and make interviews easier by shifting the focus from the interviewer-interviewee dyad to the object. This type of interview elicits richer information than regular interviews because images and objects facilitate recalling processes and memories in more detail (Harper, 2002). For this project, a protocol was developed to contribute to the understanding of participants’ development in the project’s three foci (STEM, making, entrepreneurship). The protocol started the conversation around how they approached the design and making process, with follow-up prompts about process, design, idea gathering, and prototyping. Artifact elicitation interviews took place utilizing different formats and contexts, depending on the specific circumstances of the program. For example, some artifact elicitations were recorded by the participants themselves responding to a short set of questions provided by the research team. Other interviews were conducted by the program’s facilitator as part of the debriefing process at the end of some sessions. Most artifact elicitation interviews were conducted by members of the research team as part of the data collection efforts at the beginning and at the end of each eight-week program cycle.

The role of the research team regarding its presence at the makerspace changed over the duration of the project. The first author (who was also the project’s PI) was an ongoing presence at the makerspace during its first year. During the second year of the project, he moved away, so his presence was more intermittent, focusing on key moments to collect data for the project, such as the beginning or the end of a session. The second and third authors were present at key moments to collect data, such as to gather the pre/post surveys and to conduct artifact elicitation with participants. All authors participated in the PDR process and conducted data analysis.

4.3. Data Analysis Methods

We used deductive coding (Fereday & Muir-Cochrane, 2006) to analyze artifact elicitation interview transcripts. We pre-selected a set of deductive codes based on our theoretical framework, including our five criteria for assessing agency, to identify sections of transcripts that exemplified each of the criteria. After deductive coding, we conducted thematic analysis (Fereday & Muir-Cochrane, 2006) to group codes into three broad themes: exploration, problem solving, and entrepreneurship.

4.4. Context and Participants

TERC worked with the Forge Greensboro, a makerspace in the Southeastern U.S., to develop and implement AAMASE, which integrated STEM and entrepreneurship into an

eight-week program for middle and high school young women, serving over 50 youth over two years. The research insights shared below are based on data from four groups that participated in the program for eight weeks each. In each of the first five sessions of an AAMASE program, youth were introduced to a different making discipline such as resin, woodworking, pottery, laser cutting, metalworking, 3D printing, sewing, and electronics. These disciplines were chosen in community with the participants. As a kind of capstone, for the final three sessions, youth were presented with a selection of 12 design challenges to solve a problem for a facilitator-created youth persona. Youth had full agency in selecting which challenge they wanted to take on, as well as choice in how they wanted to address the design challenge with access to multiple making disciplines, materials and making mentors around the Forge. Entrepreneurship was integrated throughout by implementing a series of strategies that included the following: participants developed their brand concept; they learned about business concepts (e.g., costs, labor, and marketing); and youth showcased their project and their business ideas in a final project presentation that included discussion of their brand, business concepts, and the problem their product contributed to address.

Each group had about 10 middle and high school age young women who were mostly African American, but also included white, Hawaiian Native, and Latina young women. Three participant cohorts were recruited through out-of-school learning organizations that had existing youth-serving programs, and one cohort was recruited from a local private school.

In this paper, we focus on three young women, Ciera, Addison, and Nora (all names are pseudonyms). Ciera and Nora were in their last year of high school, and Addison was in her first year of high school. Both Ciera and Addison participated in two rounds of the eight-week program cycles, and Nora participated in a single round. All three young women were African American young women and participated in artifact elicitation through self-recording and during data collection conducted by program researchers. The three young women came to the program through AAMASE's partnerships with local youth development groups, with Ciera and Addison coming through one partner and Nora coming through a different one. These three young women were selected for this chapter due to a few reasons. They were willing to talk with researchers and were quite articulate in their answers to our questions, which is not always the case with youth participants. We also had more videos from Ciera (7) and Addison (5) than other participants because they participated in two rounds, so we had more opportunities to conduct artifact elicitation interviews with them. We had three videos featuring Nora. The three cases presented here reflect the broader patterns observed among project participants, though with richer examples than other participants.

4.5. Limitations

Given that the analysis focuses on three individual case studies, this chapter's purpose is to provide an in-depth, contextualized, and holistic understanding of three individuals' experiences and use of agency in their participation in a program in a makerspace. Given the use of qualitative methods, these insights do not seek generalizability; rather, we used contextualized insights to answer how and why a program focused on making supports these three young women's agency, which is something that quantitative methods would not be able to answer.

5. FINDINGS. SUPPORTING AGENCY THROUGH MAKING

The application of the five criteria to assess agency through the interview transcripts with AAMASE youth serves to show examples of how each criterion may appear in the data and to provide proof of concept of this new model. In addition, this model can be used to guide practitioners in the implementation of programs that support agency development among non-dominant youth in makerspaces.

Given our working definition of agency, in addition to organizing the project to be an agency-supportive environment more generally, the specific learning activities and youth-centered pedagogy in AAMASE aimed to support the five-criteria framework of agency that we have defined above: self-efficacy, personalization, connection, planfulness, and iteration. A single making activity might incorporate support for all five of the criteria or just a subset, but no activity failed to support multiple. We found that exploring making disciplines through single-day activities supported personalization, connection, and self-efficacy, while engaging in problem solving through longer final projects provided opportunities for participants to engage in planfulness and iteration. We also found that exploring making disciplines in the context of entrepreneurship development supported personalization, planfulness, and connection. We explore three cases, Ciera, Addison, and Nora, that provide examples of how the five elements of agency were supported through AAMASE.

5.1. Supporting Agency Through Exploration

One of the single-day activities where youth explored a making discipline engaged participants in a resin art project. This meant that, unless they chose to use resin for their final project, youth typically did not get to fully iterate using this discipline. Youth worked with a mentor to experience the fundamentals of resin art as well as some of its chemistry. Youth were provided with coaster molds and various materials that could be used inside of the resin (e.g., flowers, leaves, glitter). Youth were also welcome to further personalize their projects using their own materials.

Ciera participated in two AAMASE sessions, so she got to experience most disciplines twice, which allowed her to gain meaningful experience and iterate on her ideas. She was particularly excited about the array of possibilities that working with resin afforded. She appreciated the creativity afforded by this medium in the making of objects that were both visually attractive and useful.

5.1.1. Personalization

Ciera provided an example of personalization through her engagement with her resin project, which she attempted to make more relevant to her life by making autonomous choices about its style. Ciera decided to personalize her project by incorporating a photocard of two K-pop stars, a unique decoration that she had brought, into her resin coaster pour (see Figure 1). In her artifact elicitation interview with a researcher, Ciera expressed excitement about her coaster because of its novelty. She explained that using the photocard brought a part of herself into the project:

It kind of gave it a little bit more meaning because, even though it's a piece of cardboard, you know, with two random people who probably will never know me, it brings me joy, ... making this whole piece that I know that no one else in the world

could basically remake because of how different epoxy is, it kind of makes it all a little bit more, ... gives a little bit more worth to me.

Ciera personalized the resin project, making it more relevant for herself by adding her favorite artists' photo directly into her resin pour. The open nature of the project made this possible. While the product (coaster) was the same for all students, it was open as to how they decorated and made the final product their own.

Figure 1.

Photograph of Ciera's resin coaster in which she incorporated a photo card.



5.1.2. Connection

Ciera's resin coaster project provided an example of the agency criterion of connection by bringing it together with her notion of herself and her sense of being a creative person. Ciera considered this project to be an opportunity to use her creativity and making something bespoke. She explained,

It's awesome ... I like this project a lot because it has a lot of creativity and uniqueness with it. You know, you could all be given the exact same materials and everyone could create something completely different. I like [it] because you can express your individuality, and you can basically bring yourself into your piece. And then your piece is an extension of you.

Ciera's project further demonstrated the agency element of connection as it connected her to peers through their shared interest in K-pop. In her artifact elicitation, Ciera intimated, "I kinda had [my friend] in mind when I made it." This kind of youth-driven connection to others through making was common in the AAMASE program.

5.1.3. Self-Efficacy

Ciera also demonstrated the agency criterion of self-efficacy by showing her awareness that the effort she put into her projects influenced her success. She showed that she had a sense of competence and that she was aware of the impact of her actions on herself and others. She was proud of what she created and was able to use the materials to make something personal. She shared that AAMASE provided her with a space to explore her creativity and even to get to know herself better, a key developmental milestone for teenagers. She stated,

While I’m here at the Forge, I want to dive into my own creativity. I haven’t been able to connect as well to my creative side, and I feel like, if I can, then I can get to know myself better. Plus, the more you create, the more creative you are, then, the more pieces of yourself that you get to make. And that can make others happy; it can make you happy.

In addition, she considered using her creativity to contribute to others’ happiness, building her interest in helping others. To support youth in experiencing their “creative side”, projects must support youths’ agency and support them in engaging in ways that connect to themselves. Ciera talked about making by using pieces of herself, clearly understanding the importance of personalization in the making process.

In her second time participating in AAMASE, Ciera’s choice of making discipline to address the capstone design challenge provided strong evidence of her self-efficacy, her belief that she could work towards a successful build. Ciera chose to crochet a shopping tote even though crochet was not one of the disciplines supported through the program. Ciera learned to crochet on her own (through YouTube), and she did, indeed, crochet a shopping tote.

5.2. Supporting Agency through Problem Solving

Addison participated in AAMASE twice, which meant that she did two final projects where she had two opportunities to iterate her use of a making discipline and plan a final project to solve a problem. Her two final projects were clay flowerpots and a laser-engraved chopping board. Her flowerpot project was in response to a design profile where the persona, a plant enthusiast, was looking for a fun and unique way to hold her numerous houseplants. The second project responded to a design profile where the persona is learning to cook and needs a confidence boost in the kitchen.

During one of the artifact elicitation interviews, Addison mentioned that pottery was her favorite making discipline of all those she tried in AAMASE. She saw it as a hobby that she would like to pursue in the future, so she was excited whenever she had an opportunity to work with clay in the program and enthusiastically jumped at the opportunity to have her final project use pottery.

5.2.1. Iteration

Addison provided an example of the agency criterion of iteration by talking about the qualities of different types of clay and how she had learned about each and used this knowledge to improve upon her designs. Addison’s eagerness to work with clay provided her with opportunities to try different pottery techniques, such as hand building and using the pottery wheel, and to use different types of clay, such as stoneware clay and terracotta. When hand building the flowerpots for her first final project, Addison used two different types of clay, which allowed her to iterate and improve upon the techniques that she had learned in previous projects (see Figure 2). She explained,

I made this [small rectangular planter] in [AAMASE] today. I'm not done with it. I have to add little pegs to it. But it's going to eventually be a tiny plant pot for succulents and stuff. And then I made this [larger house-shaped planter]. ... It's going to be a house for bigger plants that are going to go inside. And I think the biggest problem that I had was this one [small rectangular planter], because this is a different type of clay. This is terracotta and it's like, I don't know. This one [larger house-shaped planter clay] is easier to deal with, to mold stuff together and put it together. This one [small rectangular planter clay] is thinner, I guess. So, I definitely learned to be patient in the process of making them and then something that would help other people maybe in the future.

Not only did Addison learn to be patient but also considered using her pottery skills as something that can help others in the future by being able to make useful things for them or to teach them these skills.

Figure 2.

Photograph of AAMASE participant, Addison, presenting her small rectangular planter.



5.2.2. Planfulness

Addison provided an example of the agency criterion of planfulness by showing that she had implemented a plan in the making of a project. When working on her second final project (a cutting board with two engraved hearts), Addison kept in mind what she had learned in a previous project where the group used the laser engraver to plan for the cutting board. The first project Addison created using the laser engraver as part of AAMASE involved making a journal with wooden covers where participants laser engraved images that represented them. She and the group found that the laser burned the wood beyond the line of the image they wanted to engrave, creating a burnt shadow around the lines (see Figure 3). So, the group devised a solution: to cover the areas that were going to be engraved with tape so that the tape would dissipate heat from the base material adjacent to the engraved line and they would not have the unwanted shadow. Addison explained,

Researcher: How did you do the hearts?

Addison: Oh, we had used the laser engraver out there, and we had looked up a picture online, and then we had put it in the computer and then on the little website thing that the thing is connected to. And then we had to put tape over it so it wouldn't burn the wood that much. I don't know how to explain it, but when we had made the journals, we didn't put tape over it. So, it gave it that burning look on the outside, instead of just a clear line. ... The tape, it kind of blocked that, so it was just straight lines instead. ... And it just went straight through the tape and then we just peeled it off.

Her previous experience with the laser engraver allowed Addison to be playful in how to implement the necessary steps to produce the final project that she had in mind.

Figure 3.

Photograph of AAMASE participant, Addison, holding the laser engraved wooden journal cover that she created in her initial work with the laser engraver.



5.3. Supporting Agency through Entrepreneurship

The focus on entrepreneurship in AAMASE increased through the program’s iterations. Initially, the program had one day when the main focus was entrepreneurship, and then, in their final presentation at the end of the session, participants addressed their plan to market the product they designed for their final project. In later iterations, entrepreneurship was woven into every week’s content and even in the space’s decorations and enrichment signage (see figure 4).

Nora participated in AAMASE in one of its later iterations, when entrepreneurship was embedded throughout the program. Like other AAMASE participants, Nora was excited about the idea of creating her own products and brand, and was eager to share her ideas with the researchers.

Figure 4.

Photograph of two AAMASE participants learning to use sewing machines. On the wall in front of them, there is a board with entrepreneurship concepts, including considerations when developing a product such as a t-shirt, a definition a brand is, and channels that can be used to market a product.



5.3.1. Personalization

Nora provided an example of the agency criterion of personalization by developing a brand that articulated her choices and opinions without the need for outside approval, expressing her freedom and personal voice. Nora took the opportunity to personalize what she did in the program; she designed her own brand, positioning it so that it represented her and her ideas, and defining her products and how she wanted to sell them:

My brand, it says it's "Mars World" because it's about me. ... I would mainly make T-shirts or weird socks ... The ceramics ... I like weird stuff like little, tiny creatures, but they would be cute. My brain is like the mixture between cute and edgy.

She wanted her products and brand to reflect her feeling of being different from other youth her age, with an emphasis on creating idiosyncratic products that reflected her personality. Nora also thought that the program was empowering:

[I was excited about the program because of] the pottery and the fashion aspect of it. And then how [it] is majority based on females empowering each other.

Not only did the program allow her to explore her interests in making disciplines that she got to learn and practice, but it also provided a space for young women to support each other in very practical ways.

5.3.2. Planfulness

Nora provided an example of the agency criterion of planfulness by showing that she pursued the development of one of her projects based on a well-thought-out plan. For her final project, Nora decided to create jewelry for her school’s prom to planfully solve a problem that she had identified. She had noticed that costume jewelry is not very durable and often turns green, which can irritate the skin. To prevent this from happening, she used resin, a durable and hypoallergenic material. She made a bracelet, earrings, and a necklace charm for herself and her friends in the program:

The main concern about what to fix, I guess, would be like, you know how jewelry turns your neck or your finger or something green. ... I want to make it out of resin, so it doesn't do that.

In addition to having a defined idea for her brand and her products, Nora also had a marketing plan. She planned to sell her products through Instagram and Etsy and have her friends use her products in school as a way to advertise them by exposing other school peers to them.

Figure 5.

Photograph of two of Nora’s projects: resin jewelry to avoid the potential of discoloring the wearer’s skin, and her decorated journal. The journal cover shows the cute and edgy aesthetics that Nora wanted for her brand.



5.3.3. Connection

Nora provided an example of the agency criterion of connection by showing her sense of belonging to a community at the same time that she showed critical consciousness about social inequities and stereotypes imposed onto her community. Through the development of her brand, Nora explored the connection between her identity as a young Black woman and

her community of origin, looking for ways to reframe and reinterpret the stereotypes that are imposed on the Black community. She stated,

Just, you know, being where I grew up, reckless is considered being ghetto. But I view reckless as, like, you expressing yourself without giving regards to what anybody else thinks about you. ... And that's how I view myself. So, I would say I'm really not a reckless person. But, you know, ... I don't really care what anybody has to say. So why should you?

Here, Nora challenged existing stereotypes about being ghetto and reckless, presenting them in a positive light where being reckless is a way of being unapologetically oneself. With the reinterpretation of this stereotype, Nora presents herself and her community through a creative and self-reliant lens, which she hopes will be inspiring to those in her community to live beyond the stereotypes.

6. FUTURE RESEARCH DIRECTIONS

Given that the five-criteria framework to assess agency is a newly developed theoretical framework that has been applied only to the current study, it should be further implemented and researched in other makerspaces to test its fit and better understand its potential for application in other educational settings (e.g., library or school-based makerspaces, after-school programs focused on making) and with different populations (e.g., youth from different racial/ethnic backgrounds, different ages).

For community-based makerspaces to serve their whole community, programs should attend to the interests, abilities, and circumstances of those populations that they currently are not serving in an effort to bring everyone in. We recommend the implementation and study of participatory design strategies and youth-centered pedagogical practices to successfully broaden the makerspace's community of makers. The co-design process has three main steps: (1) *ask participating youth* what they want to accomplish, attending particularly to how projects can help support the development of their agency; (2) *listen* to what they have to say; and (3) *support* them towards their goals authentically so that facilitators can attend to the different elements of agency and ensure that youth of all backgrounds have opportunities to strengthen their agency at every step. Throughout the process, participatory design research methods should be implemented to better understand how agency development is implemented and achieved through the project, particularly with non-dominant youth.

Additional research should gather the existing validated instruments used to measure agency to identify the items that best align with the five-criteria framework for assessing agency among non-dominant youth in a makerspace. Once these items are identified, the instrument should be implemented and validated with participants in makerspaces. This process would support the development of a comprehensive instrument specifically conceived for measuring agency among non-dominant youth in makerspaces.

7. CONCLUSIONS

Given the lack of consensus on agency in the literature, we developed a five-criteria framework to assess agency in the context of working with non-dominant youth in makerspaces. The five criteria include self-efficacy, personalization, connection, planfulness, and iteration. This framework is not meant to be exhaustive or applicable in all educational

settings since it was developed in the context of a makerspace and with the purpose of understanding how a PDR making program with non-dominant youth supports their agency. It may be useful, however, as a steppingstone for those interested in systematizing their understanding of how their programs support youths' agency development.

We found that, to better support young women’s agency in makerspaces, programs should be organized to center the participants’ learning interests and focusing the learning activities on their experiences instead of on a set curriculum with specified goal products. We found that this new framework to assess agency was a useful tool to understand how AAMASE supported non-dominant youths' agency in a makerspace through some of the most common activities in makerspaces, such as exploring new making disciplines, engaging in problem solving, and getting immersed in entrepreneurship:

Supporting agency through exploration. The structure of AAMASE making activities, and particularly the one-day activities where participants explored a making discipline, supported participants’ agency most frequently through encouraging *self-efficacy*, *personalization*, and *connection*. Exploring new making disciplines provided opportunities to try new materials, learn how they responded to different treatments, and test different ideas and ways to address issues.

Supporting agency through problem solving. Final projects where youth considered how to solve a problem using one of the making disciplines that participants had previously explored supported their *planfulness* and *iteration*. This was possible because they had the opportunity to consider different solutions to the problem and how the different disciplines may or may not accomplish that. They were also able to test how their solutions worked and improve upon previous iterations.

Supporting agency through entrepreneurship. The implementation of entrepreneurship as one of the axes of the program provided opportunities for *personalization*, *planfulness*, and *connection* by presenting the youth with the opportunities to design not only products, but a brand that encompassed a personality, the solution of a problem, and a target customer.

The AAMASE participants reported and displayed high engagement and enjoyment. Additionally, Ciera, Addison, and Nora showed interest in using their newly acquired making skills to help others by making objects that they could use, by teaching them these same skills, or by redefining stereotypes imposed on communities. Experiences like Ciera’s, Addison’s, Nora’s, and those of their peers are key to supporting their agency and engaging young women in STEM-rich learning experiences, which ultimately leads to broadening STEM opportunities for all. Given that learning, including the development of agency, through making is often implicit, having the tools to identify it and make it explicit will support the value of learning through making in out-of-school environments for all youth.

REFERENCES

- Bandura, A., Barbaranelli, C., Caprara, G. V., & Pastorelli, C. (2001). Self-efficacy beliefs as shapers of children's aspirations and career trajectories. *Child Development*, 72(1), 187-206. <https://doi.org/10.1111/1467-8624.00273>
- Bentley-Edwards, K. L. (2016). Hope, agency, or disconnect: Scale construction for measures of Black racial cohesion and dissonance. *Journal of Black Psychology*, 42(1), 73-99. <https://doi.org/10.1177/0095798414557670>
- Calabrese Barton, A., Tan, E., Greenberg, D. (2017). The makerspace movement: Sites of possibilities for equitable opportunities to engage underrepresented youth in STEM. *Teachers College Record*, 119(7), 1-44. <https://doi.org/10.1177/016146811711900608>

- Calabrese Barton, A., & Tan, E. (2018). A longitudinal study of equity-oriented STEM-rich making among youth from historically marginalized communities. *American Educational Research Journal*, 55(4), 761-800. <https://doi.org/10.3102/0002831218758668>
- Castek, J., Schira Hagerman, M., & Woodard, R. (2019). *Principles for equity-centered design of STEAM learning-through-making*. Tucson: University of Arizona. Retrieved from <https://circlcenter.org/wp-content/uploads/2019/10/Castek-STEAM-Learning-Making-Whitepaper.pdf>
- Cavazzoni, F., Fiorini, A. & Veronese, G. (Eds.). (2022). How do we assess how agentic we are? A literature review of existing instruments to evaluate and measure individuals' agency. *Social Indicators Research*, 159, 1125-1153. <https://doi.org/10.1007/s11205-021-02791-8>
- Champion, D. N., Tucker-Raymond, E., Millner, A., Gravel, B., Wright, C. G., Likely, R., Allen-Handy, A. & Dandridge, T. M. (2020). (Designing for) learning computational STEM and arts integration in culturally sustaining learning ecologies. *Information and Learning Sciences*, 121(9-10), 785-804. <https://doi.org/10.1108/ILS-01-2020-0018>
- Coenraad, M., Palmer, J., Franklin, D., & Weintrop, D. (2019, June). Enacting identities: Participatory design as a context for youth to reflect, project, and apply their emerging identities. *Proceedings of the 18th ACM International Conference on Interaction Design and Children*, (pp. 185-196). <https://doi.org/10.1145/3311927.3323148>
- Creswell, J. W. (2021). *A concise introduction to mixed methods research*. SAGE publications.
- Douglas, E., Jordan, S., Lande, M., & Bumbaco, A. (2015, June). Artifact elicitation as a method of qualitative inquiry in engineering education. *122nd ASEE Annual Conference & Exposition*, Seattle, WA. <https://doi.org/10.18260/p.23574>
- Fayolle, A., & Gailly, B. (2015). The impact of entrepreneurship education on entrepreneurial attitudes and intention: Hysteresis and persistence. *Journal of Small Business Management*, 53(1), 75-93. <https://doi.org/10.1111/jsbm.12065>
- Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. *International Journal of Qualitative Methods*, 5(1), 80-92. <https://doi.org/10.1177/160940690600500107>
- Gravel, B., Tucker-Raymond, E., Kohberger, K., & Browne, K. (2018). Navigating worlds of information: Literacy practices of experienced makers. *International Journal of Technology and Design Education*, 28(4), 921-938. <https://doi.org/10.1007/s10798-017-9422-3>
- Greene, J. C. (2007). *Mixed methods in social inquiry*. John Wiley & Sons.
- Harper, D. (2002). Talking about pictures: A case for photo elicitation. *Visual Studies*, 17(1), 13-26. <https://doi.org/10.1080/14725860220137345>
- Hitlin, S., & Elder Jr, G. H. (2006). Agency: An empirical model of an abstract concept. *Advances in Life Course Research*, 11, 33-67. [https://doi.org/10.1016/S1040-2608\(06\)11002-3](https://doi.org/10.1016/S1040-2608(06)11002-3)
- Kajamaa, A., & Kumpulainen, K. (2019). Agency in the making: Analyzing students' transformative agency in a school-based makerspace. *Mind, Culture, and Activity*, 26(3), 266-281.
- Kennedy, T. J., & Odell, M. R. L. (2014). Engaging students in STEM education. *Science Education International*, 25(3), 246-258. Retrieved from <https://files.eric.ed.gov/fulltext/EJ1044508.pdf>
- Knudsen, J., Jaumot-Pascual, N., & Levin-Guracar, E. (2025, January). Maker and math identity in an afterschool making program with a focus on Latinx youth. *CRAFT Newsletter*.
- Lautamo, T., Paltamaa, J., Moilanen, J., & Malinen, K. (2020). Psychometric properties of the Assessment Tool for Perceived Agency (ATPA-22)—utility for the rehabilitation of young adults not in education, employment or training (NEETs). *Scandinavian Journal of Occupational Therapy*, 28(2), 97-109. <https://doi.org/10.1080/11038128.2020.1782983>
- Levin-Güracar, E., Jaumot-Pascual, N., Rafanan, K., Lara-Meloy, T., Eways, J. & Mitchell, I. (2024, September). *Object elicitation interviews: Engaging youth in conversations about their STEM learning through making*. Presented at the annual Association of Science and Technology Centers Conference, Chicago, IL, United States.
- Marsh, J., Arnseth, H. C., & Kumpulainen, K. (2018). Maker literacies and maker citizenship in the MakeY (Makerspaces in the Early Years) project. *Multimodal Technologies and Interaction*, 2(3), 50.

- Martin, B. C., McNally, J. J., & Kay, M. J. (2013). Examining the formation of human capital in entrepreneurship: A meta-analysis of entrepreneurship education outcomes. *Journal of Business Venturing*, 28(2), 211-224. <https://doi.org/10.1016/j.jbusvent.2012.03.002>
- Martin, L. (2015). The Promise of the Maker Movement for Education. *Journal of Pre-College Engineering Education Research (J-PEER)*, 5(1), 4. <https://doi.org/10.7771/2157-9288.1099>
- Nabi, G., Liñán, F., Fayolle, A., Krueger, N., & Walmsley, A. (2017). The impact of entrepreneurship education in higher education: A systematic review and research agenda. *Academy of Management Learning & Education*, 16(2), 277-299. <https://doi.org/10.5465/amle.2015.0026>
- NGSS Lead States. (2013). *Next Generation Science Standards: For states, by states*. Washington, DC: The National Academy Press. <https://doi.org/10.17226/18290>
- Schouweiler, D., & Heredia, S. C. (2021). Balancing individual and collective agency in informal STEM learning experiences. *Connected Science Learning*, 3(1), 12318678.
- Stevens, J. W. (2002). *Smart and sassy: The strengths of inner-city Black girls*. Oxford University Press.
- Tan, E., Calabrese Barton, A., Kang, H., & O'Neill, T. (2013). Desiring a career in STEM-related fields: How middle school girls articulate and negotiate identities-in-practice in science. *Journal of Research in Science Teaching*, 50(10), 1143-1179. <https://doi.org/10.1002/tea.21123>
- Wardrip, P., Evancho, J., & McNamara, A. (2018). Identifying what matters. *Phi Delta Kappan*, 99(6), 60-63. <https://doi.org/10.1177/0031721718762425>
- Weiss, J., Anisimova, T., Shirokova, G., & Durst, S. (2023). The entrepreneurial gender gap: The role of in-group support and national embeddedness values in young women’s entrepreneurship. *International Small Business Journal*, 41(8), 843-872.
- Weiss, C. (1995). Nothing as practical as good theory: Exploring theory-based evaluation for comprehensive community initiatives for children and families. In J. Connell, A. Kubisch, L. Schorr, & C. Weiss (Eds.), *New Approaches to Evaluating Community Initiatives*. Washington, DC: Aspen Institute.
- Vossoughi, S., Escudé, M., Kong, F., & Hooper, P. (2013, October). *Tinkering, learning & equity in the after-school setting*. Paper presented at the annual FabLearn Conference, Stanford, CA.
- Zimmerman, L. A., Li, M., Moreau, C., Wilopo, S., & Blum, R. (2019). Measuring agency as a dimension of empowerment among young adolescents globally; findings from the Global Early Adolescent Study. *SSM-Population Health*, 8, 100454. <https://doi.org/10.1016/j.ssmph.2019.100454>

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Chapter # 12

MODEL OF FUNCTIONAL LITERACY FOR TEACHERS CONCERNING THE APPLICATION OF 3D PRINTING IN SECONDARY SCHOOLS

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ABSTRACT

Teachers' functional literacy includes not only basic reading and writing skills but also the ability to use modern technologies effectively. In the context of 3D Printing, this requires understanding technical principles, working with 3D modeling software, managing the printing process, and addressing technical issues. 3D Printing serves as an innovative educational tool that enables students to visualize and explore complex concepts, fostering creativity, critical thinking, and practical skills essential for the 21st century. Teacher preparation plays a crucial role and includes technical training as well as pedagogical strategies for meaningful integration of this technology into instruction. This may involve workshops, online courses, or collaboration with experts. However, the implementation of 3D Printing also brings challenges such as financial costs, the need for technical support, and curriculum updates. Identifying barriers and seeking solutions—through grants or resource sharing among schools—is therefore essential. The chapter presents examples of good practice and emphasizes that teachers' functional literacy also includes adaptability to new technologies. Successful integration of 3D Printing requires school leadership support and continuous professional development. The chapter concludes with a model of teachers' functional literacy applicable in educational practice.

Keywords: functional literacy, 3D printing, teacher training, pedagogical strategies, educational technology.

1. INTRODUCTION

Functional literacy of teachers is a basic prerequisite for quality education in the 21st century. Functional literacy can be defined as the ability to effectively use knowledge and skills in real-life situations, encompassing not only reading and writing, but also information literacy, digital competence, communication skills and critical reflection. In the literature, this concept is understood as “a set of technical, strategic and sociocultural competences that enable an individual to use written language to achieve communicative goals in a variety of contexts” (Verhoeven, 1994). This approach is in line with the UNESCO definition, which emphasizes that functional literacy means the ability to use reading, writing and numeracy skills to participate in everyday activities and for personal and community development, with an emphasis on the application of these skills in real-life social, economic and cultural contexts (UNESCO, 2025). It is not only the ability to read and write, but a comprehensive set of skills that enable teachers to work effectively with information, use digital technologies, communicate across disciplines and reflect on their own pedagogical practice. In an era of rapid social and technological change, functional literacy is becoming a key tool for the development of innovative and inclusive education. At the university level, this

literacy should be systematically developed already during the preparation of future teachers. Higher education has a unique opportunity to shape not only the professional knowledge of student teachers, but also their ability to adapt to the changing demands of the school environment. Studies should include practical experience with digital tools, work with professional texts, the development of presentation and communication skills and the support of critical thinking. This preparation is directly reflected in teaching in secondary schools, where teachers are expected to be able to guide students to independent thinking, work with information and use technology responsibly. This approach is in line with the conclusions of the study by Nsiegbe et al. (2025), which emphasizes that inclusive education is not only a human right but also a catalyst for sustainable development. The authors identify four key areas: accessibility, curriculum design, teaching methods and support services. Accessibility includes physical, digital and socio-economic barriers that need to be removed to ensure that all students – including those with special needs – have equal opportunities. Similarly, the curriculum needs to reflect diverse perspectives and be flexible, supporting individual student needs. As the authors state: “The choice of teaching methods significantly influences the inclusiveness of the educational experience. Employing student-led approaches, differentiated instruction, and principles of Universal Design for Learning (UDL) enables educators to effectively respond to the diverse needs of students” (Nsiegbe et al., 2025). The functional literacy of teachers is closely linked to these principles. A teacher who is digitally competent, information literate, and aware of cybersecurity is able to create an inclusive environment and effectively use technology to support learning. As Kanvaria & Yadav (2024) emphasize, the integration of ICT into education not only brings new opportunities for personalization and interactive learning, but also challenges associated with the digital divide, insufficient teacher preparation, and the need for continuous professional development. The authors state: “Teacher professional development is critical to maximizing the benefits of ICT in education. Teachers should receive ongoing training and support in integrating digital tools into their pedagogy” (Kanvaria & Yadav, 2024).

Universities have a unique opportunity to systematically develop these competencies during the preparation of future teachers, through practical experience with digital tools, working with professional texts, developing presentation and communication skills, and supporting critical thinking. As Charles-Zalakoro (2025) suggests, teacher preparation should include digital content creation, information literacy, and cybersecurity awareness, which are key to inclusive and technology-oriented classrooms. Practical experience with digital tools, working with professional texts, developing presentation and communication skills, and supporting critical thinking are essential for teachers to be able to guide students to think independently, work with information, and use technology responsibly. As Kiuppis (2022) states, the provision of comprehensive support services is key to overcoming barriers to education and creating an environment that supports student well-being. Of particular importance is the functional literacy of teachers in the areas of project-based learning, environmental education, or problem-based learning, where it is shown how important the teacher's ability to think in broader contexts and lead students to deeper understanding is. Functional literacy thus becomes not only an individual competence of the teacher, but also a part of the school culture and a prerequisite for its development. Its systematic development in universities and school practice represents an investment in the quality of education and in the future of the entire society.

In the context of secondary schools, teachers' functional literacy becomes essential for integrating advanced technologies such as 3D printing into teaching (Schelly, Anzalone, Wijnen, & Pearce, 2015; Fernandes & Simoes, 2016; Song, 2018; Ford & Minshall, 2019; Holzmann, Schwarz & Audretsch, 2020; Cheng et al., 2020; Andić et al., 2023). Integrating

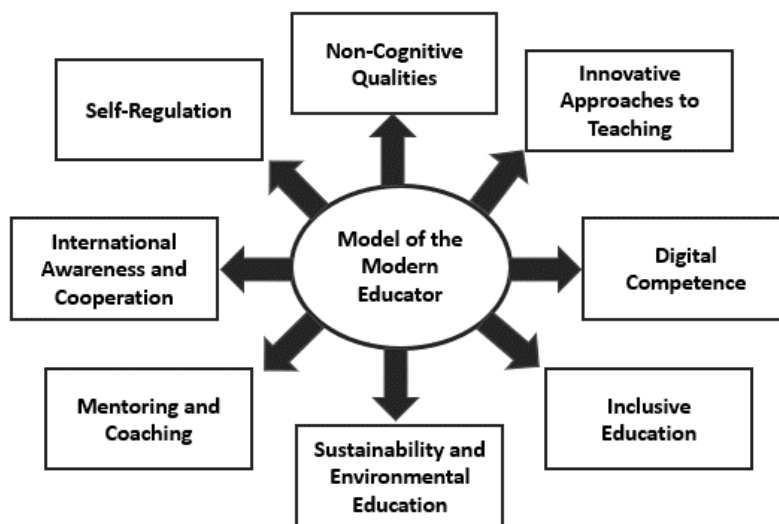
3D printing into secondary school teaching represents a significant step towards modernizing the educational process. This technology allows students to visualize and manipulate complex concepts, which supports their creativity and the development of practical skills (Lavicza et al., 2022; Wu, Liu & Huang, 2022; Kuo, 2024). 3D printing also provides students with the opportunity to actively learn and engage in projects that have a real impact on their education (Andić, 2022; Pearson & Dubé, 2022; Kalman, Nazim, Pavlenko, & Ivanov, 2024). Studies of 3D printing applications have identified six categories of use: teaching students about 3D printing; educating teachers about 3D printing; 3D printing as an assistive technology in teaching; creating teaching aids; creating technologies; supporting popularization activities (Ford & Minshall, 2019). Studies of 3D printing applications have identified six categories of use: teaching students about 3D printing; educating teachers about 3D printing; 3D printing as an assistive technology in teaching; creating teaching aids; creating technologies; supporting popularization activities (Ford & Minshall, 2019).

The aim of this chapter is to present a model of teacher functional literacy that includes the technical and pedagogical skills needed to effectively use 3D printing in teaching. The chapter focuses on the importance of teacher technical preparation, pedagogical strategies for integrating 3D printing into curricula, and overcoming the challenges associated with implementing this technology in schools. The contribution of this chapter to pedagogical practice is to provide a comprehensive model that can be widely applied and contribute to the development of key student competency. The approach presented is not an empirical study, but a theoretical-methodological contribution, which aims to synthesize available knowledge and propose a structured framework of competencies. This framework can serve as a support for teachers, curriculum designers, school leaders and researchers in planning professional development and integrating innovative technologies into the educational process.

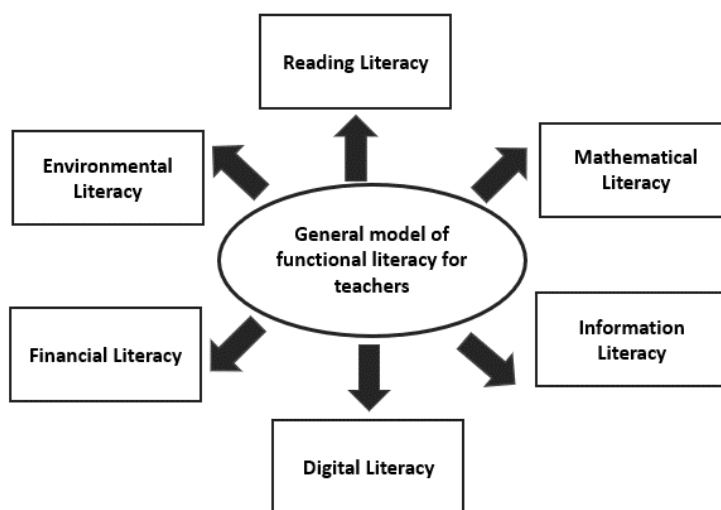
2. MODEL OF FUNCTIONAL LITERACY OF TEACHERS

The general model of functional literacy can be considered a specific application of the broader model of the modern educator, see Figure 1 (a). While the model of the modern educator includes a wide range of competencies and skills that reflect current trends and needs in education, the functional literacy model focuses on specific skills needed to support the functional literacy of students. The model of the modern educator includes innovative approaches to teaching, digital competences, inclusive education, sustainability, mentoring, international cooperation, self-regulation and non-cognitive qualities that are not explicitly included in the functional literacy model.

Figure 1.
Model of the functional literacy for teachers.



a) Model of the modern educator



b) General model of functional literacy

The modern teacher model is a comprehensive framework of professional competencies that reflect current challenges, trends and needs of the education system. At a time when education takes place in the context of rapid technological change, social diversity and global challenges, it is essential that teachers have a wide range of skills that will allow them to respond effectively to the changing conditions of teaching. This model includes not only professional knowledge, but also the ability to approach teaching innovatively, use digital

technologies, support inclusion, develop sustainable thinking, lead colleagues and students, collaborate across cultures and reflect on their own professional development. Innovative teaching approaches, such as project-based learning or gamification, bring new possibilities to teaching, how to actively involve students, support their critical thinking and connect the curriculum with real-life situations. A teacher who masters these methods is able to create an environment in which students learn through their own experience, collaboration and creativity. Digital competences, including working with online tools, cybersecurity and the ability to conduct distance learning, are becoming an essential part of pedagogical practice. Teachers must be able not only to technically master the digital environment, but also to use it meaningfully and safely, taking into account the needs of students. Inclusive education emphasizes respecting individual differences, creating a supportive environment and working with diverse groups of students. A modern teacher must be prepared to work with students with different cultural, linguistic or educational needs, while promoting equal opportunities for all. In the area of sustainability, the teacher becomes a bearer of ecological literacy, an initiator of green projects and a guide for students in finding a responsible relationship with nature and society. Environmental education should be a natural part of teaching, connected to everyday topics and activities. Mentoring and coaching are important tools for developing professional communities, supporting beginning teachers and strengthening cooperation between colleagues. A teacher who masters the principles of mentoring can guide not only students but also colleagues to deeper reflection, self-development and professional growth. International cooperation and multicultural awareness are increasingly important in a globalized world where education takes place in an international context. Involvement in international projects, exchange programs and the development of intercultural competences allows teachers and students to broaden their horizons and learn in different cultural environments. Self-regulation as a set of skills including planning, organization, self-assessment, stress management and perseverance is key to effective pedagogical activity. A teacher who is able to reflect on their own work, set goals and adapt to new situations is able to lead students not only professionally but also humanly. Non-cognitive skills such as emotional intelligence, motivation, resilience and social competence play a crucial role in building relationships, creating a safe environment and supporting a positive climate in the classroom. These qualities affect not only the quality of teaching, but also the overall atmosphere of the school. Communication competences form a cross-cutting element of the entire model. A teacher must be able to communicate effectively with students, parents, colleagues, and manage digital communication, intercultural interactions, and crisis situations. The ability to listen, formulate ideas, engage in dialogue, and resolve conflicts is essential for everyday pedagogical practice. The model of a modern teacher should be systematically integrated into teacher training at universities, where individual competences can be developed through the connection of theory with practice, reflection, collaboration, and research activities. At the same time, it should serve as a framework for the further professional development of teachers at all levels of education, including secondary schools, where the above areas are directly reflected in everyday pedagogical activities. Scientific and research reflection on this model can contribute to a deeper understanding of the teacher's professional identity, to the innovation of educational programs, and to the creation of support systems for pedagogical development. Overall, the modern teacher model represents a comprehensive framework of professional competencies that includes all aspects necessary for successful and modern education. This approach corresponds to the conclusions of Banasiak and Karczmarzyk (2018), who emphasize the role of the teacher as a leader and manager capable of leading the pedagogical process innovatively. Similarly, Gorycheva, Ignateva and Dautova (2020) point to the structural and

content characteristics of didactic competencies that are key to adapting to current challenges. Peng (2023) emphasizes the importance of the teacher as a central actor in modern education, while Mirzayeva and Mengboyeva (2024) develop a view on how a modern educator should be prepared for global and technological changes. Together, these studies confirm that the modern teacher model is not just a theoretical concept, but a practical framework that connects professional knowledge, digital competences, inclusion, sustainability and the ability for lifelong professional development.

2.1. Definition and Basic Skills

Functional literacy is a key element of modern education that enables individuals to navigate effectively in different areas of life. This general model includes reading, mathematics, information, digital, financial and environmental literacy, which together form the basis for successful and sustainable functioning in society, see Figure 1 (b). **Reading literacy** is the ability to understand and interpret texts. This skill is the basis for critical thinking and lifelong learning, encompassing not only the ability to read, but also to analyze and evaluate information from various sources (Xiong, 2020; Otsuka, 2021; Priyatni, As'ari, Suharyadi, Ahmad, & Azizah, 2021). **Mathematical literacy** is the ability to apply mathematical skills in real-world situations, which is key to solving practical problems and developing logical thinking (Priyatni, As'ari, Suharyadi, Ahmad, & Azizah, 2021). **Information literacy** is the ability to search for, evaluate and use information effectively, which is essential in the digital age (Luthfia, Handayani, Gasa, Ramadanty, & Ridzuan, 2023; Pan, Li, Chen, & Chen, 2023). **Digital literacy** is the ability to use digital technologies and tools, which is key to success in the modern world (Tiede, Treacy, Grafe, & Mangina (2022)). **Financial literacy** is the ability to understand and manage finances, which is important for personal and professional life (Pillai, Singh, Bhosale, & Doifode, 2023). **Environmental literacy** is the ability to understand and respond to environmental issues, which is key to sustainability and environmental protection (Pillai, Singh, Bhosale, & Doifode, 2023).

2.2. Specific Requirements for Functional Literacy in the Context of 3D Printing

The functional literacy model for secondary school 3D printing teachers includes the following skills: technical literacy, design literacy, material literacy, safety literacy, project literacy, innovation literacy, and quality literacy, see Table 1. The definition of these competencies is based on an analysis of available literature, which emphasizes the need for teachers to have technical, design, project and innovation literacy when integrating 3D printing into teaching. Schelly et al. (2015) and Ford & Minshall (2019) state that the successful use of 3D printing in education requires not only technical skills, but also the ability to connect technology with pedagogical goals. The study by Anđić et al. (2023) confirms the importance of design literacy and the ability of teachers to guide students to think creatively through 3D modeling. Lavicza et al. (2022) and Wu et al. (2022) emphasize that project literacy and an innovative approach are key to engaging students in practical tasks and developing their competencies. Pearson & Dubé (2022) add that qualitative literacy, i.e. the ability to control and optimize outputs, is essential to ensure the effectiveness of teaching. The teacher's functional literacy for the area of 3D printing is also closely linked to the educator's competency matrix for product life cycle presentation (Tomášková, Duda, Krotký, & Honzíkova, 2024). These findings form the basis of the proposed model of teacher functional literacy, which is based on the general framework shown in Figure 1 and is expanded with specific competencies for the area of 3D printing.

Table 1.
Specific requirements for functional literacy in the context of 3D printing.

3D Printing Literacy	Characteristics
Technical Literacy	The ability to understand and use 3D printers, including their maintenance and troubleshooting.
Design Literacy	The ability to create and modify 3D models using CAD (Computer-Aided Design) software.
Material Literacy	Knowledge of the different materials used in 3D printing and their suitability for different applications.
Safety Literacy	The ability to follow safety procedures when working with 3D printers and materials.
Project Literacy	The ability to plan and implement projects involving 3D printing, including time and resource management.
Innovation Literacy	The ability to use 3D printing to solve problems innovatively and support student creativity.
Qualitative Literacy	The ability to ensure high quality outputs from 3D printing, including quality control, optimization of printing parameters, and evaluation of results.

In technical education in secondary schools, 3D printing is becoming not only a tool for supporting creative thinking, but also a means for developing comprehensive functional literacy of teachers and students. Effective integration of this technology into teaching requires specific competencies that go beyond the framework of ordinary technical proficiency. Functional literacy in the field of 3D printing includes seven key areas that form the basis for the professional training of educators in technically oriented fields. Technical literacy refers to a deep understanding of the principles of additive manufacturing, including knowledge of types of 3D printing technologies, such as FDM (Fused Deposition Modeling - a technology based on layering of thermoplastic material), SLA (Stereolithography - a technology using laser curing of photopolymers) and SLS (Selective Laser Sintering - a technology that sinters powdered material with a laser). The teacher must be able not only to operate the equipment, but also to interpret error messages, optimize printing parameters (e.g. nozzle temperature, extrusion speed, layer height) and perform basic service interventions. Design literacy includes the ability to work with CAD software (Computer-Aided Design) such as Autodesk Fusion 360, TinkerCAD or SolidWorks, create parametric models, modify object geometry and prepare files for printing in STL (Standard Tessellation Language – a format for 3D models based on surface triangulation) or OBJ (Wavefront Object – a format supporting geometry and textures). The educator should understand the principles of structural design, tolerances, support structures and orientation of the model on the printing surface with regard to mechanical loads and output quality. Material literacy refers to knowledge of the physical, chemical and mechanical properties of printing materials such as PLA (Polylactic Acid – a biodegradable thermoplastic based on corn starch), ABS (Acrylonitrile Butadiene Styrene – a tough plastic with higher heat resistance), PETG (Polyethylene Terephthalate Glycol – a modified PET with good strength and chemical resistance) and TPU (Thermoplastic Polyurethane a flexible material suitable for printing soft and elastic parts). The teacher must be able to evaluate the suitability of the material for a specific application, taking into account its temperature stability, adhesion to the print bed, hygroscopicity and environmental impacts. Safety literacy is essential to ensure the safe operation of the equipment. It includes following the rules when handling hot

components, preventing the risks associated with VOC (Volatile Organic Compounds) emissions when printing from ABS, proper ventilation of the work area, using protective equipment and training students in safety protocols. Project literacy is the ability to plan, implement, and evaluate projects involving 3D printing. The teacher must be able to manage a timeline, allocate material and technical resources, document the process, and reflect on the outcomes with respect to educational goals. This competency is key to integrating 3D printing into project-based learning. Innovation literacy is the ability to use 3D printing as a tool for solving technical problems, supporting design thinking, and developing student entrepreneurship. The teacher acts as a facilitator who guides students to apply the principles of rapid prototyping, iterative testing, and functional optimization of designs. Qualitative literacy includes the ability to analyze print outputs in terms of accuracy, surface quality, mechanical integrity, and functionality. The teacher must be able to interpret measurement results (e.g., using a caliper, micrometer, profilometer), identify the causes of defects (e.g., stringing, warping, underextrusion) and suggest corrections to printing parameters. This technically oriented framework of functional literacy in the field of 3D printing provides a basis for systematic education of teachers of technical disciplines and at the same time serves as a methodological tool for evaluating the quality of teaching in the field of additive manufacturing. Its application in educational practice supports not only the professional growth of teachers, but also the development of technical thinking, creativity and practical skills of students.

3. OTHER INTEGRATING 3D PRINTING INTO EDUCATION

Pedagogical approaches and teacher preparation include technical training and pedagogical strategies that are key to effective teaching. Workshops, online courses, and collaborations with external partners and 3D printing experts help teachers integrate this technology into lesson plans and achieve educational goals. However, implementing 3D printing in schools faces challenges such as financial costs, technical support, curriculum updates, and resistance to change, as well as time constraints and the need for continuous professional development. Examples of good practice show successful integration of 3D printing into teaching, pedagogical approaches that support active learning and student engagement, and concrete projects that have a positive impact on the educational process (for example: analysis and study of the quality of the printing process and materials (Krotký, Honzíková & Moc (2016); demonstration of Taylor-Couette flow (Duda, Klimko, Skach, Uher & Uruba (2018); realization of experiments such as demonstration of Bernoulli equation, Taylor-Couette flow, effect of viscosity to scales and decay of turbulence and Galilean transformation inside an axial compressor (Duda, Yanovych & Uruba (2022); demonstration of time-symmetry breaking in a jet flow (Duda, Tomášková, Yanovych, Krotký, & Uruba (2024)). In the current educational environment, which is characterized by rapid technological development, increasing demands for digital competences and an emphasis on innovative pedagogical approaches, the role of school leadership is becoming crucial in creating conditions that enable meaningful and sustainable integration of technology into teaching. School leadership is no longer just an administrative function, but a strategic actor that shapes the school culture, supports the professional growth of the teaching staff and creates an environment conducive to pedagogical innovation. One of the key aspects of this role is the active support of teachers' continuous professional development, both in the area of technical skills and in the area of pedagogical-didactic integration of technology. School leadership should systematically identify teachers' learning needs, support their participation in professional training, workshops and communities of

practice, while creating space for sharing experiences and mutual learning within the school. Ensuring the availability of technical and material resources, including modern equipment, software licenses, technical support and access to digital educational tools, is also an important element. Equally important is the ability of school management to actively seek funding opportunities for technological innovations, both from public sources (e.g., national and European grant programs) and through cooperation with external partners such as universities, research institutions, technology companies or non-profit organizations. This cooperation can take the form of joint projects, professional internships, sharing of know-how or the school's involvement in wider innovation networks. From a research perspective, it is important to analyze how specific school management strategies influence the degree and quality of technology integration into teaching, what impact does leadership support have on teachers' motivation and self-confidence in using digital tools and what factors contribute to the sustainability of these changes in the long term.

The issue of pedagogical leadership also deserves special attention, i.e., the ability of school leadership to inspire, guide and support teachers in their professional growth, not only through formal structures, but also through a culture of trust, openness and shared responsibility for the quality of education. In the context of technology-oriented schools and programs, where the integration of technology is not only desirable but also necessary, it seems that the synergy between visionary leadership and professionally prepared teaching staff is a key prerequisite for the successful transformation of teaching. Research shows that pedagogical leadership has a fundamental influence on the formation of teachers' professional identity, which is a dynamic process shaped by the interaction of individual and collective factors (García-Martínez & Tadeu, 2018). Professional identity develops from the initial preparation of a teacher to his or her experience in practice, with a culture of collaboration, sharing of practice and support from school leadership playing a key role. Distributed and shared leadership, based on collaboration and teacher empowerment, is proving to be an effective way to strengthen professional capital and improve the quality of teaching. At the same time, it is clear that pedagogical leadership is closely related to effective educational governance. A study from the Peruvian environment confirms that when school leadership applies pedagogical leadership in all administrative and academic processes, there is better teamwork and the achievement of institutional goals through quality management (Rodríguez et al., 2023). Key factors are motivation, strategic use of resources, curriculum planning, support for teacher professional development and the creation of a supportive environment. Together, these elements ensure the effective functioning of the school and increase the quality of education. Furthermore, it is shown that traditional models of “learning-centred leadership” are limited in the current context, as they focus on outputs and results, while pedagogical leadership emphasizes learning processes, the epistemic nature of pedagogy and the creation of “pedagogical communities” (Male & Palaiologou, 2012). This approach emphasizes relationships between teachers, students, families, and the community, encourages knowledge sharing and collaboration, and responds to the challenges of the digital age. Educational leadership thus becomes a dynamic, evolutionary process that connects theory and practice, respects cultural and social context, and focuses on the development of knowledge, not just its transmission.

4. FUTURE RESEARCH DIRECTIONS

Given the growing importance of technological integration in education and the key role of school leadership in this process, a promising area of research is a deeper analysis of school leadership strategies in different typological school contexts

(e.g., technology-oriented schools, schools with an inclusive focus, schools involved in international projects). Future research should examine how specific forms of leadership support influence the level of technology adoption, pedagogical innovation, and professional self-reflection of teachers. Another area of research is the effectiveness of professional development models focused on digital competences, including a comparison of formal and informal education, mentoring, communities of practice, and online learning platforms. Special attention should be paid to the sustainability of professional development, i.e., how it affects pedagogical practice, teacher motivation, and teaching quality in the long term. Research on inter-institutional cooperation, especially between schools, universities, technology companies, and research centers, can also be considered key. This raises the question of what forms of cooperation are most effective for the development of school technical infrastructure, the transfer of know-how and the innovation of educational methods. Last but not least, it is necessary to examine the impact of technological integration on students, not only in terms of their academic performance, but also in terms of the development of digital literacy, critical thinking, independence and the ability to work in a project mode. Research should reflect differences between subjects, age groups and socio-economic backgrounds of students. Future research should be interdisciplinary, combining pedagogy, didactics, technology, psychology and management, and should contribute to the creation of evidence-based recommendations for school policy, educational practice and systemic innovations.

5. CONCLUSION/DISCUSSION

In today's rapidly evolving technological era, it is important that teachers are equipped with the skills and knowledge to effectively integrate modern technologies into their teaching. One such technology is 3D printing, which offers a wide range of opportunities for innovative and hands-on learning. The model presented in this chapter focuses on the specific skills needed to support the functional literacy of students, especially in the area of 3D printing applications in secondary schools. The proposed model of functional literacy for teachers represents a comprehensive framework that responds to current demands for technical education. It defines seven key areas of competence: technical, design, material, safety, project, innovation and quality literacy necessary for the effective use of 3D printing in education. These competences include not only technical knowledge, but also the ability to connect technology with pedagogical strategies, support creativity and ensure the safety and quality of outputs. The model is therefore an appropriate expression of the skills that teachers need in the digital age, as it combines technological proficiency with project-based learning, critical thinking and innovative approaches. This creates a basis for active student engagement and sustainable integration of modern technologies into education. The linking of the model with the support of pedagogical leadership, as presented in Chapter 3, emphasizes that successful implementation depends not only on teacher expertise, but also on institutional conditions and a culture of collaboration. This approach makes the chapter a significant contribution to the discussion on innovation in education.

The proposed model of functional literacy for teachers in the field of 3D printing represents a significant contribution to the modernization of technical education. The model is based on the general framework of functional literacy (Figure 1) and expands it with seven specific competencies necessary for the effective integration of 3D printing into education: technical, design, material, safety, project, innovation and quality literacy. These competencies are supported by current research (Schelly et al., Ford & Minshall, Anđić et al., Lavicza et al., Wu et al., Pearson & Dubé) and connected to the educator's competency

matrix for product life cycle presentation (Tomášková et al., 2024). The chapter thus offers a theoretical and methodological framework that responds to current trends in digital technologies, supports the development of key teacher skills and contributes to the innovation of educational practice. This approach emphasizes not only technical aspects, but also pedagogical strategies, leadership and sustainability, thereby creating a comprehensive basis for further research and practical implementation.

REFERENCES

- Andić, B., Lavicza, Z., Ulbrich, E., Cvjetičanin, S., Petrović, F., & Maričić, M. (2022). Contribution of 3D modelling and printing to learning in primary schools: A case study with visually impaired students from an inclusive biology classroom. *Journal of Biological Education*, 58(4), 795-811. <https://doi.org/10.1080/00219266.2022.2118352>
- Andić, B. et al. (2023). A Phenomenography Study of STEM Teachers' Conceptions of Using Three-Dimensional Modeling and Printing (3DMP) in Teaching. *Journal of Science Education and Technology*, 32, 45-60. <https://doi.org/10.1007/s10956-022-10005-0>
- Banasiak, M. A., & Karczmarzyk, M. A. (2018). Teacher as Leader and Teacher as Manager: Competences of Modern Educator. *Psycho-Educational Research Reviews*, 7(3), 32-37. Retrieved from <https://www.perjournal.com/index.php/perjournal/article/view/228>
- Charles-Zalakoro, J. L. (2025). Inclusive education and digital literacy: Developing essential skills in the digital age in selected public secondary schools in Bayelsa State. *International Journal of Educational Management*, 1(2), 266-283.
- Cheng, L. et al. (2020). Exploring the influence of teachers' beliefs and 3D printing integrated STEM instruction on students' STEM motivation. *Computers & Education*, 158, 103983. <https://doi.org/10.1016/j.compedu.2020.103983>
- Duda, D., Klimko, M., Skach, R., Uher, J., & Uruba, V. (2018). Experimental Fluid Mechanics 2018 (EFM18). *Proceedings from the 13th International Conference on Experimental Fluid Mechanics*, 213, Article Number 02014. doi: 10.1051/epjconf/201921302014.
- Duda, D., Yanovych, V., & Uruba, V. (2022). Simple Rheoscopic Flows Used in Teaching Fluid Mechanics. *Proceedings from the Conference on Topical Problems of Fluid Mechanics*, 37-43. doi: 10.14311/TPFM.2022.006
- Duda, D., Tomášková, T., Yanovych, V., Krotký, J., & Uruba, V. (2024). Demonstration of time-symmetry breaking in a jet flow. *Education and New Developments 2024*. Porto: inScience Press. <https://doi.org/10.36315/2024v2end067>
- Fernandes, S. C. F., & Simoes, R. (2016). Collaborative use of different learning styles through 3D printing. *2nd International Conference of the Portuguese Society for Engineering Education (CISPEE)* (pp. 1-8). Vila Real, Portugal. <https://doi.org/10.1109/CISPEE.2016.7777742>
- Ford, S., & Minshall, T. (2019). Invited review article: Where and how 3D printing is used in teaching and education. *Additive Manufacturing*, 25, 131-150. <https://doi.org/10.1016/j.addma.2018.10.028>
- Gorycheva, S. N., Ignateva, E. Y., & Dautova, O. B. (2020). Structural and Content Characteristic of Didactic Competency of a Modern Educator. In S. Alexander Glebovich (Ed.), *Pedagogical Education - History, Present Time, Perspectives*, vol 87. *European Proceedings of Social and Behavioural Sciences* (pp. 658-666). <https://doi.org/10.15405/epsbs.2020.08.02.86>
- Holzmann, P., Schwarz, E. J., & Audretsch, D. B. (2020). Understanding the determinants of novel technology adoption among teachers: the case of 3D printing. *Journal of Technology Transfer*, 45, 259-275. <https://doi.org/10.1007/s10961-018-9693-1>
- Kalman, O., Nazim, A., Pavlenko, I., & Ivanov, V. (2024). Advantages of 3D printing in the education process. In M. Balog, A. Iakovets, S. Hrehová, & K. Berladir, (Eds.), *The 2nd EAI International Conference on Automation and Control in Theory and Practice*. EAI ARTEP 2024. EAI/Springer Innovations in Communication and Computing. Springer, Cham. https://doi.org/10.1007/978-3-031-59238-6_1

- Kanvaria, V. K., & Yadav, A. (2024). Integrating and innovating: The role of ICT in education's evolution—An in-depth analysis of emerging technologies, current trends, challenges, and future directions in the digital age. *International Journal for Multidimensional Research Perspectives*, 2(2), 33-48.
- Kiuppis, F. (2022). *Inclusion in education: From policies to practices*. Springer. <https://doi.org/10.1007/978-3-030-85874-2>
- Krotký, J., Honzíkova, J., & Moc, P. (2016) Deformation of Print PLA Material Depending on the Temperature of Reheating Printing Pad. *Ústí nad Labem: UJEP, FVTM [Manufacturing Technology]*, 16(1), 140-144.
- Kuo, H. C. (2024). Transforming tomorrow: A practical synthesis of STEAM and PBL for empowering students' creative thinking. *International Journal of Science and Mathematics Education*, 23, 2061-2087. <https://doi.org/10.1007/s10763-024-10511-0>
- Lavicza, Z. et al. (2022). Developing and evaluating educational innovations for STEAM education in rapidly changing digital technology environments. *Sustainability*, 14(12), 7237. <https://doi.org/10.3390/su14127237>
- Luthfia, A., Handayani, F., Gasa, F. M., Ramadanty, S., & Ridzuan, A. R. (2023). Navigating the Cyber Frontier: Youth Capabilities to Confront Dis/Misinformation with Digital Literacy and Digital Security. *2023 17th International Conference on Telecommunications (ConTEL)*, Graz, Austria. doi: 10.1109/ConTEL58387.2023.10198919
- Male, T., & Palaiologou, I. (2012). Learning-centred leadership or pedagogical leadership? An alternative approach to leadership in education contexts. *International Journal of Leadership in Education*, 15(1), 107-118. <https://doi.org/10.1080/13603124.2011.617839>
- Martínez, Í. G., & Tadeu, P. J. A. (2018). The influence of pedagogical leadership on the construction of professional identity: a systematic review. *Journal of Social Studies Education Research*, 9(3), 145-161.
- Mirzayeva, G. E., & Mengboyeva, S. O. (2024). How a Modern Educator Should Be Today. *Excellencia: International Multi-Disciplinary Journal of Education (2994-9521)*, 2(6), 428-429. <https://doi.org/10.5281/>
- Nsiegbé, C. G., Nte, O. H., Nyegornum, S. A., & Anyanwu, D. (2025). Inclusive education for sustainable development in public universities in Rivers State. *International Journal of Educational Management*, 1(2), 44-59.
- Otsuka, Y. (2021). Evaluation of the effect of ICT in education on the academic literacy of high school students. *2021 Ninth International Symposium on Computing and Networking Workshops (CANDARW)*, 305-308. doi: 10.1109/CANDARW53999.2021.00058.
- Pan, Y.-Y., Li, M.-C., Chen, C.-M., Chen, Y.-T. (2023). The Effects of Web-based Inquiry Learning Mode with the Support of Collaborative Digital Reading Annotation System on Information Literacy Learning Effectiveness and Technology Acceptance. *14th IIAI International Congress on Advanced Applied Informatics (IIAI-AAI)*, 247-252. doi: 10.1109/IIAI-AAI59060.2023.00057
- Pearson, H. A., & Dubé, A. K. (2022). 3D printing as an educational technology: Theoretical perspectives, learning outcomes, and recommendations for practice. *Education and Information Technologies*, 27, 3037-3064. <https://doi.org/10.1007/s10639-021-10733-7>
- Peng, Z. (2023). The Role of the Teacher in Modern Education. *International Journal of Education and Humanities*, 8(2), 117-118. <https://doi.org/10.54097/ijeh.v8i2.7758>
- Pillai, D., Singh, A. S., Bhosale, T., Doifode, A. (2023). A Perspective on the Application of Fintech as a Gateway for Financial Literacy. *2023 International Conference on Information Technology (ICIT)*, 811-814. doi: 10.1109/ICIT58056.2023.10225810.
- Priyatni, E. T., As'ari, A. R., Suharyadi, Ahmad, & Azizah (2021). The Development of an Online Teacher Training Model for Reading Literacy and Numeracy Improvement. *7th International Conference on Education and Technology (ICET)*, 161-166. doi: 10.1109/ICET53279.2021.9575078
- Rodriguez, V. H. P. et al. (2023). Pedagogical leadership in the educational management of Peruvian educational institutions. *International Journal of Professional Business Review*, 8(4), 1-17. <https://doi.org/10.26668/businessreview/2023.v8i4.1548>

- Schelly, C., Anzalone, G., Wijnen, B., & Pearce, J. M. (2015). Open-source 3-D printing technologies for education: Bringing additive manufacturing to the classroom. *Journal of Visual Languages & Computing*, 28, 226-237. <https://doi.org/10.1016/j.jvlc.2015.01.004>
- Song, M. J. (2018). Learning to teach 3D printing in schools: how do teachers in Korea prepare to integrate 3D printing technology into classrooms? *Educational Media International*, 55(3), 183-198. <https://doi.org/10.1080/09523987.2018.1512448>
- Tiede, J., Treacy, R., Grafe, S., Mangina, E. (2022). Fostering Learning Motivation of Students with Reading and Spelling Difficulties by an AR-Enhanced Gamified Educational App for Literacy Learning. 2022 *IEEE Games, Entertainment, Media Conference (GEM)*. doi: 10.1109/GEM56474.2022.10017825
- Tomášková, T., Duda, D., Krotký, J., & Honzík, J. (2024). Ecodesign as a new possibility in teaching technical subjects in secondary schools. *Education and New Developments*, 2024. Lisbon, Portugal: inScience Press.
- UNESCO Institute for Lifelong Learning. (2025). *Definitions of adult functional literacy and numeracy for SDG indicator 4.6.1* (GAML6/WD/4). UNESCO Institute for Statistics.
- Verhoeven, L. (Ed.). (1994). *Functional literacy: Theoretical issues and educational implications* (Vol. 1). Amsterdam/Philadelphia: John Benjamins Publishing Company.
- Wu, C. H., Liu, C. H., & Huang, Y. M. (2022). The exploration of continuous learning intention in STEAM education through attitude, motivation, and cognitive load. *International Journal of STEM Education*, 9, 35. <https://doi.org/10.1186/s40594-022-00346-y>
- Xiong, X. (2020). Research on Chinese Individualized Reading Teaching Based on "Big Data" Education Platform. 2020 *2nd International Conference on Information Technology and Computer Application (ITCA)*, 668-671. doi: 10.1109/ITCA52113.2020.00145

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Chapter # 13

DE-CENTERING THE HUMAN: CRITICAL POSTHUMANISM AND THE REFIGURATION OF EDUCATIONAL FUTURES

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ABSTRACT

My starting point is critical posthumanism as a post-anthropocentric deconstruction of both cultural and technological determinism. This paper aims to lay the groundwork for critically examining the possible refigurations of the broader purposes of education. I will be looking into (1) the adoption (or resistance to adoption) of technology in schools and also into (2) the need for decentring the human, rethinking the position of other-than-human actors and their role in shaping knowledge and practices within (post-)educational contexts. My approach challenges the official or commonly accepted understanding of social reality, political relations, and conceptual categories by examining alternative viewpoints (e.g., “traditional” education vs. education in light of technological innovations), thereby offering an analysis of fundamental concepts. By employing a posthumanist lens, I foreground several “failures” of humanist assumptions, including the framing of education as a purely human-centered project and the presumed clear ontological separation between the human and the nonhuman. A still prevailing narrative suggests that digital technology inherently makes education “better” (i.e., more efficient, more accessible, etc.); however, the question arises of how well education is equipped to deal with present complexities, one of them being how to treat educational technologies so as not to mask their agency and power.

Keywords: critical posthumanism, postanthropocentrism, technology, human, post-education.

1. INTRODUCTION

I aim to interrogate the conceptual – and, inevitably, practical – entanglements between what we mean by “education” and what we mean by “the human” today, in the context of globalization, technoscience, late capitalism, and climate change. The central question guiding this contribution is how to reimagine education as a stage populated not only by human actors, but also by nonhumans, among them technological ones, that are assuming leading roles.

My primary starting point is critical posthumanism, a theory that examines the relationships among the actors in the so-called cybernetic triangle: humans, animals, machines (or technology, information systems, etc.). These relations are, in the light of contemporary rethinking and various posthuman, even transhuman, possibilities, reconfigured and rethought, together with the consequences of this reconfiguration. Donna Haraway discusses “three crucial boundary breakdowns” (Haraway, 1991), where the temporal and spatial coordinates no longer allow border wars to be easily won. There is pleasure, she says, in the confusion of boundaries, but also responsibility in their construction (Haraway, 1991).

It is worth noting that there are several strands of posthumanism, differing in their views on the ontology of the human, the relationship to technology, visions of the future (including techno-utopias), and related questions. A detailed discussion of these perspectives, however, lies beyond the scope of this contribution. The same applies to the specificities of transhumanism, which envisions the enhancement of human abilities through various technological additions and modifications, and is, in this regard, an extension of the humanist agenda, as put by Siân Bayne. Transhumanism is about “seeing the human as something that has the capacity to become better and better through scientific progress” (Bayne & Jandrić, 2017). And this is precisely what gets complicated in the posthumanist framework.

A brief explanation of what is meant by “technology” is in order. Technology is not merely a tool or an instrument, as it is often described, but an entity that has profound effects on the fabric of our societies, on who we are, and on who we are becoming in the process of using technology. Technologies do not simply help us with tedious tasks; they are not only fun, but they also reshape our identities. This is all the truer with the recent advent of the next-generation AI (chatbots and the like). In short and very much to the point, “Technology is the active human interface with the material world” (Le Guin, 2005).

At present, as digital technologies become ever more perceptibly constitutive of educational experience, I argue that education, edtech, and policy need to be thought together, as co-constructed and co-constructing. This also means that education is “always enacted through technology, and teachers cannot avoid learning to use it. Some technologies are so embedded in educational systems that they are almost invisible” (Fawns, 2022). This embeddedness of old technologies is even less visible in today’s era of AI, which is understood as something completely different (which it is, on many levels). However, technology has always been part of education, albeit in forms that appear “simpler” when viewed from today’s perspective, e.g., boards, chalk, pens, projection devices, and the like.

So, if we set aside the hype surrounding AI for a moment and look more closely, it becomes clear that “our distinctions between ‘technology-enhanced’ and general learning, or even digital education and general education, are somewhat artificial (Fawns, 2022).

Another overlooked factor is the increasing normalization of market logic as equivalent to ethical and epistemological frameworks. The technology used in the classroom, as said, is not only (or not predominantly) classroom gadgets/tangible devices, but “rather something much broader, that encompasses the imagined benefits of data, vast data collection infrastructures, complex data-driven technologies and their associated expertise, and the scaled effects of algorithmic and networked systems” (Knox, 2019). Such technology is “fuelling a capitalistic desire for data” (Knox, 2019). The result is a subtle but consequential alignment of educational goals with datafication and optimization, a dimension that policymakers too often fail to adequately foreground. And then there are the environmental costs of the digital (the use of rare metals, exploitation of natural resources, pollution, and the like), which amount to the lack of a broader understanding of the socio-technical systems (Knox, 2019). All these points clearly speak against technology as being a “mere” tool and against thinking that the role of technology is instrumental.

2. POSTHUMANIST DISCONTENTS

Posthumanism, as is often the case with such terms, can mean many different things to different people and is frequently accompanied by doubts about its relevance. On the one hand, there are fears that this might mean the human era is coming to an end, as the “post-” might imply, raising the question of alternative ways of being human. On the other hand, there is scepticism that these ideas are merely a repetition of earlier philosophical and

anthropological debates. David Edward Rose has the following on this: “How is posthumanist theory different from postmodern critiques of the subject? It is in the emphasis on the impact of technology. Human-modifying technology has a distinct effect on modern social and economic arrangements and the self-understanding of the subject” (Rose, 2023).

I start from the understanding of posthumanism as the need or aspiration of non-hegemonic ways of conceptualizing the human today. As put by N. Snaza et. al. (2014), posthumanism “allies itself with the politico-pedagogical projects of feminism, postcolonialism, anti-racism, and queer activism as it confronts the systematic dehumanization of people under the hegemonic Western form of political right”.

The term is used for contemporary theoretical positions of research in various disciplines or sciences (philosophy, literary studies, science and technology studies, communication studies) (Bolter, 2016). This also brings a new epistemology that is not (anymore) based on dualisms, known to Western thought. N. K. Hayles says that there is the prospect of breaking out of old frameworks and opening up new possibilities of how to be human and what kind of human. It does not mean the end of humanity, but rather the end of a certain conception of man, a conception that was at best considered to be “a fraction of humanity that had the wealth, power, and enough free time to conceptualize itself as autonomous beings fulfilling its will through individual action and choice” (Hayles, 1999).

Furthermore, this is “not to be confused with a nostalgia for another human, or a new humanism. Instead, it is part of a new theoretical paradigm emerging from all these challenges to humanism, humanity, and the human, and which are causing the erosion of traditional demarcations between humans and nonhumans and are calling for alternative ways of thinking” (Herbrechter, n.d.).

I stand on a position – in line with feminist posthumanities (cf. Ferrando, 2019) – that humanist hierarchical conceptualizations clearly show that all humans do not belong to the same category of humanity. This must be rigorously questioned, along with the notion of human exceptionalism (i.e., the primacy of humans over nonhuman animals), as it shapes epistemic privileges and, consequently, the knowledge produced through these processes (Vendramin, 2023).

The prefix “post-” (as in posthumanism) does not signify a complete break with the main part of the term, but rather is a sign of the ongoing deconstruction of what it “prefixes”. It is a kind of “conceptual parasite that inhabits humanism itself and tries to get it to address its own contradictions” (Herbrechter, 2018). Posthumanism is not about what comes after humanism in a chronological progression, but about rethinking epistemological and ontological questions related to “being human” (Pedersen, 2010). This definition neatly sets aside concerns about how to interpret the “post-” and whether it signals a rupture or the obsolescence of humanity. It simultaneously emphasizes a shift in perspective that encompasses multiple dimensions: political, ethical, and epistemological, among others. The need for this shift stems from the human no longer being understood as the central agent. The emerging models of power and responsibility foreground entangled agencies of human and non-human animals and technology.

It is now clear that posthumanism is not a completely new “discourse”, but a way of recognizing and integrating a wide range of different critical approaches (feminism, anti-colonialism, technology studies, ecology ...), which are “directly based on challenging how humanism has limited politics and education” (Snaza et al., 2014). Closely related to this is the need for a political-pedagogical commitment to projects such as feminism and postcolonialism, understood as forms of resistance to the systematic dehumanization of people (Snaza et al., 2014).

In this regard, Stefan Herbrechter (n.d.) names various questions that need to be addressed and eventually answered, such as: “What does it mean to be human? What is the role of technology in evolution and hominization? Is a postanthropocentric world picture possible, desirable, or even necessary?” Besides, the claim that “we have always been technological” (Snaza et al., 2014) encapsulates the idea of the co-evolution of humans and technology. This indicates that “at no stage in the process of hominization can you reach a point where you have, on the one side, the human, and, on the other side, the technical” (Herbrechter, 2018).

The questions raised above extend well beyond the field of education; they must be considered within a broader social and cultural framework. Nevertheless, they remain crucial for shaping the future role and forms of education.

3. POSTHUMANIST EDUCATION OR POST-EDUCATION?

All this brings us to the question of how to define education in light of changes at several levels in our societies and traditions. Can education, say, side-track the role of teachers, schools, curricula, socialization, etc., contrary to the understanding that education means “‘pure’ human relationships between teachers and their students, or amongst constructivist social groupings” (Knox, 2019)? Formal education in the West, as Helena Pedersen (2010) argues, is firmly rooted in humanistic ideals, which also means thinking about life from the perspective of a single species. Similarly, Nathan Snaza points out: education is understood as a practice of humanization. But this also entails, in principle, the possibility of dehumanization, since the human as a social construct is defined in relation to various non-human Others (Snaza, 2013).

If education makes us human, it is high time we (re)define what human is, considering various de-humanized and even non-human Others that have hereto been relegated to a lower step on the hierarchical scale of our anthropocentric world. It remains to be seen to what extent and how these changes will take place and how they will “reform” the definition of education and education itself in an ongoing process. (I am not talking here about changes brought in by digitalization and the like.) If education means leading the subject (student, pupil) into humanity and being fully human, what kind of subject is envisaged as the outcome of such education (Snaza, 2013)? At the same time, which is not at the forefront here, but it is a pertinent question, we should ask ourselves what the re-imagined end(s) of the human might be and when/if human stops being human (Callus & Herbrechter, 2012).

Humanistic ideals view knowledge and learning as constructed and achieved. This is in contrast to posthumanist stance in which learning is understood as a mutual contagion between human (teacher, learner, child, student), nonhuman entities or material resources (classroom, computer, textbook, subject matter), even time (weekdays between 8:00 a.m.-3:00 p.m.) and spatial engagement (the adult moves about the room, the students work at their tables) (Pedersen, 2016; Strom & Martin, 2022). All these “factors” “intra-act to enable the recognition of the adult in this space and time as ‘teacher’” (Strom & Martin, 2022). So, knowledge emerges through entangled pedagogical practices involving learners, teachers, technologies, curricula, spaces, and policies.

N. Friesen (2018) speaks of educational posthumanism and sees a lot of problems if we embark on a posthumanist ship unconditionally:

For better or worse, education cannot be anything else but predominantly human. [...] To the degree that posthumanisms deny human agency and responsibility, they also “post” the project of education; to the degree that they affirm these human characteristics, they cannot be called posthumanist.

He continues: “Through its denial of the centrality of human agency and choice, posthumanism also requires us to reconceptualize the most fundamental assumptions and understandings of education itself” (Friesen, 2018). While I cannot but agree with the call to reconceptualize education, I am less convinced by the way responsibility is addressed. Posthumanism does not deny human agency or responsibility; rather, it reconceptualizes them as relational and situated and emphasizes ethical accountability toward the entanglements with the non-human.

But, still, there is also a rub. Either we accept the predominant role of humans that shape the educational processes and proclaim posthumanist tenets to be misplaced, or we admit that in these specific times, we can no longer limit ourselves to seeing education and learning as exclusively human-centred in one way or the other.

But this thing that disrupts or that will substitute the heretofore known education clearly needs a name. Do we need to introduce the term post-education here? There are other possibilities, according to David Edward Rose (2023), such as posthuman education, human post-education, or post-education humanism. Take your pick, says Rose, but of course, we are still at a speculative level. I suggest post-education here as I see fit to foreground the entanglements between humans, technologies, and environments. Nonhuman agents (AI, data, and ecosystems) are included as active participants in learning, allowing us to envision learning as a fluid, networked, and collaborative process entangled with both human and nonhuman actors, rather than confined to classrooms or traditional hierarchies. This is the essence of posthumanist thought: nonhuman actors actively participate in the shaping of knowledge, thereby decentering the human subject and expanding the possibilities for learning (cf., e.g., Braidotti, 2019). For example, a human teacher’s agency could “come up against the workings of data to conduct another, and different, kind of teaching which is neither human nor machinic but some kind of gathering of the two” (Bayne & Jandrić, n.d.).

Or, we might opt for as-if-education as proposed by Richard Susskind (2021): *quasi-education*, *as-if education*, meaning something like education, but not quite (Susskind himself is not particularly happy with this solution). Let us regard this as an attempt not to name different things with the same words, although it is hard not to use labels, designed for humans, to describe what is going on when machines deliver outputs. Susskind (2025) points out that the basic error is failing to recognize that AI systems do not mimic human reasoning (this is an all too-human-centric view) and that we should perhaps change our prevailing mindset, which is still very focused on task substitution.

I want to return here to the question of human (and humanity) and the definition of it, as this has a profound effect on how to approach the issue of education. Do we – if we opt for a transformed definition of human (a moral human being) and education (purposive and normative that it is) – lose the education’s addressee (Herbrechter, in Friesen, 2018) and with that the edifice that supports humanity? I suggest that posthumanism has the potential to bring about positive transformations in education in several ways. According to Snaza et al. (2014):

First, it forces us to reckon with how resolutely humanist almost all educational philosophy and research is. Second, it allows us to reframe education to focus on how we are always already related to animals, machines, and things within life in schools [...] Third, [...] it enables us to begin exploring new, posthumanist directions in research, curriculum design, and pedagogical practice.

To briefly comment on and emphasize these three interconnected benefits of posthumanism: first, it invites us to reflect on new possibilities for educational research and practice, including a critical examination of the exclusions within humanism concerning both human and non-human Others. Second, reframing education in light of posthumanist thinking could serve as an enrichment, ideally without losing sight of the core of education itself. Third, since pedagogical practice must engage with technology on both conceptual and practical levels, posthumanism may open up new possibilities for improving educational approaches. The overall aim is “to question what happens when the liberal subject, subject of and subject to modernising education, is humbled, *enfeebled* (italic mine) and put in question” (Rose, 2023). This is ultimately about a transformation in how we understand ourselves and our relations with other-than-human entities, with technology placed at the center of this inquiry. While the focus here is on digital technological change, it is important to acknowledge that education will also be shaped by other emerging contexts, such as the use of cognitive enhancers (“smart drugs”) and potential genetic interventions.

It could be argued, at least conditionally, that changes emerging on the horizon are less a matter of the supposed previously non-existent technology in schools and more the outcome of new sensibilities to think beyond the human. However, this shift is not always immediately detectable, as it is often obscured by the focus on the advent of the latest developments in AI.

4. CONCLUSION

One of the main contributions of critical posthumanism to the current educational debates is posing some very relevant questions that are “far from techno-utopian or techno-dystopian, but instead involve an entirely new understanding of the relationship between education, technology, and the human” (Herbrechter, 2018). This might also mean de-essentializing all three, along with the general problematization of thinking “in essences and universals” (Mambrol, 2018), to find “a way out of the maze of dualisms in which we have explained our bodies and our tools to ourselves” (Haraway, 1991).

The question that currently invites more speculative answers is, then, how can posthumanism help change educational theory and practice, and how can it “enrich,” “change,” or even “improve” practices of knowledge acquisition and communication? Since posthumanism includes postanthropocentrism and since educational institutions are the primary places where people are “indoctrinated” into anthropocentrism (Herbrechter, 2016), there are far-reaching consequences of dismantling the latter. It is too early to conclude that non-human actors will be included in the educational processes; however, there is an ongoing need for the *Anthropos* to step down from the position of being a measure of all things. Posthumanism also stresses that human dominance is not an inherent attribute, but a negotiated position within a system (Pedersen, 2010).

It is counterproductive to view technology either as a threat or as a final achievement capable of solving all our problems, educational or otherwise. This is especially true as some problems undoubtedly have not yet arisen, and we do not know what they will be and how to start solving them (Susskind, 2025).

Discussions of pedagogy driving technology, or vice versa, reinforce a false dichotomy. Pedagogy is not just a method; technology is not just a vehicle for implementing that method (Fawns, 2022). The adjustments that will eventually be required in our educational practices include the meaningful integration of technology, understood here in the narrower sense of digital technology, into schools (the process triggered by the recent pandemic), as well as identifying the social and educational problems we have and why we have them (Jamison & Haraway, 1992).

It might well turn out that virtual or digitally transmitted experiences do not always offer “the same kind of experience one has in a lived experience”, as technology transforms both people and their experiences (Jamison & Haraway, 1992). This is accurate, but there are two ways of looking at this: either lived experience is better and more attuned to the goals of education, or not. The important thing to stress in this context, according to Siân Bayne, is the following: the digital should not be viewed as a substitute for familiar interpersonal practices (Bayne & Jandrić, 2017; similarly, Susskind, 2025). The digital can be even said to be “a privileged mode, one in which new ontological positionings, and new dispositions toward teaching and toward knowledge might be explored and delighted in” (Bayne & Jandrić, 2017).

So, by way of conclusion, I suggest making the following points. Firstly, rethinking and reconfiguring education in terms of what kind of education is the norm, and what kind of education might be the aberration. For now, we are seeing “the on-campus as the norm and digital education at a distance as a kind of deviant position” (Bayne & Jandrić, 2017). And this does not refer solely to the topography of teaching (e.g., “here” vs “at a distance”), but needs to include the modified role of the teacher. Secondly, we need to rethink education as “a process of in-duction: leading the pupil into being ‘human’” (Snaza, 2013). What “it means to be human is constructed differently at different historical moments, by biology, philosophy, political theory, and educational institutions” (Snaza et al., 2014). Some of the past constructions, such as human as white, male, heterosexual, etc., have already been dismantled. Thirdly, now is the time to rethink the present-day definitions and boundaries between our anthropocentric selves and other Others, which will result in changed onto-epistemologies, or, better still, in new ethico-onto-epistemologies (Barad, 2007) – i.e., concerning ethics, being, and knowing and regarding them as no longer separated (Barad, 2007).

In light of what has been said here, it is clear that the move toward posthumanist thinking profoundly shifts the notions associated with the human subject. Therefore, to speak of the posthuman and the end of education (Herbrechter, 2018) (i.e., as we have known it) means to consider several postanthropological questions that are not necessarily technoutopian or dystopian, but involve a reflection on, or perhaps a new understanding of, the relationship between education, technology, and the human (Herbrechter, 2018; see also Vendramin, 2021). This affects the “remnants” of humanism that underpin the entire concept of education as a process of guiding students toward humanity, toward becoming human. Perhaps this is an opportunity to critically re-examine human agency and pedagogical entanglements, emphasizing, with Karen Barad (2007), how all the elements involved are mutually constitutive.

REFERENCES

- Barad, K. (2007). *Meeting the Universe Halfway. Quantum Physics and the Entanglement of Matter and Meaning*. Durham and London: Duke University Press.
- Bayne, S., & Jandrić, P. (2017). From anthropocentric humanism to critical posthumanism in digital education. *Knowledge Cultures*, 5(2), 197-221. <https://doi.org/10.22381/KC52201712>
- Bolter, J. D. (2016). Posthumanism. In K. Bruhn Jensen & R. T. Craig (Eds.), *The International Encyclopedia of Communication Theory and Philosophy* (pp. 1–8). Hoboken: John Wiley & Sons. <https://onlinelibrary.wiley.com/doi/pdf/10.1002/9781118766804.wbiect220>
- Braidotti, R. (2019). *Posthuman Knowledge*. Cambridge: Polity.
- Callus, I., & Herbrechter, S. (2012). Introduction: Posthumanist subjectivities, or, coming after the subject ... *Subjectivity*, 5, 241-264. <https://doi.org/10.1057/sub.2012.17>

- Fawns, T. (2022). An entangled pedagogy: Looking beyond the pedagogy–technology dichotomy. *Postdigital Science and Education*, 4, 711-728. <https://doi.org/10.1007/s42438-022-00302-7>
- Ferrando, F. (2019). *Philosophical Posthumanism*. London and New York: Bloomsbury Publishing.
- Friesen, N. (2018). Posthumanism = Posteducation. A reply to Siân Bayne's "Posthumanism: a navigation aid for educators". *On Education. Journal for Research and Debate*, 1(2). https://doi.org/10.17899/on_ed.2018.2.8
- Haraway, D. (1991). *Simians, Cyborgs, and Women. The Reinvention of Nature*. London: Free Association Books.
- Hayles, N. K. (1999). *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics*. Chicago, London: The University of Chicago Press.
- Herbrechter, S. (2018). Posthumanism and the ends of education. *On Education. Journal for Research and Debate*, 1(2). https://doi.org/10.17899/on_ed.2018.2.2
- Herbrechter, S. (n.d.). *Critical posthumanism*. Retrieved March 11, 2025, from <https://stefanherbrechter.com/>
- Jamison, P. K., & Haraway, D. (1992). No Eden under glass: A discussion with Donna Haraway. *Feminist Teacher*, 6(2), 10-15.
- Knox, J. (2019). What does the 'postdigital' mean for education? Three critical perspectives on the digital, with implications for educational research and practice. *Postdigital Science and Education*, 1(1), 357-370. <https://doi.org/10.1007/s42438-019-00045-y>
- Le Guin, U. (2005). *A rant about "technology"*. Retrieved July 1, 2025, from <https://www.ursulaklequin.com/a-rant-about-technology>
- Mambrol, N. (2018). *Posthumanist criticism*. Retrieved March 21, 2025, from <https://literariness.org/2018/07/25/posthumanist-criticism/>
- Pedersen, H. (2016). *Education*. Retrieved January 2, 2026, from <https://criticalposthumanism.net/education/>
- Pedersen, H. (2010). Is "the posthuman" educable? On the convergence of educational philosophy, animal studies, and posthumanist theory. *Discourse: Studies in the Cultural Politics of Education*, 31(2), 237-250. <https://doi.org/10.1080/01596301003679750>
- Rose, D. E. (2023). Introduction: Take your pick! Posthuman education, human posteducation or posteducation humanism. *International Journal of Philosophical Studies*, 31(4), 467-474. <https://doi.org/10.1080/09672559.2023.2282768>
- Snaza, N., Appelbaum, P., Bayne, S., Carlson, D., Morris, M., Rotas, N., Sandlin, J., Wallin, J., & Weaver, J. A. (2014). Toward a posthumanist education. *Journal of Curriculum Theorizing*, 30(2), 39-55. <https://doi.org/10.63997/jct.v30i2.501>
- Snaza, N. (2013). Bewildering education. *Journal of Curriculum and Pedagogy*, 10(1), 38-54. <https://doi.org/10.1080/15505170.2013.783889>
- Strom, K. J., & Martin, A. D. (2022). Toward a critical posthuman understanding of teacher development and practice: A multi-case study of beginning teachers. *Teaching and Teacher Education*, 114, 1-11. <https://doi.org/10.1016/j.tate.2022.103688>
- Susskind, R. (2025). *How to Think About AI. A Guide for The Perplexed*. Oxford: Oxford University Press.
- Vendramin, V. (2021). Kako smo postali posthumani?: o človeku, tehnologiji in izobraževanju [How We Became Posthuman?: On Human, Technology and Education]. In I. Ž. Žagar, & A. Mlekuž (Eds.). *Raziskovanje v vzgoji in izobraževanju: medsebojni vplivi raziskovanja in prakse* (pp. 61–71). Ljubljana: Pedagoški inštitut.
- Vendramin, V. (2023). (Posthumanist) reflection on universal knowers and the nature of knowledge. In *Arts and Humanities in Digital Transition: Book of Abstracts*. Lisbon: Nova University of Lisbon, 6-7 July 2023. 4–5. Retrieved August 31, 2025, from https://ah-digitaltransition.fcsh.unl.pt/wp-content/uploads/2023/07/ONLINE_Book_of_Abstracts.pdf

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Chapter # 14

THE IMPORTANCE OF INTEGRATING ENGINEERING AND SCIENCE STUDENTS IN BANKING: Enhancing innovation and security

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ABSTRACT

The digital transformation of the banking sector has created an unprecedented demand for technical, analytical, and creative problem-solving skills. This chapter examines how scientific and engineering (STEM) students might be strategically integrated into the banking industry to meet this need, with a focus on Namibia and the Democratic Republic of the Congo (DRC). Despite the widespread recognition of the potential benefits of this type of integration, including enhanced cybersecurity, data-driven innovation, and operational efficiency, many questions remain regarding practical implementation strategies and how to overcome sector-specific barriers, particularly in developing countries. This study examines the key contributions, perceived benefits, and significant obstacles of integrating STEM talent into banking using a mixed-methods approach (in-depth interviews with 30 participants and surveys with 200 respondents). The findings indicate that 85% of banking professionals firmly believe that STEM students foster creativity. Additionally, quantitative research reveals a substantial positive correlation between integration and process innovation ($r = 0.65$, $p < 0.01$). However, there are still barriers including cultural reluctance at banks (55%) and a lack of awareness of STEM competencies (60%). According to the chapter, successful integration requires specific strategies including transdisciplinary project design, structured mentorship, and updated recruitment frameworks in order to effectively use STEM skills for banking's impending challenges.

Keywords: workforce development, cybersecurity, interdisciplinary talent, banking innovation, STEM education, Namibia, DRC.

1. INTRODUCTION

Digitalization, cybersecurity threats, and shifting consumer expectations are causing the global banking industry to undergo significant change (Berger, 2020; Reis, 2024). A workforce with sophisticated technological, analytical, and systems-thinking abilities is needed for this transition in addition to traditional financial knowledge. With these specific abilities, students pursuing STEM fields, science, technology, engineering, and mathematics represent a vital talent pool, according to the National Academies of Sciences, Engineering, and Medicine (2018). From creating trustworthy FinTech applications to strengthening cybersecurity frameworks and streamlining operational processes, their expertise in data analysis, algorithmic thinking, and structured problem-solving is directly applicable to modern banking processes (Demirgüç-Kunt et al., 2020; Nnaomah, 2024). The potential of this skill pool and its actual application in the banking industry, particularly in developing nations, differ significantly, though. Banks frequently still use traditional hiring silos that prioritize recent graduates in business and finance above the creative potential of STEM

minds (Bresnahan et al., 2002). According to Yi and Duval-Couetil (2018), STEM students often do not know about banking career options or how their abilities relate to financial services. Banks lose out on important innovation drivers as a result of this disconnect, while STEM talent ignores a vibrant industry in need of their skills. This chapter's main issue is how the banking industry can strategically integrate science and engineering students in countries like Namibia and the Democratic Republic of the Congo to use their skills for increased security and innovation, and what are the main factors that encourages and hinder this integration? This study looks at the systemic difficulties, real-world applications, and perceived advantages of integrating STEM students into banking. It offers a nuanced view on workforce development in changing financial environments within African contexts by concentrating on Namibia and the Democratic Republic of Congo. The chapter makes the case that intentional integration is essential to the competitive resilience and ongoing innovation of banking in the twenty-first century, rather than just an HR tactic.

2. LITERATURE REVIEW AND THEORETICAL GROUNDING

2.1. Theoretical Foundations: Bridging Human Capital and Organizational Behavior

Three alternative theoretical frameworks can be used to explain the why, what, and how of integrating non-traditional talent into well-established sectors like banking. The fundamental economic justification is provided by Human Capital Theory (Becker, 1964). It asserts that both individuals and organizations can profit from investments in human capital, or skills and knowledge. According to theory, integrating STEM graduates into the banking industry is a direct investment in technical human capital, which should boost creativity and productivity (Goldin, 2016). Nevertheless, this argument by itself is unable to explain why such investments are not made more easily. The emphasis is shifted to strategic advantage by the Resource-Based View (RBV) (Barney, 1991). It contends that resources that are valuable, rare, unique, and non-substitutable (VRIN) are the basis of long-term competitive advantage. Such strategic assets can be represented by the distinct, technologically focused, and numerically demanding skill sets of STEM graduates, such as proficiency in algorithmic automation, cybersecurity, and complicated modeling. By going beyond the conventional resource of financial knowledge, their integration enables banks to develop unique capabilities that are challenging for rivals to imitate. Ajzen's (1991) Theory of Planned Behavior (TPB) is essential to comprehending the implementation gap. It discusses how attitudes toward the activity, subjective standards (organizational culture), and perceived behavioral control impact behavioral intention (e.g., to hire and integrate STEM talent). Therefore, deeply rooted cultural norms that favor finance backgrounds and a perceived lack of control over integrating "different" personnel might impede action even if bank managers understand the value (positive attitude) (Nnaomah, 2024). This approach is a direct influence on how we investigate obstacles such as "cultural resistance." These theories work together to create an analytical triad: TPB describes the organizational and behavioral barriers that need to be addressed, RBV presents the investment as a strategic imperative, and HCT defends the investment.

2.2. STEM Education and Skill Transferability: Beyond Technical Proficiency

According to recent studies, STEM education today develops the exact skills that digital banking requires. STEM education places a strong emphasis on data literacy, systems thinking, and computational problem-solving in addition to fundamental technical

knowledge. These abilities are directly relevant to risk modeling, process optimization, and FinTech development (Xu & Zhou, 2022; Korkmaz et al., 2021). Crucially, entrepreneurship education is increasingly commonly incorporated into STEM curricula, encouraging a creative mentality and business savvy (Yi & Duval-Couetil, 2018; Sunyoto, 2019). Because they learn to structure technical solutions within workable business models, graduates are especially well-suited to fast-paced, customer-centric industries like banking.

2.3. Innovation in Banking: The Imperative for Interdisciplinary Teams

Technology is being emphasized more and more in the banking literature as a major force for development. FinTech adoption studies show how technology changes operational strategy and service delivery (Nnaomah, 2024; Reis, 2024). Innovative concepts frequently come from interdisciplinary teams that question received wisdom, according to parallel studies on innovation management in the financial services industry (Battisti et al., 2022). But putting together diverse teams isn't enough to realize this innovative potential. It necessitates an organizational culture that embraces and incorporates a variety of expertise types as well as efficient knowledge management (Silwana & Jokonya, 2020). The literature frequently refers to a "cultural lag" in which the adoption of technology surpasses the organizational norms and structures required to accommodate new talent types.

2.4. Synthesis and Research Gap

Two parallel narratives are firmly established by the literature currently in publication: (1) the significance of technical proficiency and creativity in contemporary banking, and (2) the worth and changing character of STEM education. At their crossing, however, there is still a sizable conceptual and empirical divide. The majority of research focuses solely on STEM education or financial innovation. The actual method, techniques, and lived experience of integrating STEM students into financial institutions are not well studied, especially in the particular socioeconomic situations of developing African countries. By combining these discourses and offering factual, contextually grounded evidence on the advantages, difficulties, and realistic integration pathways from the dual viewpoints of STEM students and industry workers, this chapter fills this vacuum.

Guiding Research Questions:

1. What are the purported benefits of integrating engineering and scientific students into the banking sector, as perceived by both students and banking professionals?
2. What part do engineering and scientific students play in the creativity and efficiency of banking operations?
3. What barriers might scientific and engineering students face when trying to integrate into banking roles?
4. How can banks use the expertise of science and engineering students to enhance their data analysis and cybersecurity measures?
5. How does entrepreneurship education help students studying science and engineering get ready for banking jobs?

3. METHODOLOGY

3.1. Research Design

A sequential explanatory mixed-methods design was used in this investigation (Creswell & Plano Clark, 2018). In order to find general trends, opinions, and correlations, this method initially required gathering and evaluating quantitative survey data. A qualitative

interview phase that aimed to clarify, contextualize, and expand on the quantitative findings came after this phase. By offering both statistical breadth and narrative richness, this method enables triangulation, improving the results' validity and depth.

3.2. Population and Sampling

Two different populations were the focus of the study:

1. Banking professionals in Namibia and the DRC, including managers, IT specialists, human resources staff, and innovation officers.
2. STEM students from universities in the same nations who are either final-year students or recent graduates in technology, computer science, data science, and related subjects.

3.2.1. Sampling Strategy and Justification

Both representativeness and perceptual depth were guaranteed by a complementing mixed sampling technique.

- Quantitative Phase (Survey): We chose 200 respondents (100 professionals and 100 students) using stratified random selection. Department-based stratification applied to professionals (IT, Operations, HR, etc.). It was determined by the discipline of the students (Physical Sciences, Computer Science, Engineering). This made sure that a variety of pertinent viewpoints from each group were represented in the sample.

- Qualitative Phase (Interviews): We selected 30 participants (15 professionals, 15 students) from the survey respondents using purposive sampling. Strong opinions (positive or negative), relevant experience (e.g., professionals involved in recruiting or digital projects, students with finance-related projects or internships), and diversity of background were among the criteria used to select participants. According to Palinkas et al. (2015), this approach is the best for gathering comprehensive, information-rich data from key informants.

3.3. Data Collection

- Surveys: To gauge attitudes toward integration as well as opinions of advantages, contributions, and difficulties, a standardized questionnaire with 5-point Likert scales was used. Along with items drawn from the theoretical frameworks, it also contained demographic questions (e.g., items on perceived behavioral control associated with TPB).

- Interviews: Exploratory discussion was made possible by semi-structured interview guidelines.

Organizational experiences, perceived worth, and institutional barriers were the main topics of professional interviews. Interviews with students centered on perceived readiness, skill application, and career perceptions. With the participants' permission, the 30- to 45-minute interviews were audio recorded and verbatim transcribed.

3.4. Data Analysis

- Quantitative Analysis: SPSS software was used to examine the data. The data was summarized using descriptive statistics (frequencies, means, and standard deviations). Relationships between variables, such as the connection between integration levels and perceived innovation, were investigated using inferential statistics (Pearson correlation, multiple regression analysis).

- **Qualitative Analysis:** Thematic analysis was used to examine interview transcripts in accordance with Braun and Clarke's (2006) six-phase methodology. This included getting to know the data, creating preliminary codes, looking for themes, evaluating themes, defining and labeling themes, and creating the report. The inductive nature of the analysis allowed themes to surface from the data.

3.5. Ethical Considerations

Strict ethical procedures were followed during the investigation. Every participant gave their informed consent. They were made aware of their freedom to leave at any moment and without consequence. Transcripts and reports were stripped of all identifying information to ensure anonymity and confidentiality. Password-protected devices were used to safely store data.

4. RESULTS

4.1. Demographic Profile of Respondents (N=200)

There are 55% men and 45% women.

Age range: 18–35 years; mean = 25.

Groups: 100 banking executives and 100 STEM students.

4.2. Quantitative Findings

Perceived Benefits: 78% of professionals saw significant potential for increased operational efficiency, and 85% of professionals believed that STEM integration stimulates organizational creativity.

Particular Contributions: According to 72% of respondents, STEM students could greatly improve their cybersecurity and data analytics skills. **Major Obstacles:** 60% of respondents mentioned that management and HR were unaware of STEM competencies. A significant obstacle, according to 55% of respondents, is cultural opposition to unconventional ideas at banks. **Entrepreneurship Education:** According to 70% of students, taking entrepreneurship courses increased their preparedness for jobs in banking. • **Statistical Relationships** Perceived process innovation and the reported degree of STEM integration were found to be strongly positively correlated ($r = 0.65$, $p < 0.01$). Technical skills ($\beta = 0.45$, $p < 0.01$) and cybersecurity contributions ($\beta = 0.35$, $p < 0.05$) were both significant predictors of improved operational efficiency (Model $R^2 = 0.30$, $p < 0.001$), according to regression analysis.

4.3. Qualitative Themes

The interview data revealed four main themes:

1. Professionals observed that STEM students *"approach problems from first principles"* and *"question legacy processes in ways finance-trained staff don't,"* which results in innovative solutions for customer experience and digital services.
2. **Specific Contributions in Technical Roles:** STEM abilities are directly utilized in the following roles, according to interviews: a) Data analysts for consumer insights and risk modeling. b) Cybersecurity experts for system integrity and threat identification. · Process/Systems engineers to optimize and automate workflows. c) FinTech development teams are responsible for creating new platforms and applications.

3. Structural and Cultural Barriers as Fundamental Issues: Banks' "siloe d mindset" was mentioned a lot. *"Our promotion and project allocation systems are built for finance careers, not for technical specialists,"* a senior manager clarified. They soon hit a glass ceiling. And other individual expressed regulatory worry: *"Using an engineer to model risk is one thing, but having them propose a new product triggers compliance concerns we're not set up to manage efficiently."*
4. The Crucial Role of Applied Bridges and Mentorship: Both groups stressed that hiring is not enough on its own. Formal mentorship and structured internships were considered necessary to convert academic knowledge into workable financial solutions. A student said: *"I learned about compliance restrictions from my mentor, a senior quant. This demonstrated that my technical paradigm was not just ingenious but also workable."*

5. DISCUSSION

The results firmly support the central claim of the chapter, which is that incorporating STEM talent is a powerful but underutilized lever for banking innovation and security. Human Capital Theory is empirically supported by the significant association between integration and process innovation, which demonstrates that investments in technical human capital result in observable innovative returns. The Resource-Based View supports the identification of specialized, value-adding positions such as data analysts and cybersecurity professionals, which position these abilities as uncommon and important strategic assets. Nonetheless, the significance of the Theory of Planned Behavior (TPB) is validated by the existence of considerable hurdles, especially awareness gaps (60%) and cultural opposition (55%). According to the research, there are good attitudes toward STEM abilities, but action is impeded by low perceived behavioral control (unsure how to integrate) and subjective norms (entrenched finance-centric cultures). This shifts the conversation from a straightforward "skills gap" to an organizational adaption issue.

Our research adds context-specific empirical evidence from Namibia and the DRC to the body of current literature (e.g., Silwana & Jokonya, 2020; Battisti et al., 2022). They show that more resource-constrained training infrastructures and possibly weaker industry-academia ties exacerbate the integration difficulty in underdeveloped nations. This is consistent with the Organizational Learning Theory (Senge, 1990), which holds that banks must change into "learning organizations" that are able to modify their structures and cultures in order to incorporate new expertise. Practical and Strategic Implications: A systemic change is necessary for banks to integrate effectively: • Talent Pipeline Management: Construct "tech in finance" awareness campaigns, engage in STEM career fairs, and conduct focused outreach outside of business schools. • Structural Innovation: Develop parallel technical career ladders apart from managerial tracks, create hybrid jobs (such as "Quantitative Business Analyst"), and set up innovation labs where STEM personnel work with business divisions. • Cultural Intervention: To dismantle silos, actively support cross-functional initiatives and leadership messaging that promotes a variety of ways to problem-solving.

Limitations and Future Research: This study focuses on two distinct country contexts and is cross-sectional. Longitudinal studies monitoring integrated STEM graduates' career advancement should be part of future study. Contextual best practices would be found through comparative research across various regional economies (such as those in East and Southern Africa). A critical next step is to look at the ethical and legal frameworks that either permit or prohibit the use of technical expertise in delicate financial positions.

6. FUTURE RESEARCH DIRECTIONS

Several research directions are suggested in order to expand on the findings of this study:

- (1) Longitudinal studies to monitor the innovation outputs and long-term career impact of integrated STEM workers in banking.
- (2) Comparative studies between industries and regions to find transferable and contextual integration tactics.
- (3) Research on governance, ethics, and regulatory frameworks that influence how technological talent is used in financial services.
- (4) Research by discipline to assess hybrid education approaches and distinguish the contributions of different STEM fields.
- (5) Research on leadership techniques and organizational transformation to evaluate solutions that go past structural and cultural obstacles.
- (6) Foresight research that looks at how new technologies like blockchain and artificial intelligence may change the responsibilities and skill requirements for banking in the future.

7. CONCLUSION AND RECOMMENDATIONS

This chapter shows that for banks navigating digital transformation, the strategic integration of scientific and engineering students is a crucial requirement rather than just an additional talent strategy. The advantages are evident and quantitatively supported in terms of promoting innovation, strengthening cybersecurity, and increasing operational effectiveness. However, overcoming ingrained institutional, cultural, and awareness-based hurdles will necessitate a concerted, multi-stakeholder effort in order to realize these benefits. The perspective on STEM graduates must change from one of "technical support" to one of "core innovation partners."

Suggested actions:

For Financial Institutions and Banks:

1. Create focused recruitment and awareness initiatives that actively involve STEM departments.
2. Provide organized programs for integration that include clear technical career tracks, rotational assignments, and official mentoring.
3. Create cross-functional teams and innovative challenges to actively promote multidisciplinary cooperation.

For Teachers and Educational Establishments:

1. Use case studies, specialized modules, and guest lectures from the banking industry to incorporate financial settings into STEM courses.
2. Broaden and enhance the curriculum for entrepreneurship to include topics like business model innovation, regulatory environments, and financial ethics.

For Policymakers:

1. Encourage collaboration between industry and academics by offering incentives for collaborative research, sponsoring internships, and developing curricula that emphasize digital financial competencies.

In order to secure its innovative edge and operational resilience in an increasingly digital world, the banking industry in Namibia, the Democratic Republic of the Congo, and comparable contexts can change from being a passive consumer of talent to an active co-creator of a workforce prepared for the future by implementing this cooperative and strategic approach.

REFERENCES

- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179-211.
- Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, 17(1), 99-120.
- Battisti, G. et al. (2022). Innovation in financial services: A review. *Technovation*, 118, 102516.
- Becker, G. S. (1964). *Human capital: A theoretical and empirical analysis, with special reference to education*. Chicago, IL: University of Chicago Press.
- Berger, A. N. (2020). The economic effects of technological progress: Evidence from the banking industry. *Journal of Money, Credit and Banking*, 52(S1), 5-40.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101.
- Bresnahan, T. F., Brynjolfsson, E., & Hitt, L. M. (2002). Information technology, workplace organization, and the demand for skilled labor. *The Quarterly Journal of Economics*, 117(1), 339-376.
- Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). Thousand Oaks, CA: Sage Publications.
- Demirgüç-Kunt, A. et al. (2020). The global financial crisis and the role of banks. *Journal of Financial Stability*, 50, 100772.
- Goldin, C. (2016). Human capital. In C. Diebolt & M. Hauptert (Eds.), *Handbook of cliometrics* (pp. 55-86). Berlin, Germany: Springer.
- National Academies of Sciences, Engineering, and Medicine. (2018). *The integration of the humanities and arts with sciences, engineering, and medicine in higher education: Branches from the same tree*. Washington, DC: The National Academies Press.
- Nnaomah, U. (2024). Integrating FinTech in banking: Reshaping employee attitudes and operational strategies. *Journal of Financial Services Research*, 66(1), 1-20.
- Palinkas, L. A. et al. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health and Mental Health Services Research*, 42(5), 533-544.
- Reis, J. (2024). The impact of AI technologies on operational efficiency in banking. *Journal of Banking and Finance*, 128, 106-120.
- Senge, P. M. (1990). *The fifth discipline: The art and practice of the learning organization*. New York, NY: Doubleday.
- Silwana, S., & Jokonya, O. (2020). Knowledge management and innovation in organizations: A systematic review. *South African Journal of Information Management*, 22(1), a1207.
- Sunyoto, Y. (2019). The influence of entrepreneurship education on students' entrepreneurial interest. *Journal of Entrepreneurship Education*, 22(4), 1-12.
- Xu, Y., & Zhou, Y. (2022). Students' attitudes towards STEM fields and their learning skills. *International Journal of Science Education*, 44(2), 1-20.
- Yi, S., & Duval-Couetil, N. (2018). What drives engineering students to be entrepreneurs? Evidence of validity for an entrepreneurial motivation scale. *Journal of Engineering Education*, 107(2), 291-317.

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Chapter # 15

ARTIFICIAL INTELLIGENCE AS A CATALYST FOR FASHION'S DIGITAL FUTURE

Insights from university-company collaboration

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ABSTRACT

Since the Industrial Revolution, six essential innovation waves have been widely acknowledged as having significantly transformed the world economy and society. Today, we are witnessing the emergence of the sixth wave, characterized by breakthroughs in artificial. In the fashion sector, AI has already emerged as a game-changer. It can enhance trend forecasts and design processes, optimize supply chain management, and boost personalized customer engagement. These innovations collectively lead to significant improvements in efficiency, profitability, and sustainability within the sector. The rapid convergence of fashion and technology has created a pressing need for individuals possessing strong digital skills. Fashion companies must rapidly adapt to this changing environment, while fashion education must simultaneously evolve to provide students with the essential competencies they need. This paper presents a case study of a collaborative workshop between a university and a company, designed to provide students with hands-on experience in advanced AI applications within the fashion sector. This effort enables students to gain a deep understanding of the industry's digital transformation while cultivating a passion for emerging technologies. The authors hope that the experiences presented in this paper will be a valuable resource for researchers and practitioners investigating the convergence of fashion, design, and technology.

Keywords: AI fashion, digital fashion, fashion design education, university-company collaboration.

1. INTRODUCTION

Innovation has consistently had a substantial impact on the global economy throughout contemporary history. Experts have attempted to categorize these cycles of invention using the hypothesis of the “Six Waves of Innovation.” This concept originated in the early 20th century, with Austrian economist Joseph Schumpeter establishing the intellectual groundwork in his seminal work, *Capitalism, Socialism, and Democracy* (1942), wherein he posited that capitalist economies progress through cycles of creative destruction—intervals during which clusters of innovations disrupt existing frameworks and engender new economic paradigms.

As of today, six significant waves have been broadly recognized. The initial wave was driven by the mechanization of the textile industry and the adoption of hydraulic power in the late 18th century. During the mid-19th century, the second wave was driven by the emergence of steam power and the proliferation of railway networks. The third wave emerged in the late 19th and early 20th centuries, coinciding with the expansion of electricity, steel manufacturing, and chemical industries. The fourth wave emerged in the mid-20th century, characterized by the mass production of automobiles and airplanes, as well as the extensive use of fossil fuels. The fifth wave, beginning in the late 20th century, marked a revolution in

information and communication technology, characterized by the emergence of computers, the internet, and digital media (Freeman & Louca, 2002). Currently, we are witnessing the emergence of the sixth wave of innovation, defined by the convergence of artificial intelligence (AI), sophisticated robots, the Internet of Things (IoT), and a significant societal transition towards sustainable energy solutions (Silva & Di Serio, 2016).

In the fashion industry, AI has already become a transformative force. It can improve trend predictions and design processes, optimize supply chain operations, and enhance tailored consumer interactions. These advances collectively result in substantial efficiency, profitability, and sustainability within the sector. AI is now considered more of a creative partner than a mere engineering tool. Designers emphasize that AI can animate and accelerate the creative process, generating ideas, patterns, and variations at a pace far faster than one could achieve by hand. Far from limiting creativity, AI can be considered an aid that helps foster creativity by providing designers with numerous options to experiment with in a short amount of time. This opens up an interesting way to view AI as an inspiration tool, enabling creative minds to take approximately days from conception to prototype, as opposed to weeks, and spend time digitally fine-tuning the very spirit and essence of their artworks.

Following such an analysis, the potential of AI extends beyond supporting various forms of creativity and remains a decisive factor in accelerating production throughout the entire fashion workflow. Partnered with 3D design technologies, it facilitates the precise visualization of garments, such as determining whether a Dresden pleat will drape properly across the shoulder before the fabric has even been cut or stitched. This simultaneously diminishes the need to create physical samples innumerable times, saving time and resources. Reducing waste and streamlining production cycles will enable brands to implement sustainable initiatives without compromising on quality or speed. For a significant portion of the industry, this fusion of AI and 3D design is remembered as a cost-saving measure and is inextricably linked with a forward-looking strategy to meet the global demand for eco-conscious innovation. Transitioning from the prevailing traditional production paradigm to a more streamlined model by embracing digital AI technology has become an urgent requirement and the next normal (Bertola & Teunissen, 2018; Gonzalo et al., 2020).

Perhaps the most significant transformation brought about by AI is the collaborative nature of internal operations within fashion organizations. It was formerly slow, sequential, and one-sided, as design was separate from merchandising and marketing. However, the use of AI has combined all three functions much earlier through shared data, simulations, and predictive insights. Thus, teams have a higher accuracy in predicting consumer needs and adapting the design way before production. Hence, the entire setup becomes highly responsive and agile to actual cultural and market shifts. At the end of the day, the view is that AI will not replace human talent, but rather augment it, making it smarter, quicker, and more cost-effective in the realization of creative ideas.

The rapid convergence of fashion and technology has created an urgent need for professionals possessing digital expertise and skills across all fields. A global survey by MOTIF, which gathered insights from 900 professionals across the value chain, reveals that 57 percent of respondents encounter difficulties in filling positions that require digital skills, particularly in digital creation (Alvanon, 2020). The discovery indicates that conventional skill sets are inadequate in this rapidly evolving landscape. It is essential to reconfigure the talent development pipeline and provide upskilling initiatives, particularly in digital competencies, to reconcile the disparity between business demands and existing educational offerings.

Nonetheless, integrating advanced AI technologies into fashion curricula encounters significant challenges, especially for traditional public universities. Unlike private schools, which exhibit superior adaptability and stronger connections with commercial partners, state universities often face cumbersome and protracted procedures for curriculum updates, implementing essential technology advancements more challenging. Establishing collaborative educational pathways between private enterprises and public universities may provide a viable and pragmatic solution to this issue (Ingaramo, 2022). This paper presents a case study of a joint workshop activity between Style3D and POLI.design, founded by Politecnico di Milano, examining how university-company partnerships might leverage AI technology to foster innovation in fashion design education. The authors hope that the insights and experiences detailed in this paper will serve as a helpful reference point for other researchers exploring digital fashion and design practices in relevant areas.

2. THEORETICAL FRAMEWORK: AI, CREATIVITY, AND FASHION DESIGN EDUCATION

The application of artificial intelligence, along with its potential in creative fields, has opened up new discussions regarding the relationship between human creativity and computer-based systems. The literature already highlights the potential for AI to serve as an ideation partner, thereby assisting creative professionals in tasks such as generating alternatives, enhancing visual representations, and facilitating rapid replays (Shneiderman, 2020). In the creative sector, generative AI has been viewed through the lens of co-creativity, where the human designer's intent and the algorithmic output are the two forces that together dictate the design directions (Boden, 2016). This kind of interpretation highlights that the role of AI is not limited to replacing human creativity but rather to augmenting it and also opening up paths of exploration that would be nearly impossible to achieve without human assistance.

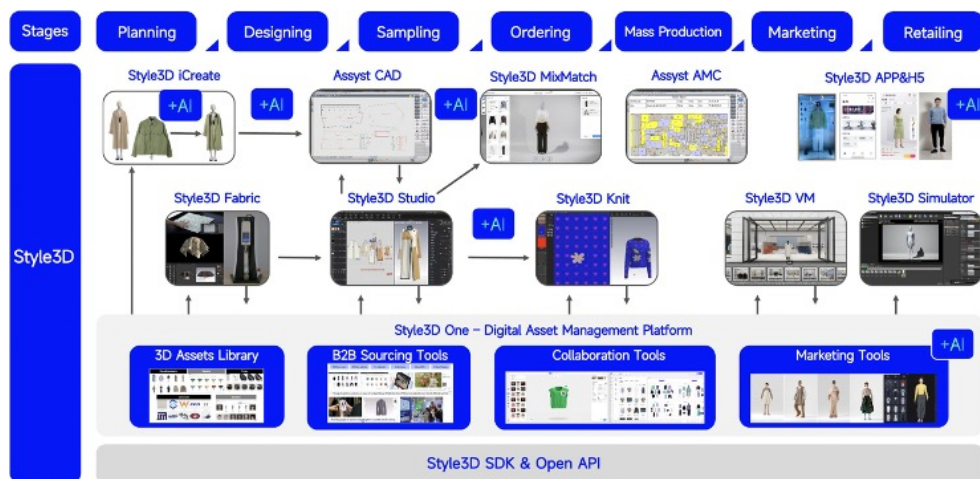
In the realm of design education, the introduction of AI has led instructors to rethink the teaching methods they use, which heavily rely on traditional, analogue processes and studio-based critiques. According to Kolb (1984), learning through projects and experiential learning frameworks remains the primary method in the design curriculum. However, the introduction of AI tools necessitates a reinterpretation of these methods, which should include digital literacy, prompt engineering, and critical evaluation of machine-generated outputs. Recent research in AI literacy emphasizes the importance of students acquiring not only the skills for using tools but also for questioning algorithmic biases, understanding model limitations, and expressing their creativity in the design process (Long & Magerko, 2020). The AI-ness in creative education raises the issue of a possible decline in distinct visual languages due to the overlapping of different styles, ideation consuming less human time, and concerns about an entire machine being the author of a piece of creative work, simply generating originals. The academic community has differing opinions regarding the fact that AI can, at times, accelerate the creative process. However, an insufficient pedagogical structure may result in superficial exploration of ideas, less critical adoption of algorithmically produced styles, or a shallower understanding of concepts (Holmes & Porayska-Pomsta, 2022). Hence, it is essential for instructors to create learning environments that allow students to experiment and reflect on their experiences, thereby making AI a creative catalyst rather than a replacement for the intentional design thinking process. Collaboration between universities and industries is an effective method for addressing such challenges. The parties involved in this collaboration not only have access to the most advanced tools, but also students get a chance to practice in real-world workflows.

Finally, the institutions receive support in making changes to their curricula that have been slow to adapt (Perkmann et al., 2013). The case study discussed in this chapter is an example of how AI tools can be effectively utilized in the fashion industry through joint experimentation.

3. STYLE3D DIGITALIZATION ECOSYSTEM

Style3D is a science-driven enterprise offering a comprehensive digital infrastructure tailored to the fashion industry. By seamlessly integrating advanced 3D modeling and artificial intelligence (AI) technologies, Style3D facilitates the creation, visualization, and collaboration of digital assets, thereby driving the digital and innovative transformation of the global fashion industry (Figure 1). Its digitalization ecosystem spans three primary domains: 3D tools for fashion (Studio, Fabric, MixMatch, Cloud), AI tools for fashion (iWish, iCreate), and 3D tools for computer graphics (Atelier, Simulator).

Figure 1.
Style3D 3D+AI digitalization ecosystem. Source: Style3D.



Their AI tools, Style3D iWish and Style3D iCreate, exemplify the application of AI in accelerating and enhancing fashion design processes. Style3D iWish enhances creative efficiency by generating lifelike virtual models with diverse age ranges and skin tones, enabling AI-powered scene swapping for seamless integration into various contexts and allowing for detailed garment refinements to achieve photorealistic output. Complementing this, Style3D iCreate leverages deep learning to expedite the creation and modification of apparel, accessories, and design concepts. It lets designers quickly visualize garment combinations on digital models, generates high-quality product images from text, sketches, or references, and precisely modifies product components, including color harmonization and graphic detailing.

According to Eric Liu, founder and CEO of Style3D, the traditional fashion supply chain—a mechanism long dominated by a rigid, linear, step-by-step progression—is undergoing a profound transformation. As advanced digital tools come into place, such as those offered through Style3D for digital product creation, the industry is slowly drifting

away from siloed working and towards a much more dynamic, interconnected web that calls for more agility and collaboration (Isatou, 2023). At the 2024 China Fashion Forum, organized by the China National Garment Association, Liu proposed AI+3D as a triggering new platform to rethink fashion's future. He believed that the AI would further streamline production models, as well as craft custom AI solutions for enterprises to reinforce a brand's creative DNA and establish its identity in the market (Fashiontopnet, 2024). AI-enhanced 3D technology is a powerful combination that can significantly speed up design cycles, optimize production efficiency, and bring sustainable practices into the mainstream across the entire industry. Through Style3D's ecosystem, designers can rapidly generate, iterate, and visualize their concepts while cohesively collaborating in a virtual environment.

In the following sections, the authors focus on the functionalities and applications of the Style3D iCreate software. The illustration is framed through a case study of a collaborative workshop designed to provide students with hands-on experience in advanced AI applications. By engaging directly with such a tool, students gain practical insights into the digital transformation of the fashion industry while fostering a deeper interest in emerging technologies.

4. CASE STUDY: AN IMMERSIVE AI EXPERIENCE

The one-day immersive AI experience workshop in March 2025 is a collaborative activity between Style3D and POLI.design, founded by Politecnico di Milano. This workshop primarily introduced students to the problems, advancements, and trends currently shaping the fashion industry, as well as how Style3D's innovative AI technologies can enhance the capabilities of designers and marketers in multiple ways. Company representatives presented a comprehensive overview of two newly developed software solutions: Style3D iWish and Style3D iCreate (Figure 2, left).

The workshop involved 57 master-level students, who were permitted to investigate and evaluate the various functions of Style3D iCreate beforehand (Figure 2, right). Despite these tools being in development, interaction with cutting-edge technologies in the industry greatly benefits students. The rapid advancement of technological innovation underscores the need for collaboration between corporations and academic institutions. These contacts and experiences enable students to stay aware of evolving market demands, equipping them with the attitudes crucial for their future careers. The following section outlines students' immersive experience with Style3D iCreate, providing a comprehensive overview of its capabilities and applications.

Figure 2.
Style3D Representatives presented the software, students tried the functions beforehand.



Style3D iCreate is an inspiration accelerator for designers that utilizes the sophisticated features of Artificial Intelligence Generated Content (AIGC). This program streamlines the development and refinement of design concepts, enabling designers to operate more efficiently (Dong, 2024). The Style3D iCreate functionalities are categorized into two modules: StyleNext (previously called AI Editor) and InnoStyle (previously called AI Creator); each module is specifically designed to address different stages of the design process (Table 1).

Table 1.
Two modules of Style3D iCreate: StyleNext and InnoStyle.

StyleNext	Designers can fine-tune details such as garment features, proportions, ensuring the result aligns with their vision. This iterative editing process enables users to achieve further customization and refinement, facilitates virtual try-ons with suitable virtual models and renders high-quality visual outputs of the pre-defined designs.
InnoStyle	Enables designers to generate initial design concepts rapidly. By inputting textual descriptions as prompts, uploading an image or a design sketch, users can direct the AI to create corresponding designs and partially modify the designs. This feature simplifies the ideation process, offering designers various options from which to start.

During the workshop, the company experts provided students with hands-on guidance to explore the functionalities of Style3D iCreate. This was achieved through four workflows, each designed to showcase a different entry point for initiating the design process.

- Workflow 1 Starts with a sketch

Upload a sketch and ask InnoStyle to generate garments accordingly, then partially replace the detail and color.

- Workflow 2 Starts with a textual prompt

Type a precise textual description as a prompt and ask InnoStyle to generate garments accordingly, then generate a pattern. Finally, back to StyleNext to fabricate the pattern to style.

- Workflow 3 Starts with images

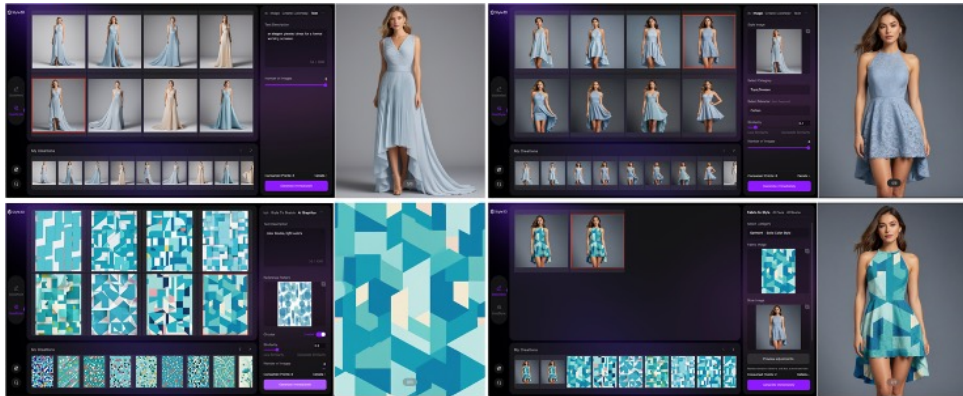
Upload two garment images and ask InnoStyle to combine and generate a new garment accordingly, then partially replace the details and color.

- Workflow 4 Free creation

After completing the previous three workflows, students can freely create their own workflow for their designs.

The following illustrates one participant's trial (Workflow 4) during the workshop as an example of how Style3D iCreate AI-assisted design tools were utilized. The participant began by using InnoStyle, where she entered a textual prompt: "an elegant, pleated dress for a formal working occasion." In response, the AI generated a series of proposals aligned with the prompt. From these, the participant selected a preferred option (Figure 3, top left). To further explore stylistic variety, the participant reinserted the initially selected image into InnoStyle, prompting the AI to generate alternative dress designs with low similarity to the original. This iterative process—repeating the image-to-image prompt with modified criteria of similarity—was carried out several times. Eventually, one satisfactory dress was chosen (Figure 3, top right). Thereafter, the participant employed the AI Graphics function in InnoStyle. By uploading a reference pattern and providing a new textual prompt - "light color blocks" - the AI generated a series of custom textile patterns to be chosen from (Figure 3, bottom left). Finally, using the Fabric to Style feature in StyleNext, the participant merged the selected dress silhouette with the chosen generated pattern, creating a final garment design (Figure 3, bottom right). The entire workflow took the participant several dozen minutes to complete. Naturally, these steps can be repeatedly integrated and iterated in practical use to achieve a fully satisfying design outcome.

Figure 3.
One example of the workshop outcomes.



The analysis of the workshop revealed several recurring patterns in students' interactions with AI-assisted design tools. The first benefit was that the use of AI significantly accelerated the idea generation process, allowing students to create numerous variations of the design in a short time and significantly reduce their initial creative blocks. Monitoring students showed that text-to-image and image-to-image functions were mainly used by students for rapid iterations. The second point was that the use of AI technology lowered the technical barriers, especially for learners who had little talent in drawing or 3D modeling. It made it easier for these students to visualize and, at the same time, more daring in design, to convey their ideas visually. At the same time, a dilemma arose as to whether to view the author as a computer or a human. Many of the participants asked how much of the AI-made products was their own artistic intent, and were worried that they might be turning off their own creative idea if they let AI make up their minds. Last but not least, the workshop showed the benefits of cooperation between the university and the industry: the students were delighted that they were able to use the latest tools and get direct tuition from the manufacturers' experts, thereby reinforcing the importance of the connection between university education and professional workflows in the real world.

The workshop results indicate that there are both opportunities and challenges in the application of AI in fashion design education. Similar to the existing literature about human-AI co-creativity, the workshop revealed that AI not only helps students to find more design options but also removes some of the barriers to the process of quality experimentation. Nevertheless, students may find it challenging to maintain the flow of their creativity and develop deeper conceptual reasoning without the use of prearranged pedagogical models. The workshop's illustration of automation versus authorship reflects broader discussions about the role of AI in creative fields. The plus side of AI is its ability to create visuals quickly. However, students still need to communicate their design intent, reason about the aesthetics of the work, and participate in the critique process to avoid producing trivial results. As a result, educators become increasingly important in helping students develop the kind of use of AI that is both unintentional and critical. Moreover, the workshop emphasizes the importance of university-industry partnerships in equipping students with the latest digital skills through the constant exchange of information. Gaining access to the likes of Style3D iCreate not only enables students to become technologically literate but also requires partnerships between academic and professional fields, accompanied by flexible curricula and proper assessment frameworks, to make the sharing of information truly effective.

5. FUTURE RESEARCH DIRECTIONS CONCLUSION AND FUTURE DIRECTIONS

Upon trying the software, students were impressed by the efficiency and ease facilitated by today's AI technologies. Company representatives indicate that this software is now undergoing modification; subsequent versions of Style3D software will incorporate an enhanced capability to instantly transform imported photographs into 2D patterns, which may thereafter be effortlessly modified in 3D within the platform. These improvements optimize the design process and augment designers' efficiency.

Nevertheless, this convenience introduces new obstacles. A primary concern is reconciling the use of AI-generated outputs with preserving the designer's creative contributions and conceptual profundity. Although technologies such as Style3D iCreate possess significant potential to transform design workflows, their incorporation into professional and educational settings must be cautiously undertaken. Deliberate tactics are necessary to guarantee that these tools augment creativity rather than serve as substitutes, preserving the distinctive personal and creative vision that characterizes significant design work.

The educational structure must adapt to confront these simultaneous opportunities and difficulties, as this is an inevitable future trend. Students require systematic direction to integrate AI tools while preserving their creative potential. This entails promoting critical thinking, iterative design methodologies, and reflective assessments that guarantee AI-generated ideas only augment their original thoughts. Activities such as brainstorming, concept research, mood board development, and narrative storytelling, carefully overseen by teachers, can guarantee that students possess a distinct and innovative vision for their projects, preventing the AI tool from overshadowing the human design process.

In practice and observations, the authors believe that the following directions are worth exploring for future works:

- **Technological Adaptation:** Since students have different levels and degrees of familiarity with new digital tools, this can lead to steep learning curves. It is, therefore, essential to evaluate participants' knowledge before the start of the course in order to balance the class. The introduction of digital technologies can be facilitated by simplified workflows, offering practical instruction, and implementing flexible foundational training programs. Peer-assisted learning and frequent feedback sessions can also help students who are having trouble with unfamiliar digital tools.
- **Curriculum Inflexibilities:** Incorporating critical digital skills into fashion education is sometimes delayed by traditional educational frameworks' inability to adjust quickly to technological changes. To overcome this, universities and companies need to work together to develop flexible programs that adapt to changing industry needs. Structured internship programs, joint research initiatives, and industry-sponsored competitions can also be helpful for long-term advancement.
- **Balance between Creativity and Automation:** As AI is used increasingly in fashion design and business, there are concerns that this could lead to an over-reliance on automation, potentially affecting originality. Frameworks for education should highlight how AI may enhance human creativity rather than take its place. This can be accomplished by emphasizing concept development and narrative while using AI tools in the creative process. Students can preserve their artistic intent and cultivate a strong creative vision by participating in design projects that blend manual and AI-driven outputs.

- **Goal Alignment:** It can be challenging to balance the short-term academic achievements with the long-term strategic objectives of industrial relationships. Clear communication, shared goal-setting, and regular check-ins are essential to ensure a productive partnership. Better alignment and the achievement of significant results by both parties are made possible by establishing standard benchmarks and flexibility for in-progress modifications. Stronger, longer-lasting collaborations can also be developed through long-term planning that integrates industry feedback into curriculum changes.

Several limitations should be acknowledged. First, the workshop was short in duration, limiting opportunities for longitudinal observation of learning outcomes. Second, data collection was exploratory, derived mainly from informal feedback and observations rather than formal interviews or surveys. Third, participants represented a relatively homogeneous group of design students, which may restrict generalizability. Finally, the AI tools used were still under development, which potentially affected their usability and influenced students' responses.

In the following year, the insights and experiences gained from this work will serve as the basis for improving current workshop formats and spawning new collaborative projects involving universities and industry partners. This iterative, practice-driven model keeps the educational structure adaptable to the fast technological transformations in the fashion landscape. By continuously engaging in renewed workshop development and stronger academia-company collaboration, the experimental aim is to provide students with advanced digital knowledge, creative problem-solving skills, and hands-on work experience, thereby enabling them to compete in the ever-changing and dynamic fashion world. In addition to the paper's educational impact, the authors also envision it as a contribution to the ongoing discourse concerning the interface between fashion, design, and technology. The authors hope that the ideas and experiences presented in this paper will be a valuable resource for researchers and practitioners investigating the convergence of fashion, design, and technology.

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REFERENCES

- Alvanon. (2020). New global survey identifies knowledge gaps in fashion industry — 57% of respondents struggling to fill skilled roles creating a digital skills gap. *Alvanon*. Retrieved from <https://alvanon.com/article/the-state-of-skills-in-the-apparel-industry-2020>
- Bertola, P., & Teunissen, J. (2018). Fashion 4.0. Innovating fashion industry through digital transformation. *Research Journal of Textile and Apparel*, 22(4), 352-369. Retrieved from <https://www.emerald.com/insight/content/doi/10.1108/rjta-03-2018-0023/full/html>
- Boden, M. A. (2016). *AI: Its nature and future*. Oxford University Press.
- Dong, X. (2024). *Style3D: Experience the future of digital fashion at an astonishing pace of innovation!* Retrieved from http://www.taweekly.com/hzdt/202408/t20240829_4355749.html

- Fashiontopnet. (2024). Style3D Liu Chen: Hoping AI+3D Becomes a New Productive Force in the Fashion Industry. *Fashiontopnet.com*. Retrieved from <http://www.fashiontopnet.com/articleid/148626.html>
- Freeman, C., & Louca, F. (2002). *As time goes by: From the industrial revolutions to the information revolution*. Oxford University Press.
- Gonzalo, A., Harreis, H., Altable, C. S., & Villepelet, C. (2020). *The fashion industry's digital transformation: Now or never*. Retrieved from <https://www.mckinsey.com/industries/retail/our-insights/fashions-digital-transformation-now-or-never>
- Holmes, W., & Porayska-Pomsta, K. (2022). *The Ethics of Artificial Intelligence in Education. Practices, Challenges, and Debates*. New York: Routledge.
- Ingaramo, M. (2022). Premium Design: Enhancing Synergies between Design and Business in Education and Practice. *Politecnica*. [e-book]. <https://doi.org/10.30448/UNI.916.50894>
- Isatou, N. (2023, October 4). How Style3D Is Bridging the Fashion Supply Chain's Information Gap. *Just-Style.com*. Global Data UK Limited. Retrieved from <https://go.gale.com/ps/i.do?p=AONE&u=anon~e7c90d2f&id=GALE%7CA767708954&v=2.1&it=r&sid=sitemap&asid=57351457>
- Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice Hall.
- Long, D., & Magerko, B. (2020). What is AI literacy? Competencies and design considerations. *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. ACM. <https://doi.org/10.1145/3313831.3376727>
- Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'Este, P., Fini, R., Geuna, A., Grimaldi, R., Hughes, A., Krabel, S., Kitson, M., Llerena, P., Lissoni, F., Salter, A., & Sobrero, M. (2013). Academic engagement and commercialisation: A review of the literature on university-industry relations. *Research Policy*, 42(2), 423-442. <https://doi.org/10.1016/j.respol.2012.09.007>
- Silva, G., & Di Serio, L. C. (2016). The sixth wave of innovation: are we ready? *RAI Revista de Administração e Inovação*, 13(2), 128-134. <https://doi.org/10.1016/j.rai.2016.03.005>
- Shneiderman, B. (2020). Human-centered artificial intelligence: Reliable, safe & trustworthy. *International Journal of Human-Computer Interaction*, 36(6), 495-504. <https://doi.org/10.1080/10447318.2020.1741118>

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Chapter # 16

USE OF AI AGENTS AND AGENTIC AI TO EVALUATE UNIVERSITY CURRICULA

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ABSTRACT

AI agents are specific AI tools, while agentic AI shows many aspects of human thinking, and is touted as replacing functions which human educators now perform. This chapter first discusses the differences between AI agents and agentic AI, and then identifies which aspects of the university curriculum they appear best suited to perform, before discussing a model of AI functions enhancing human thinking processes. These AI augmentations constitute technological evolution, involving ongoing adaptation to emerging technologies, not just in education, but in everyday life, as we now live in cities which are technosystems. However, while methods, media and tools are constantly evolving, there are basic functions which remain constant in the teaching/learning process. The functions performed by AI agents or agentic AI are discussed in terms of how they might facilitate the basic teaching/learning functions in a generic model of course design. Two applications, one based on AI agents, the other, on agentic AI, are then described to show how they operate in evaluating aspects of university curricula. It is emphasized that AI agents and agentic AI should be used to serve the key human social purposes of education, rather than education being reshaped to fit technological innovations.

Keywords: AI agents, agentic AI, curriculum evaluation, modelling, course design.

1. INTRODUCTION

AI agents refer to specific AI tools, many of which are already in common use in University courses. Agentic AI, on the other hand, is a more complex mechanism which shows many aspects of human thinking, and is touted as replacing, autonomously, many functions now performed by human educators. This chapter first looks at the differences between AI agents and agentic AI, and next, identifies which aspects of the university curriculum they appear best suited to perform. It then discusses work in progress on a model of AI functions which identifies which human thinking processes AI enhances and how, as well as the implications for university curricula. A proviso is that current university disciplines are by no means static, and are constantly adapting to various workplace changes and challenges initiated by the Fourth Industrial Revolution (Fomunyan, 2019). These developments, it is suggested, should more properly be termed technological evolution, as they involve ongoing change and adaptation to emerging technologies, not just in education, but in everyday life, as we live in cities which are technosystems, based on layers of interlocking systems (Aunger, 2010).

It is generally accepted that AI is now part of the education system, whatever its pros and cons (Illinois College of Education, 2024), and can contribute extensively to alleviating the administrative teaching load in universities. Accounts have been published of university approaches and guides (African Observatory on Responsible Artificial Intelligence, 2024), but these, understandably, are context-specific and address issues of concern and interest to

the universities publishing them. Even international forums do not appear to be able to formulate an overall approach to AI at universities, apart from emphasising accountability and a human-centred approach, with which we unreservedly concur (Women in Science, 2024).

For our part, it will be suggested that, while methods, media and tools are constantly evolving, there are basic functions which remain constant in the teaching/learning process, whether overseen by a human academic or “Professor Bot” (Bidarian, 2023; Fourie, 2023). The functions performed (or simulated) by AI agents or agentic AI are next discussed to suggest to what extent they facilitate the basic teaching/learning functions in a generic model of course design. Two applications, one based on an AI agent, the other, using agentic AI, are then described to show how they operate in evaluating aspects of university curricula. Concluding on the evolutionary theme, it is emphasized that AI agents and agentic AI should be used to serve the key human social purposes of education, rather than education being reshaped to fit technological innovations.

2. BACKGROUND

This section first looks at the differences between AI agents and agentic AI, next, at a model showing AI augmentation of human design capacities, and finally, a model showing types of thinking augmented by AI tools. It then sums up the implications of these models for university curricula, and suggests how they provide the rationale for the methodology for the two higher degree AI-assisted projects described in this chapter.

2.1. AI Agents and Agentic AI

An AI agent is a digital application which performs simple tasks as specifically directed, while agentic AI can do complex tasks and has the ability to learn over time as it adapts to users’ needs (Lisowski, 2024; MacVittie, 2025; Marr, 2025). Most educators are familiar with AI agents in terms of using them for Internet searches, statistical calculations and tools in web-based learning (WBL) platforms, and are aware of their nature and capacities:

They’re designed to help you with something - like answering questions, organizing your calendar, or even managing your email inbox. AI Agents are great at automating simple, repetitive tasks but don’t have the autonomy or decision-making abilities that Agentic AI does. Think of them as virtual helpers that do exactly what you tell them to do, without thinking for themselves. (Lisowski, 2024, p. 2)

However, educators are not so familiar with the features of agentic AI:

At its core, Agentic AI is a type of AI that’s all about autonomy. This means that it can make decisions, take actions, and even learn on its own to achieve specific goals. It’s kind of like having a virtual assistant that can think, reason, and adapt to changing circumstances without needing constant direction. (Lisowski, 2024, p. 1)

The descriptions above show that, while both AI agents and agentic AI are forms of artificial intelligence, each operates in very different ways. An AI agent just does what you use it to do (search, gather data, calculate, and so on), although we have noticed that developers are ‘sneaking in’ agentic enhancements in simple tools like web searches and browsing options, we suspect, as a form of surreptitious marketing for forthcoming agentic

AI products. This is because agentic AI is somewhat daunting to potential users when they realise that it operates very much like humans, in “four key stages” (Lisowski, 2024):

- Perception: It gathers data from the world around it.
- Reasoning: It processes this data to understand what’s going on.
- Action: It decides what to do based on its understanding.
- Learning: It improves and adapts over time, learning from feedback and experience.

It must be noted that terms such as “perception”, “reasoning”, “action” and “learning” are *analogues*, not *replications* of human processes with the same names.

While agentic AI’s human-like autonomy may arouse concern, its robotic applications appear to be viewed with enjoyment by people in general, in watching AI-programmed robots competing (not so well, actually) with human runners in long distance races (AFP, 2025) or people shaking hands with socially-aware robotic pooches (https://www.youtube.com/watch?v=SDp_i25xagg). However, agentic AI publishing of a newspaper (AFP, 2024) or an agent masquerading as a student applying for a university degree may not be quite so humorous for journalists in terms of ethical issues and accuracy (Muindi, 2025), or for human students looking for university places (Wu, 2025). What is not so amusing for *all* of us is the prediction that: “Six million South Africans risk job displacement as WEF predicts tech dominance” (Naidoo, 2025). As As Muggah and Giussani (2025) point out: “there are rising concerns that the political, social and economic fallout from mass labour displacement will deepen inequality, strain public safety nets and contribute to social unrest.”

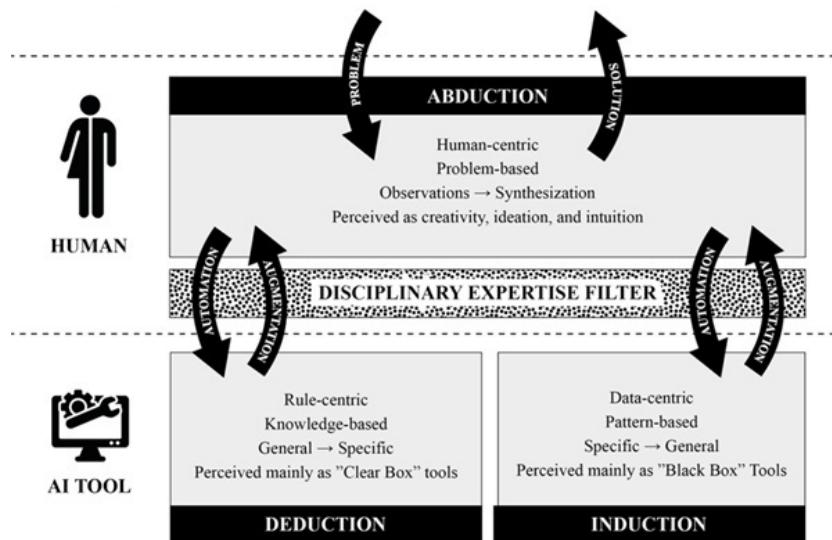
While Lisowski lists some current common uses of AI, the spinoffs of AI use can be seen to have potential impact on *all* human activities. It is like asking the eponymous creative thinking exercise: “How many uses can you think of for a paper clip?” (Ward, 2020); except that AI is more like a “double-edged sword” (Kruger, 2025), with more ominous connotations. Moreover, people are confused about the use of the more complex tools. Academics seem to be most confused of all, with universities focusing on maintaining academic integrity in research and research writing rather than an ethic of care for participants. Potential users do not realise that agentic AI needs to be briefed to work as required. As Fortune (2025, p. 1) points out: “the average person is left poking at ChatGPT like it’s a mysterious alien artefact, not quite sure how it works or why the results aren’t as impressive as expected.”

This is true of Copilot, an example of agentic AI used in one of the projects described. Copilot can do complex tasks and learn over time as adapting to users’ needs, and not merely an AI agent, performing simple tasks as specifically directed (Lisowski, 2024; MacVittie, 2025; Marr, 2025). Most educators will be familiar with Copilot as it is integrated into Windows 11 and Microsoft 365 applications. It is also available as a “standalone app” and at <https://copilot.microsoft.com/chats/1NddUYXGRxnNbVAaPPqF6>. The standard version is free, but more complex versions can be purchased. Explanations of its use can be found at <https://learn.microsoft.com/en-us/microsoft-365-copilot/extensibility/> (Graham et al., 2024). However, to further confuse the distinction between AI agent and agentic AI, *Copilot can create AI Agents to carry out tasks required by the user*. Finally, while Copilot is an agentic form of AI, as it can do complex tasks, it cannot perform tasks requiring judgment or experience, which require abductive, or human-centric, processing (Hansen, 2023, p. 3; Larson, 2021, pp. 157-190). This means that, in both of the projects discussed here, human judgement and experience were part of the briefing given to the AI tools involved.

2.2. Model Showing AI Augmentation

The descriptions of AI agents and agentic AI tend to focus on the technical aspects, without giving educators a clear idea as to which aspects of the university curriculum they appear best suited to perform. The model discussed in this section offers more insight into which processes can be relegated to AI tools and which need to be performed by humans. According to the model (Hansen, 2023, p. 3), AI-tools cannot perform tasks requiring judgment or experience, which require abductive or “human-centric” processing (confirmed in some detail by Larson, 2021, pp. 157-190). The model in Figure 1. is an adapted version of Hansen’s “proposed model based on deduction, induction, and abduction” (2023, p. 5), which was intended to illustrate how AI tools might enhance the graphic design process. The term Hansen used for such enhancements was “augmentation”. However, the model can be seen to be relevant to the creation of any artefact using AI tools, as well as to design processes in general, including, it is proposed, course design.

Figure 1.
Adaptation of Hansen’s model based on deduction, induction, and abduction
(Pratt, 2025, p. 2).



The adapted model in Figure 1. shows how the elements used in logical and inferential reasoning are shared between human designers and the AI tools they use. The “disciplinary expertise filter” shows that use of AI, as well as the functioning of AI as a tool, is limited to the disciplinary area of the designer. The terms “black box” and “clear box” suggest that some functions are conscious, and others, hidden or intuitive. According to the model, abduction refers to reasoning done by human designers, which requires human judgement and creativity; deduction, to ready-made rules and tools which computers (or digital applications) can apply; and induction, to tools computers can create from mass data. The arrows between the functions signify input from humans to computers and vice versa. Hansen’s model suggests that human creativity can be viewed as a form of abductive inference, which AI cannot perform. According to the model, only humans can be truly creative, as all AI can do is provide data to feed the human designer’s creativity.

The placement of abduction at the top of the model does not imply that abduction is superior to deduction and induction, but shows that the design process is initiated and driven by humans, and not by machines.

The relevance of the adapted model to higher education is that it suggests how schools in all academic subjects (and not just Design) might adapt their curricula and delivery to include the increasing availability of AI tools. However, it makes it quite clear that AI is “just a tool”, and that tasks must be initiated and controlled by humans: “AI works for us, not the other way around” (Hansen, 2023, p. 4).

2.3. Model of Types of Thinking Augmented by AI Tools

The adapted model in Figure 1 can be seen to highlight the division between left-brain and right-brain thinking modes, as shown in Table 1, in which deduction and induction are grouped under left-brain thinking. The column on the right-brain side includes judgement and experience: these are holistic, conceptual entities, as experienced by human educators, and not rule- or logic-based, as performed by AI tools (whether AI agents or agentic AI).

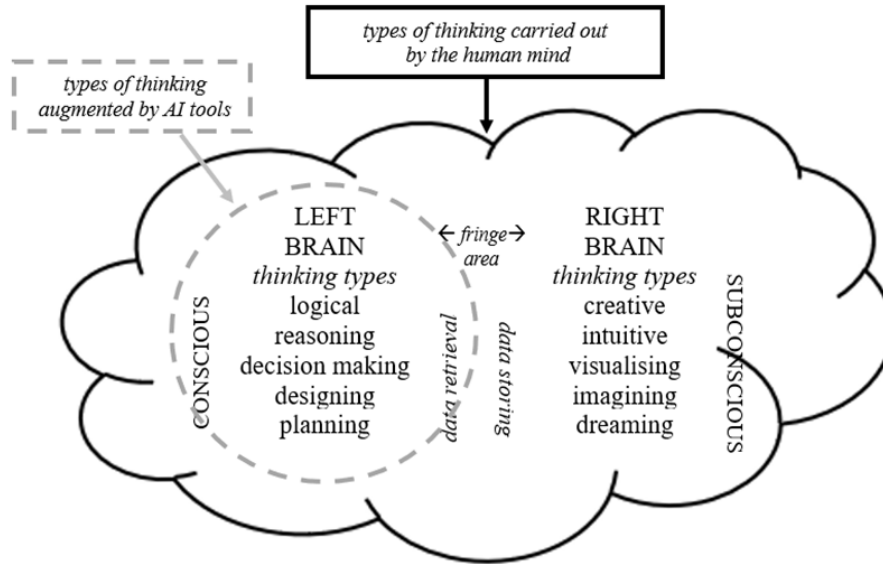
Table 1.
Left- and right-brain thinking modes (Pratt, 2025, p. 3).

	LEFT BRAIN	$\leftarrow \text{fringe} \rightarrow$ area		RIGHT BRAIN	
CONSCIOUS	<i>thinking types</i>	<i>data retrieval</i>	<i>data storing</i>	<i>thinking types</i>	SUBCONSCIOUS
	logical			creative	
	reasoning			intuitive	
	decision making			visualising	
	designing			imagining	
	planning			dreaming	

The division into left- and right-brain thinking modes suggested, in turn, a model of the types of thinking augmented by AI tools in Figure 2 (Pratt, 2025, p. 3), clarifying some of the issues in the adapted model shown in Figure 1. The reason for highlighting these types of thinking is that most educators are familiar with AI tools such as spelling/grammar checkers and auto-assessed multiple-choice tests on web-based learning platforms, but not used to agentic AI which performs, and even initiates, complex multi-layered tasks, and carries them out as if autonomously. The left-brain processing of agentic AI also suggests control over a process, and it is our position that pedagogical control should be vested in the hands of the human educator, and that agentic AI is carefully briefed and monitored so that it does not overstep these boundaries.

In suggesting the types of thinking augmented by AI tools, Figure 2 complements the adapted model shown in Figure 1. The left-brain types of (human) thinking are those which the adapted model suggests can in fact be augmented by use of AI tools. This is because these are conscious, logic-based processes, unlike the subconscious concepts which emerge when we are trying to design something, including an academic course. It is these subconscious intuitions which are fundamental to the process of conceptualising teaching and learning, and therefore essential for effective course design, whether for online, offline or blended courses.

Figure 2.
Types of thinking augmented by AI tools (Pratt, 2025, p. 4).



This concludes the review of theory, existing and in progress, applicable to this chapter, the main points of which are summarised as follows:

- *The differences between AI agents and agentic AI* suggest that, while AI agents are simple tools, agentic AI can carry out many of the processes carried out by humans in much the same way as in human problem-solving. Moreover, agentic AI, like humans, can also delegate specific tasks to AI agents.
- *The model showing AI augmentation* identifies the processes which should be left to humans and those which can be relegated to AI tools, and goes in some way towards clarifying the nature of human/digital collaboration.
- *The model showing types of thinking augmented by AI tools* shows how the predominance of left-brain types of thinking augmented by AI tools suggests it is that which controls pedagogy, which, we believe, should not be relegated to AI without human oversight and monitoring.

The implications for university curricula are that AI tools (including agentic AI) cannot conceptualise, which requires human-centric abductive thinking. Also, as Hansen as Hansen (2023, p. 8) points out: “The ability of humans to blend soft skills such as intuition, empathy, sympathy, and emotional intelligence with their experience and professional expertise is an invaluable factor in the abductive process referred to as ‘creativity’”. The review thus goes some way towards explaining how the two higher degree AI-assisted projects featuring in this chapter were planned and carried out in, it is hoped, harmonious human/AI collaboration, and ethical responsibility for participants, as shown in the next section. These projects constituted a Copilot-assisted online course design evaluator and an application designed for evaluation of actual online courses.

3. METHODOLOGY

Briefing the AI applications involved in both projects was done by using a systemic model of course design (Reddy & Pratt, 2024, p. 6897), as it identifies the basic functions involved in the teaching/learning process, irrespective of the mechanisms (human or AI) carrying out these functions. After an account of this model and why it was considered suitable for briefing the applications, the design and construction of both applications is described.

3.1. The Systemic Model of Course Design

It was suggested at the outset that, while methods, media and tools are constantly evolving, there are basic functions which remain constant in the teaching/learning process. These functions are explicated in the systemic model of course design (Table 1). The model evolved from doctoral research into the system of functions involved in human communication, which subsequently provided a rubric for evaluating mixed mode or totally online course design (Reddy & Pratt, 2024). The theory supporting this position is the output of research into the nature of communication in written mode, carried out within a critical realist orientation, which posits an external reality arrived at by logical inference (commenced in Pratt, 1987; and ongoing from Pratt, 2007 to present day). In the research, Franck's (2002) systemic modelling process, involving a type of reverse engineering, was used to arrive at the system of functions involved in human communication. The modelling process resulted in formulating a theoretical model comprising the "functional architecture" (Franck, 2002, p. 88) representing felicity conditions for communication. The model identified the contextual, ideational, interactive, social and reflexive functions as being the primary functions needing to be carried out for communication to occur (Pratt, 2011, pp. 60-61). In later projects, these functions were found to have relevance not only for written communication, but also for interactions in education and research (Pratt, 2013, p. 382). The course design principle suggested by the system of communicative functions was later formulated as a rubric for online course evaluation (Reddy & Pratt, 2024, p. 6897).

The proposed online course assessment model in Table 1 was intended for evaluation of online course design as well as assessment of how online courses were experienced by participants. The "essential functions" as explained in column 2., refer to those functions thought to be necessary for learning to take place to achieve the desired outcomes, the specifics of which will differ according to context (Reddy & Pratt, 2024, p. 6897). The questions in column 3. are those which need to be asked overall, relate to learning in general, and are not paradigm-specific. However, they are specific enough to home in on the course context and delivery mode.

Table 2.
The proposed online course assessment model.

<i>Essential functions</i>	<i>As applied to course design</i>	<i>As applied to assessment of online courses</i>
Contextual	This function relates to the social context in which knowledge is constructed, and requires the course designer to decide how learning is to be contextualised.	Was the way in which the course was contextualised likely to achieve the desired outcomes? <i>What WERE the course outcomes?</i>
Ideational	This function relates to the source of the knowledge to be constructed, or the process whereby knowledge actually comes into being (it also raises the question of course content).	Are the ways in which knowledge was constructed likely to achieve the desired outcomes? <i>What WAS course content and how was it intended to be acquired or learned?</i>
Interactive	As knowledge is constructed in learning interactions (including interactions with resources), the course designer needs to anticipate how participants will interact in constructing knowledge.	What learning interactions were set in place? <i>Did they ASSIST with achieving the desired course outcomes, and how/ how not?</i>
Social	The social parameters, conventions or constraints operating in a given learning situation need to be identified and made explicit to learners, particularly in respect of local assessment criteria.	What were the institutional/ disciplinary conventions /constraints and how were they communicated to students? <i>Did students FOLLOW these “rules” successfully?</i>
Reflexive	This relates to how participants will reflect on and assess their performance in constructing knowledge, and includes the issue of formal assessment (if any) and how it will be carried out, as well as course assessment.	What forms of student assessment were used and were they suited to the desired outcomes? <i>Did student scores REFLECT their expertise as indicated by their course interaction?</i>
	Course Evaluation Students and instructors should also be asked to give feedback on course evaluation.	Kindly rate the effectiveness of the course in terms of achieving the course outcomes. Your comments could include some suggestions for improving the effectiveness of the course.

Both projects required briefing of the AI tools by their human designers, the authors. Apart from the fact that human-centric abductive thinking, based on human judgment and experience, was needed to conceptualise the projects, there was also the issue of the ethic of care which is a prerequisite for educational practice. This, as Hansen suggested (above), includes emotional and compassionate empathy (Gibbs, 2017; Maxwell, 2017). AI has cognitive empathy only, that is, it can analyse verbal texts and other cues to conclude what people are thinking, including what they are feeling, but it cannot empathise with the subjects or feel sympathy for them (Chaturvedi, 2024, pp. 17-18). It is also not a “team player”, although attempts are being made to develop this attribute (Carter-Browne et al., 2021; Williams, Fiore, & Jentsch, 2022). In spite of these shortcomings as to ‘affect’, current research suggests that agentic AI is actually *better* at textual analysis than humans (Carew, 2025, p. 4), which made analysis of both the model text and course design text descriptions an appropriate task for it to fulfil. After both applications were constructed, they were tested out by the authors for any further corrections refinements, if/as needed. Neither application has as yet been used on DUT online courses, as these would need perfecting for use and ethical clearance, as well as ‘buy-in’ from the Centre for Excellence in Learning and Teaching (CELT) and academic departments.

3.2. Copilot-Assisted Online Course Design Evaluator

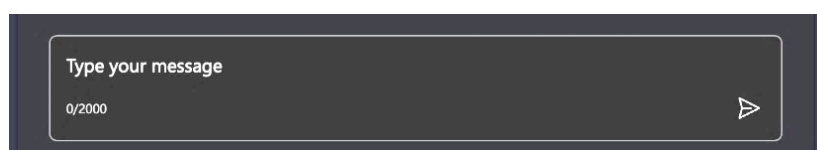
This agentic AI application was briefed by using the Copilot briefing interface to insert specifications as well as inputting the conference paper: *A systemic model for evaluating online course design: a critical realist approach* (Reddy & Pratt, 2024) so that Copilot could use its AI cognitive empathy to analyse what was meant. Copilot’s interpretation of the briefing is given in Table 3.

Table 3.
Copilot briefing criteria for creating the Course Design Evaluator agent
(Reddy & Pratt, 2025, p. 400).

Instructions - Evaluate course design based on the model provided in the paper. - Assess courses described or provided in documents or web addresses. - Perform five essential functions: Contextual, Ideational, Interactive, Social, Reflexive. - Use a Likert-scale questionnaire and open-ended feedback embedded in Moodle. - Provide detailed feedback and offer suggestions for improvement. - Analyze feedback to identify trends, strengths, and areas for improvement. - Ensure feedback is anonymous and voluntary. - Report findings clearly and concisely. - Facilitate interactions between learners, instructors, and resources. - Explicitly communicate institutional/disciplinary conventions and assessment criteria. - Incorporate reflection and formal assessment mechanisms.

Copilot then created an AI agent to carry out the specifications: its name was “Course Design Evaluator agent”. All the authors had to do to evaluate instances of course design was to insert the name of the online course and its web address into the interface provided (see Figure 3.)

Figure 3.
Interface for inserting instructions into the Course Design Evaluator agent
(Reddy & Pratt, 2025, p. 401).



Two online courses available to the public were used for course design evaluation, chosen at random: the MIT course, *Introduction to Computational Thinking and Data Science* and the *AI Fluency Project on GitHub*. Our objective was not to evaluate the course designs in terms of value judgements, but to see whether the agent created by Copilot could perform an analytical evaluation, using cognitive empathy, based on the criteria given in the model of course design. The evaluation was to be carried out in terms of whether the verbal descriptions of the online courses showed evidence of the course carrying out the ‘essential functions’ necessary for learning to take place, as shown in the systemic model of course design. The model of course design was the way in which human creativity, experience and ethic of care was included in this instance of human/AI collaboration. In other words, the evaluation was not based on cognitive empathy only, but also included the experience,

as well as emotional and compassionate empathy of the authors, when we designed the course evaluation rubric so as to ensure students and educators would benefit from quality instruction. It must be emphasised, when delegating tasks to AI, that it does not have the capacity to care about students: this needs to be factored into the application design by educators.

3.3. Online Course Evaluation Using a Built-In Moodle Module

For this project, a Moodle survey was used, with AI agents added for participant interactions, was used. As is the case with including simple AI agents in standard LMS tools, this application took much more time and designer input than that used for the course design evaluator. A prototype has been constructed and is at the time of writing being tested out by the authors on a working Moodle course, *English for Research Purposes*, which has been run for some time (including on DUT Moodle), but currently has no higher degree student or lecturer participants. The course evaluation feedback module survey, as it would appear to students at the completion of a course, is shown in Figure 4, and an example of the analysis of the results is shown in Figure 5.

Figure 4.
Link to course evaluation feedback (Pratt & Reddy, 2025, p. 236).

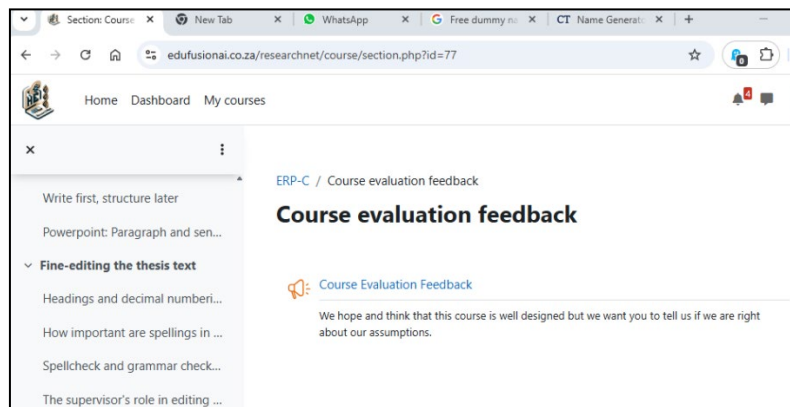
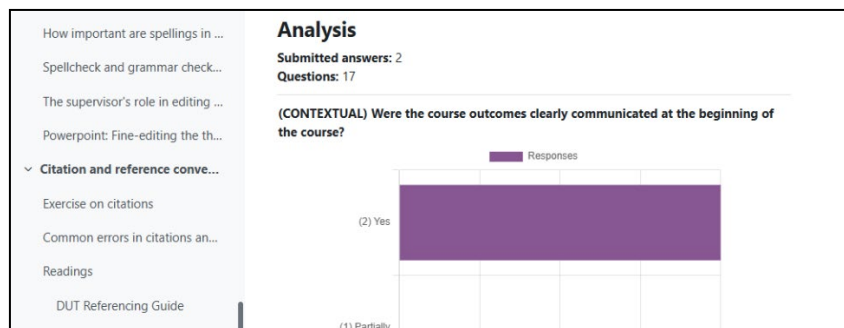


Figure 5.
Analysis results of the contextual section (Pratt & Reddy, 2025, p. 236).



4. RESULTS

The results indicate that using the systemic model of course design facilitated the briefing of both AI applications to fit their educational purpose, that is, evaluating both course design as well as showing how the course was actually experienced by participants. It also assisted the AI applications to do what they are best fitted to do, that is, speedy mass computations, relieving educators of the drudgery involved in widescale assessment.

4.1. Use of the Systemic Model of Course Design

The model has a venerable history, commencing in 1987 and continuing to present day, and is in fact informed by a generalizable interactive principle, which, however, is the topic for another paper. Because it is framed in clear terms, without jargon, the model can easily be understood by educators, who would have specific mechanisms and surface manifestations in their own discipline-specific higher degree courses. It is anticipated that use of the applications described here will stimulate discussion and suggest any necessary modifications, depending on the nature of the courses involved. It must be emphasized that having the model already formulated materially facilitated briefing of both AI agent and agentic AI in terms of allowing us to focus on the mechanisms involved without having to go back and re-think the theory in the middle of the process.

4.2. Use of Agentic AI and AI agents

The online course evaluator agent configured by the authors and created by Copilot removed the drudgery of poring through course design texts, and was able to identify and deliver a clear exposition of both exemplary features and shortcomings in course design. In particular, the time taken for a fully comprehensive evaluation, including recommendations for improvements, was 30 – 45 seconds, a compelling motivation for using agentic AI for educational purposes. This provides an exemplar of using AI for a function at which it is best, textual analysis, providing a clear picture of the meaning content of documents, displaying “cognitive empathy” (Carew, 2025, p. 4).

The course evaluation survey, with AI agents included, took much longer to set up and test out, and is still very much ‘work in progress’. So far, peer feedback related to the following aspects, apart from occasional glitches and checking that the feedback survey was user friendly:

- Orthographic corrections, such as spelling, punctuation and style.
- Operational issues, such as giving the participants the option of seeing all the questions in advance; options to go back and change answers during or after doing the survey; removing answer numbers; better grouping of quantitative (yes/no) and qualitative questions.
- Participant-focused issues, such as using test students’ names fitting the university demographics; giving students deadlines (e.g. end dates); reassurances of confidentiality and anonymity; giving students the option to view their own results after analysis.

In spite of shortcomings, we can confirm that Copilot, as agentic AI, assisted in evaluating course design, according to the rubric provided, and that testing out of the Moodle survey tool, with included AI agents, did show its potential for mass ongoing experiential feedback from participants engaged in online learning. Both applications performed what we proposed in our previous paper (Reddy & Pratt, 2024). The overall benefits of using these are mass auto-performance and speedy analysis and retrieval of results. The key issue is that humans are performing the abductive task of applying experience and judgment as to what

teaching and learning involve, while agentic AI and AI agents are assisting with the mechanical aspects of applying the resulting rubrics rapidly and efficiently. It is suggested that the success of these projects lay in thinking through, in advance, which AI attributes could best be combined with human attributes to achieve the desired outcome, and in what manner humans and AI could best collaborate.

However, while we believe that both projects provide exemplars of effective human/digital collaboration, until the applications are used in real life educational settings, it is not possible to evaluate their general effectiveness and usefulness. One future development which has occurred to us is allowing options for academics to customize the applications for specific academic courses. This could in fact be done without changing the general specifications of the course design module, and in fact training sessions could be held for using Copilot. Changing the Moodle survey would, we concede, would be time consuming and staff would probably be unwilling to take this on. Another option, perhaps more daunting for academic staff, would be, with user knowledge and consent, to elicit specific problems with course design (e.g., deficits in design skills) and course delivery (e.g., deficits in teaching skills) and to present these to academic staff, confidentially, in ways which would motivate them to develop more advanced competences in course design and pedagogy. Even more daunting (to Management, we think) would be an option for potential higher degree students to use the course design evaluator for an oversight of the design features of a course before actually registering.

5. CONCLUSION

Every day, as this chapter was being written and is now being read, new predictions and AI inventions populate the press, and it is not our function to double guess what will actually happen in the future, but to share what we believe are some basic fundamentals about teaching and learning, which, we predict, will be at the core of university curricula no matter how much the mechanisms and surface elements may change. What this chapter explored, tentatively, is the nature of AI and how it can best be used to collaborate with human educators and course designers. The following are some of the conclusions arrived at in the course of the authors' engagement in human/digital collaboration.

It is important to understand which educational processes can best be handled by AI tools and are best left to humans. However, there is such a wide range of disciplines in higher degree institutions that one cannot generalize which subjects lend themselves to processing by AI tools or in what manner: this range will also be increasing exponentially with the evolution of AI in society. While academic staff and technicians clearly need to be prepared for effective use of AI tools, it must not be assumed that universities should now include courses on AI tools for students, rather that the various disciplines should adopt ways of familiarizing students with working with AI tools in ways which enhance disciplinary work. As Dr. Hannelie Adendoff asks: "Should we be preparing students for specific tasks AI can do – or should we be focusing on what humans do best such as critical thinking, creativity and ethical judgment?" (Stellenbosch Corporate Communications and Marketing, 2025). A systemic, that is, conceptual, approach should be the focus in developing theory, not systematic, which implies that mass processing has value over intelligent thinking, a case of 'more is less'. The qualities of AI tools, in particular, mass rapid processing of data, should not be allowed to dictate the nature of academic subject content and pedagogy. Finally, control of pedagogical processes cannot be abdicated by educators and relegated to AI agents or agentic AI. As we said at the outset, it is important to ensure that AI tools are used to serve the key human social purposes of education, rather than education being reshaped to fit technological innovations, which is a soul-less protean outcome not to be wished for.

REFERENCES

- AFP. (2024, March 24). Italian paper published AI-generated edition. *The Mercury*.
- AFP. (2025). Humanoid robots stride into the future with world's first half-marathon. *IOL*. Retrieved from <https://iol.co.za/technology/2025-04-19-humanoid-robots-stride-into-the-future-with-worlds-first-half-marathon/>
- African Observatory on Responsible Artificial Intelligence. (2024, January 15). Generative AI guidelines at South African universities. Retrieved from <https://www.africanobservatory.ai/social/generative-ai-guidelines-at-south-african-universities>
- Aunger, R. (2010). Types of technology. *Technological Forecasting & Social Change*, 77, 762-782.
- Bidarian, N. (2023). Meet Khan Academy's chatbot tutor. *CNN Business*. Retrieved from <https://edition.cnn.com/2023/08/21/tech/khan-academy-ai-tutor/index.html>
- Carew, J. (2025). Meeting of minds at Wits' AI institute. *ITWeb*. Retrieved from <https://www.itweb.co.za/article/meeting-of-minds-at-wits-ai-institute/kLgB17ezoe1M59N4>
- Carter-Browne, B. M., Paletz, S. B. F., Campbell, S. G., Carraway, M. J., Vahlkamp, S. H., Schwartz, J., & O'Rourke, P. (2021). *There is no "AI" in teams: a multidisciplinary framework for AIs to work in human teams*. Retrieved from [https://www.arlis.umd.edu/sites/default/files/2022-03/No_AI_In_Teams_FinalReport%20\(1\).pdf](https://www.arlis.umd.edu/sites/default/files/2022-03/No_AI_In_Teams_FinalReport%20(1).pdf)
- Chaturvedi, A. (2024). Exploring empathy in artificial intelligence: synthesis and paths for future research. *Information Discovery and Delivery*, 53(4). doi: 10.1108/IDD-03-2024-0048
- Fomunyam, K. G. (2019). Education and the Fourth Industrial Revolution: challenges and possibilities for Engineering education. *International Journal of Mechanical Engineering and Technology*, 10(8), 271-284.
- Fortune, R. (2025, March 15). A little AI knowledge is a dangerous thing. *Independent on Saturday*.
- Fourie, L. (2023). Introducing Professor Bot: would you know the difference? *IOL*. Retrieved from <https://www.iol.co.za/business-report/companies/introducing-professor-bot-would-you-know-the-difference-c77dbedb-1b58-4de4-bf62-52f9399eab17>
- Franck, R. (2002). *The explanatory power of models: bridging the gap between empirical and theoretical research in the social sciences*. Norwell, MA: Kluwer Academic Publishers.
- Gibbs, P. (2017). *The pedagogy of compassion at the heart of higher education*. Cham, Switzerland: Springer International Publishing.
- Graham, S., Imura, T., Johnston, J., Navara, E. D., Wakle, V., & Ypalika, V. (2024). *Microsoft 365 Copilot extensibility overview*. Retrieved from <https://learn.microsoft.com/en-us/microsoft-365-copilot/extensibility/>
- Hansen, S. M. (2023). A model for understanding the evolving role of graphic designers in the era of artificial intelligence. *HUB - Journal of Research in Art, Design and Society*, 1(0). Retrieved from <https://www.researchcatalogue.net/view/2156238/2156237>
- Illinois College of Education, Office of Communications. (2024). *AI in schools: pros and cons*. Retrieved from <https://education.illinois.edu/about/news-events/news/article/2024/10/24/ai>
- Kruger, C. (2025). AI: a double-edged sword for the future of work. *Independent on Saturday*.
- Larson, E. J. (2021). *The myth of artificial intelligence: why computers can't think the way we do*. Cambridge, MA: Harvard University Press.
- Lisowski, E. (2024, December 18). AI agents vs agentic AI: what's the difference and why does it matter? *Medium*. Retrieved from <https://tutorials.botsfloor.com/ai-agents-vs-agentic-ai-whats-the-difference-and-why-does-it-matter-03159ee8c2b4>
- MacVittie, L. (2025). *AI agents vs. agentic AI: understanding the difference*. Retrieved from <https://www.f5.com/company/blog/ai-agents-vs-agentic-ai-understanding-the-difference>
- Marr, B. (2025, February 25). The important difference between agentic AI and AI agents. Retrieved from <https://www.forbes.com/sites/bernardmarr/2025/02/25/the-important-difference-between-agentic-ai-and-ai-agents/>
- Maxwell, B. (2017). Pursuing the aim of compassionate empathy in Higher Education. In P. Gibbs (Ed.), *The pedagogy of compassion at the heart of higher education* (pp. 33-48). Cham, Switzerland: Springer.

- Muggah, R., & Giussani, B. (2025). AI a double-edged sword of challenges and opportunities. *The Independent on Saturday*. Retrieved from https://www.pressreader.com/south-africa/the-independent-on-saturday/20250419/281895894089442?srsId=AfmBOopwtq8zCrqNs-FYBzyW2Nwr_hFB0Tj9PzafZXLIVgf9jyAKcK-P
- Muindi, T. H. (2025). AI as newsroom of the future. *The Citizen*. Retrieved from https://www.pressreader.com/south-africa/the-citizen-kzn/20250508/281711210533881?srsId=AfmBOoql4KLsQ4_IDPAGhdIjGJMX4yJo9aOwCVT32aVGdhfs6jH_6iXx
- Naidoo, D. (2025, January 25). Six million South Africans risk job displacement as WEF predicts tech dominance. *Independent on Saturday*. Retrieved from <https://iol.co.za/news/south-africa/2025-01-22-six-million-south-africans-risk-job-displacement-as-wef-predicts-tech-dominance/>
- Pratt, D. D. (1987). *A process approach: the formulation of a simplified conceptual framework showing the stages of the writing process, and an investigation into the effects on writing behaviour of communicating this framework directly to the learner*. (Master's thesis, University of Natal, Durban). Retrieved from https://www.academia.edu/4628511/Pratt_1987_A_process_approach_the_formulation_of_a_simplified_conceptual_framework_showing_the_stages_of_the_writing_process
- Pratt, D. D. (2007). *A realist approach to writing: developing a theoretical model of written composition to inform a computer mediated learning application*. (Doctoral dissertation, Durban University of Technology). Retrieved from https://www.academia.edu/3829511/Pratt_2007_A_realist_approach_to_writing_developing_a_theoretical_model_of_written_composition_to_inform_a_computer_mediated_learning_application
- Pratt, D. D. (2011). *Modelling written communication: a new systems approach to modelling in the social sciences*. Dordrecht: Springer, Methodos Series.
- Pratt, D. D. (2013). A systems approach to modelling communicative processes. In V. Tuzlukov (Ed.), *Communication systems: new research* (pp. 361-413). New York: Nova Science Publishers.
- Pratt, D. D. (2025). *Types of thinking augmented by AI tools*. Retrieved from https://edufusionai.co.za/researchnet/pluginfile.php/365/mod_resource/content/3/Pratt%202025%20-%20Types%20of%20thinking%20augmented%20by%20AI%20tools.pdf
- Pratt, D. D., & Reddy, P. (2025). Digital-human collaboration in higher degree course evaluation. *International Journal of Technologies in Learning*, 32(2), 223-240. Retrieved 17 September 2025, from <https://cgscholar.com/bookstore/works/digitalhuman-collaboration-in-higher-degree-course-evaluation>
- Reddy, P., & Pratt, D. D. (2024, March 4-6). *A systemic model for evaluating online course design: a critical realist approach*. Paper presented at the 18th International Technology, Education and Development Conference, Valencia, Spain.
- Reddy, P., & Pratt, D. D. (2025). Copilot-assisted online course design evaluator. In T. Bastiaens (Ed.), *EdMedia + Innovate Learning* (pp. 395-405). Association for the Advancement of Computing in Education (AACE). <https://www.learntechlib.org/p/226168/>
- Stellenbosch Corporate Communications and Marketing. (2025, February 28). Challenges and opportunities of AI use at SU in the spotlight. Retrieved from <https://www.sun.ac.za/english/Lists/news/DispForm.aspx?ID=11134>
- Ward, J. (2020). *The perfection of the paper clip: curious tales of invention, accidental genius, and stationery obsession*. New York: Simon and Schuster.
- Williams, J., Fiore, S. M., & Jentsch, F. (2022). Supporting artificial social intelligence with theory of mind. *Frontiers in Artificial Intelligence*, 5. doi: 0.3389/frai.2022.750763
- Women in Science. (2024). *Artificial Intelligence (AI) under spotlight at UN General Assembly Science Summit*. Retrieved from <https://www.womeninscience.africa/artificial-intelligence-ai-under-spotlight-at-un-general-assembly-science-summit/>
- Wu, D. (2025). Meet Flynn: an AI art student who might earn a diploma. *Independent on Saturday*. Retrieved from <https://iol.co.za/ios/world/2025-04-22-meet-flynn-an-ai-art-student-who-might-earn-a-diploma/>

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Chapter # 17

REFRAMING SUBJECT ADVISORS' PROFESSIONAL ROLES AS CATALYSTS FOR SUSTAINABLE LIFE SCIENCES EDUCATION

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ABSTRACT

This chapter examines how partnerships between universities and Life Sciences subject advisors can foster sustainable teacher professional development in rural South African contexts, aligned with Sustainable Development Goal 4. Drawing on Sociocultural Theory, the study explores how subject advisors mediated learning, negotiated authority, and demonstrated resilience during a collaborative professional development initiative with university facilitators. A qualitative multiple case study design was employed, involving two subject advisors from Northern KwaZulu-Natal who participated in a series of university-facilitated workshops. Data was generated through semi-structured interviews, questionnaires, reflective journals, and observations, and analysed thematically through constant comparison and triangulation. Findings reveal that Life Sciences subject advisors' roles evolved from administrative oversight to collaborative mediation, enabling richer teacher engagement and contextualised curriculum support. However, structural constraints such as workload, limited resources, and lack of policy recognition impeded sustained participation. The chapter argues that sustainable teacher professional development requires reframing subject advisors' roles as pedagogical partners and knowledge brokers. It concludes that intentional, interactive partnerships between universities and education departments are vital for achieving the inclusive and equitable quality education envisioned by SDG 4.

Keywords: subject advisors, sociocultural theory, professional development, sustainable development goal 4, life sciences education, rural South Africa.

1. INTRODUCTION

The pursuit of equitable and quality education has taken center stage globally, reflected in the United Nations' Sustainable Development Goal 4 (SDG 4), which calls for inclusive and equitable quality education as well as lifelong learning opportunities for all (United Nations, 2015). Within the South African context, achieving this vision remains deeply intertwined with efforts to strengthen teacher professional development (PD), especially in rural schools where resource constraints, linguistic diversity, and cultural dynamics shape educational realities (Spaull & Jansen, 2019). On the other hand, Life Sciences as one of the gates keeping subjects to elite careers seeks to cultivate inquiry, reasoning, and problem-solving, is particularly challenged by the legacy of teacher under-preparedness, low learner achievement, as well as inadequate support structures (Xaba & Sondlo, 2022; Mavhunga, 2020).

Over the past decade, universities have increasingly sought to act as catalysts for sustainable change through community engagement and knowledge exchange with the school system (Boughey, 2024). This chapter emerges from a university-led initiative in KwaZulu-Natal that explored collaborative professional learning with Life Sciences teachers,

subject advisors, and higher education partners. The initiative aimed to enhance pedagogical content knowledge, integrate Indigenous Knowledge Systems (IKS), and foster professional resilience among teachers in rural schools. Grounded in a sociocultural perspective, the study recognises that teacher development does not occur in isolation but through meaningful participation in socially mediated activities (Eun, 2023; Johnson & Golombek, 2011).

This collaborative orientation is essential for addressing the persistent PD gap that undermines the realisation of SDG 4 in rural contexts. Subject advisors which are often viewed as bureaucratic intermediaries between the Department of Basic Education (DBE) and schools, play a crucial but under-examined role in mediating professional learning (Xaba, 2025). When reconceptualised as facilitators of dialogue and reflective practice, the study proposes that their role can evolve from administrative supervision to pedagogical mentorship that empowers teachers to become agents of curriculum transformation (Obi & Ticha, 2020; Xaba, 2025). Such a shift aligns with contemporary understandings of teacher professional learning as a situated, and socially mediated process (Eun, 2023; Shabani, 2016). Thus, this chapter addresses the following guiding research questions:

- How do subject advisors experience their professional roles in supporting teacher development in rural contexts?
- How can partnerships between universities and subject advisors foster sustainable teacher professional development aligned with SDG 4 (Quality Education)?

To address these questions, the study adopted a multiple case study design involving two Life Sciences subject advisors from two different districts in Northern Kwa-Zulu Natal who collaborated with university lecturers in a rural university–district professional development project. Data was collected through semi-structured interviews, reflective focus group interviews and questionnaires.

By linking the findings to issues of teacher professional identity, contextual constraints, and rural education development, this chapter contributes to the discourse on sustainable teacher professional learning in the Global South. In doing so, it reframes the subject advisor's role not only as a functional position but as a transformative agent in achieving SDG 4 through collaborative, context-sensitive professional development.

2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1. Literature Review: The Role of Subject Advisors in Professional Development

Subject advisors are central actors in the educational ecosystem of the Global South, yet their professional roles are often misunderstood or underutilised (Obi & Ticha, 2020). In South Africa, subject advisors serve as intermediaries between the DBE and schools, tasked with providing curriculum support, monitoring, and professional guidance to teachers (Xaba, 2025). However, systemic pressures, administrative burdens, and lack of continuous professional learning opportunities often constrain their effectiveness (de Beer, 2021; Sithole & Tachie, 2024; Van der Westhuizen & de Beer, 2021).

Emerging literature suggests that when subject advisors are empowered to act as facilitators of professional learning rather than inspectors of compliance, they contribute significantly to teachers' growth and confidence (Mutemeri, 2023). Within the sociocultural lens, subject advisors' interactions with teachers become mediational spaces where shared meaning-making unfolds. For example, collaborative lesson planning and reflective dialogue sessions can promote the internalisation of new pedagogical concepts while respecting teachers' experiential knowledge (Johnson & Golombek, 2011).

In rural contexts, subject advisors can also play a vital role in addressing the epistemic divide between Western scientific knowledge and IKS. By validating teachers' cultural resources, they help bridge the gap between local realities and formal curriculum expectations (Maphosa & Jita, 2020). This orientation supports both cognitive and affective dimensions of teacher development, contributing to the holistic professional growth that SDG 4 envisions.

2.2. Theoretical Framework: Sociocultural Perspectives on Teacher Learning

This study is underpinned by SCT, which views learning and development as fundamentally social and mediated by cultural tools, language, and interaction (Vygotsky, 1978). Within PD contexts, SCT foregrounds the idea that teachers and advisors learn through participation in shared activities, dialogue, and reflection rather than through transmission of knowledge (Johnson & Golombek, 2011). From this perspective, the collaborative teacher PD workshops examined in this study functioned as activity systems where Life Sciences subject advisors, lecturers, and teachers engaged in meaning-making through social exchange. The concept of mediation is central here, because the Life Sciences subject advisors acted as mediators between institutional expectations and classroom realities, facilitating communication and co-construction of pedagogical understanding.

Furthermore, SCT's notion of internalisation provides a useful lens for understanding how professional practices introduced during the workshops became embedded in the Life Sciences advisors' ongoing work. Through repeated interaction, it was envisioned that the Life Sciences advisors would develop new conceptual tools such as reflective dialogue, co-facilitation, and pedagogical scaffolding that will enable them to redefine their professional roles. This vision emanated from Shabani's (2016) argument that sociocultural approaches to PD has the potential of cultivating transformative learning through collaboration and guided participation.

By combining SCT with the sustainability principles of SDG4, this study frames PD as a dynamic, relational, and contextually grounded process. The integration of these frameworks highlights that sustainable educational change arises when professional growth is socially mediated, culturally responsive, and institutionally supported.

3. METHODOLOGY

To respond to the guiding research questions, the study adopted a qualitative approach situated within an interpretivist paradigm, which holds that social reality is constructed through meanings that people ascribe to their experiences (Creswell & Poth, 2018). The interpretivist stance is congruent with the chapter's theoretical framing in SCT, which emphasises that professional learning is mediated through interaction, language and participation.

A multiple case study design (Yin, 2018) was employed to enable contextualised, in-depth exploration of two Life Sciences subject advisors who participated in a university-school professional development initiative in Northern KwaZulu-Natal. The multiple case approach facilitated comparative analysis of how contextual factors (for example, district performance, workload and access to resources) shaped each subject advisor's enactment of role and partnership practices.

Two Life Sciences subject advisors were selected through purposive and convenience sampling. Purposive selection ensured that participants held official advisory roles and had substantive involvement in the PD initiative, thereby maximising information richness relative to the research questions. Convenience sampling reflected pragmatic considerations

of access and ongoing collaboration within the project (Creswell & Poth, 2018). The project spanned from 2023 to 2024. Table 1 summarises the advisors' demographic and professional profiles.

Table 1.
Demographic information of participating Life Sciences subject advisors.

Attribute	Subject Advisor 1	Subject Advisor 2
Highest qualification	Master's degree	Pursuing PhD
Years of experience	8 years	14 years
Number of schools overseen	45	50
District performance	High-performing district	Lowest-performing district

Data collection combined multiple qualitative instruments to illuminate the advisors' lived experiences and the dynamics of university–advisor partnerships. Each Life Science subject advisor participated in a one-hour semi-structured interview that explored their perceptions of role, experiences of collaboration with university facilitators, examples of support offered to teachers, and perceived enablers and barriers to sustaining professional learning. Semi-structured interview prompts were designed to align directly with the two guiding research questions.

At the end of the first year of the project, the two subject advisors completed a short structured descriptive rating scale designed to support qualitative comparison rather than statistical analysis. The instrument consisted of six role-related indicators, namely attendance, co-facilitation, support to teachers, resource provision, content contribution, and teacher motivation. Each indicator was rated on a 0–5 scale, where 0 indicated no involvement and 5 indicated full involvement. Given the small sample, these ratings were not treated as survey data but were used as analytic heuristics to complement the semi-structured interview narratives and observational evidence. This approach enabled systematic cross-case comparison of how each Life Sciences subject advisor enacted their role within the partnership, while remaining consistent with the interpretivist orientation of the study and its emphasis on meaning, context, and experience rather than measurement or generalisation.

Semi-structured interview transcripts, questionnaires, observational data and university lecture reflective journals were analysed using thematic analysis (Braun & Clarke, 2006). Analysis proceeded iteratively through familiarisation, coding, theme development, and refinement. Codes were developed inductively from participants' accounts but interpreted deductively through the lens of SCT (mediation, internalization and community participation to mention a few).

The university–district PD workshops were designed to strengthen both pedagogical and practical competencies in Life Sciences teaching within rural contexts. Workshop sessions focused on improving the teaching of practical work, including the development of scientific process skills, formulation of practical-based assessment questions, laboratory safety procedures, and strategies for improvising resources in under-resourced school settings as earlier mentioned in the chapter. In addition, sessions addressed pedagogical content knowledge by engaging teachers and subject advisors in collaborative lesson planning, discussion of common learner misconceptions, and alignment of curriculum content with assessment requirements. These activities were deliberately structured to enable subject advisors to mediate between university-based expertise and classroom realities, positioning

them as active participants in meaning-making rather than passive recipients of training. The workshop content therefore provided a concrete context through which subject advisors enacted, reflected on, and reframed their professional roles within the collaborative partnership.

Cross-source triangulation was used to confirm emergent themes and to ensure that interpretations answered the research questions about advisors' experiences and the ways that university–advisor partnerships contributed to sustainable professional development. Ethical clearance was obtained from the appropriate institutional review board. Participants provided written informed consent; anonymity was protected through pseudonyms and secure storage of data. To strengthen trustworthiness, the study employed multiple strategies: triangulation of data sources, member checking of key thematic summaries with participants, maintenance of an audit trail of analytical decisions, and researcher reflexivity documented in memos. These procedures supported credibility, dependability, and confirmability of the findings (Creswell & Poth, 2018; Yin, 2018).

4. RESULT AND FINDINGS

The analysis of data generated from the multiple data sources such as questionnaires, semi-structured interviews, observations and university lecture reflective journals produced three interrelated themes: (1) Mediation and the Reframing of Professional Roles, (2) Collaborative Meaning-Making as Professional Learning, and (3) Resilience and Sustainability in Rural Teacher Development. These themes emerged through a process of constant comparison and triangulation across data sources. They are discussed below in relation to the theoretical framing informed by Sociocultural Theory (Vygotsky, 1978) and Sustainable Development Goal 4 (SDG 4), which calls for inclusive, equitable, and quality education for all (UNESCO, 2023).

Table 2.
Overview of Data Triangulation.

Data Source	Analytical Focus	Emergent Theme(s)	Exemplifying Excerpt
Questionnaire (Subject Advisors, n=2)	Reflections on professional identity and collaboration	Mediation and reframing of roles	<i>“Support means learning together, not inspecting.”</i>
Semi-structured Interviews, o and journal (University partners)	Observation of shifts in advisor-teacher dynamics	Collaborative meaning- making and sustainable partnerships	<i>“Advisors began initiating dialogues about pedagogy rather than compliance.”</i>
Observation	Evidence of continuing engagement beyond formal training	Resilience and sustainability	<i>“We started WhatsApp groups to discuss upcoming lessons.... ”</i>

Theme 1: Mediation and the Reframing of Professional Roles

The first theme illustrates how the advisors' participation in the collaborative workshops encouraged a shift from viewing themselves as administrative monitors to recognising their potential as learning mediators. Both advisors acknowledged that their

professional roles had been historically framed around compliance and monitoring rather than co-learning. However, Subject Advisor 1, who engaged more consistently in the workshops, described a growing appreciation for learning “*alongside teachers*” rather than merely evaluating them. In an interview, he reflected:

I realised that supporting teachers goes beyond checking their work schedules. It means being part of the process—helping them understand concepts and not just expecting results.

Observational data supported this reflection, showing that during practical sessions, Advisor 1 often co-facilitated discussions on safety precautions, improvised resources, and question formulation, mediating teachers' understanding through guided questioning. The questionnaire data reinforced this pattern, showing Advisor 1's relatively higher ratings in attendance (4/5), co-facilitation (3/5), and support to teachers (5/5) compared to Advisor 2, who scored lower due to limited participation.

While Subject Advisor 2 demonstrated lower levels of visible engagement in the collaborative workshops, the data suggests that this limited participation was shaped primarily by structural and contextual constraints rather than a lack of professional commitment. Interviews and field notes indicated that Advisor 2 was responsible for a larger number of schools within a low-performing district, which required extensive administrative oversight, frequent crisis management, and sustained compliance-related responsibilities. These demands constrained his capacity to remain for full workshop sessions or to engage in co-facilitation activities. In this sense, Advisor 2's experience illustrates how institutional workloads and district-level performance pressures can restrict opportunities for subject advisors to enact developmental and mediational roles, even when they recognise the value of collaborative professional learning. This finding stresses a key tension within rural education systems, where subject advisors are positioned as agents of instructional improvement but are simultaneously overburdened by managerial expectations that limit sustained pedagogical engagement.

Through the lens of SCT, this reframing of role reflects mediation which is the process by which individuals construct meaning and internalise new practices through socially situated activity (Vygotsky, 1978; Shabani, 2016). By engaging in collaborative inquiry with teachers and university facilitators, the more active advisor transformed his professional identity from oversight to participation. The data reveal that mediation occurred not only between teachers and facilitators but also within the evolving identity of the advisor himself.

Theme 2: Collaborative Meaning-Making and Sustainable Partnerships The second theme revealed that partnerships between university Life Sciences lecturers and subject advisors fostered collective learning environments characterised by shared authorship, mutual respect, and dialogic engagement. Rather than occupying a peripheral or supervisory role, subject advisors experienced themselves as active contributors to knowledge production within the professional development process. Advisors explicitly noted a shift in how their expertise was recognised and valued, as illustrated below:

For once, we were asked what we thought before being told what to do...

University lecturers' reflections corroborated this perception, acknowledging that advisor contributions disrupted deficit-oriented assumptions about rural classrooms and enriched their own understandings of contextual realities:

The advisors' insights challenged our assumptions about rural classroom realities.

These reciprocal interactions cultivated a community of practice (Wenger, 1998) in which theoretical knowledge from the university and contextual knowledge from the field were brought into productive dialogue. Within this space, subject advisors engaged critically with pedagogical concepts rather than merely transmitting policy directives, enabling deeper professional learning and shared meaning-making. Such collaborative engagement aligns with the transformative intent of SDG4, which emphasises inclusive, locally grounded, and culturally relevant approaches to educational development (Maphosa & Jita, 2020; UNESCO, 2023). Importantly, the partnership signalled a shift from hierarchical, top-down models of PD toward dialogic and social forms of learning. This shift resonates with Eun's (2023) sociocultural interpretation of PD, where learning is co-constructed through language, reflection, and shared inquiry. As the PD progressed, the Life Sciences subject advisors increasingly assumed facilitative roles within teacher learning communities, initiating discussions and supporting peer reflection independently. This emerging capacity suggests that professional learning was not only collaborative but also becoming self-sustaining beyond the formal intervention

Theme 3: Resilience as a Pillar of Sustainable Development in Professional Learning

Resilience emerged as a collective phenomenon rather than an individual trait. Despite persistent infrastructural and systemic challenges which included limited resources, erratic connectivity, and geographical distance, Life Sciences subject advisors sustained their engagement through creative and self-initiated strategies. During a semi-structured interviews session, advisors described how they established WhatsApp support groups and peer study circles to maintain professional dialogue beyond formal sessions, thereby enacting SDG 4's vision of lifelong learning under conditions of adversity (United Nations, 2015).

One advisor reflected:

When sessions ended, we opened a WhatsApp group to discuss upcoming lessons... even if it meant using our personal data...

These practices illustrate the internalisation of agency (Shabani, 2016), whereby mediated professional learning experiences were transformed into self-directed and collectively sustained practices. Rather than withdrawing in the face of constraint, advisors mobilised available social and digital resources to support continued learning. Reflective journals further highlighted the affective dimensions of resilience, with one facilitator observing:

Their optimism and sense of purpose were contagious... they turned challenges into opportunities for innovation.

At the same time, advisors articulated frustration with institutional rigidity or structural stagnations, particularly the absence of policy mechanisms to recognise and reward their expanded developmental roles. Participants noted that while they were expected to support teacher learning and curriculum implementation, these contributions often remained institutionally invisible. Such silences, as Van der Westhuizen and de Beer (2021) argue, frequently undermine the sustainability of professional learning initiatives in rural South African contexts. These findings suggest that while resilience can be collectively cultivated through relational and agentic practices, its long-term sustainability depends on institutional frameworks that legitimate, recognise, and resource relational forms of professional development.

5. FUTURE RESEARCH DIRECTIONS

Future research should deepen understanding of how subject advisors' professional trajectories evolve within sustained partnerships and across diverse disciplinary contexts. Longitudinal ethnographic studies could trace how advisors' identities, beliefs, and practices shift as they participate in university-led interventions over time. Comparative research across provinces may also reveal contextual nuances in how policy environments and institutional support systems shape advisory practices. Further, mixed-method investigations could integrate network analysis to map the relational dynamics among universities, subject advisors, and teachers, providing empirical insight into how knowledge flows within such ecosystems. Examining how digital platforms can mediate collaborative learning in remote contexts, particularly under resource constraints would potentially extend the relevance of this work to broader educational transformation efforts across the Global South.

Finally, a critical area for future exploration involves reimagining the PD frameworks that underpin subject advisory roles. Research should interrogate how professional standards, accountability measures, and performance indicators can be restructured to value reflective practice, mentorship, and dialogical engagement as core elements of sustainable teacher development aligned with SDG 4. Together, these avenues could extend the knowledge base on how advisory practices can be leveraged as catalysts for both professional resilience and systemic sustainability in science education across resource-constrained contexts.

The findings point to the need for policy frameworks that formally recognise and support the developmental role of subject advisors within collaborative professional learning initiatives. At present, advisors' engagement in pedagogical mediation remains largely dependent on individual commitment rather than institutional design. To enhance sustainability, education departments could explicitly define subject advisors' responsibilities to include co-facilitation, curriculum mediation, and sustained teacher support within PD programmes. Such role clarification should be accompanied by workload adjustments, recognition mechanisms, and time allocations that enable advisors to participate meaningfully in collaborative initiatives without compromising their administrative obligations. In addition, structured partnerships between universities and education departments could be institutionalised through formal agreements that outline shared responsibilities, communication structures, and cycles of joint reflection. These measures would enable subject advisors to function as mediators of professional learning rather than peripheral administrators, thereby strengthening systemic capacity for sustainable teacher development in alignment with the equity and lifelong learning aspirations of Sustainable Development Goal 4.

6. CONCLUSION/DISCUSSION

The findings of this study reveal the multifaceted and evolving role of subject advisors within university-school partnerships, particularly in rural and under-resourced South African contexts. Drawing on Sociocultural Theory (Vygotsky, 1978; Shabani, 2016), the analysis revealed that the professional identities of Life Sciences subject advisors are shaped through mediated collaboration and reflective practice rather than mere administrative compliance. Their interactions within the professional learning communities became sites of

co-construction of meaning, enabling them to transition from oversight agents to learning partners. This transformation resonates with Johnson and Golombek's (2011) assertion that teacher learning is inherently social and dialogic, emerging from engagement within communities of practice. The Life Sciences subject advisors' gradual repositioning suggests that sustainable teacher development depends on creating dialogical spaces where hierarchical relations are re-negotiated. In such spaces, university facilitators, teachers, and advisors collectively contribute to pedagogical renewal, rather than reinforcing one-way models of capacity building (Eun, 2023). However, the study also highlights systemic barriers that constrain the actualisation of SDG 4's goals of inclusive and equitable quality education. Structural limitations such as inadequate staffing, extensive geographical coverage, and fragmented communication between universities and provincial departments often restrict subject advisors' potential to act as mediators of sustainable professional learning. These conditions reproduce what Van der Westhuizen and de Beer (2021) describe as "systemic inertia" in rural education systems, where innovative initiatives risk remaining episodic rather than embedded.

Critically, the study stresses that sustainability in professional development must be understood not only as programmatic continuity but as social and epistemic resilience. The Life Sciences advisors' sustained engagement, even amid logistical challenges, reflects the internalisation of professional agency, a key sociocultural mechanism for enduring transformation (Shabani, 2016). Thus, aligning SDG 4 with sociocultural mediation offers a novel lens through which to conceptualise teacher learning as an evolving and collective enterprise. This chapter has demonstrated that the professional role of subject advisors in rural South African contexts is not static but socially constructed through interaction, mediation, and reflection. Through collaborative engagement with universities and teachers, subject advisors can become pivotal agents in enacting SDG 4's vision of equitable and quality education for all. However, realising this potential requires intentional capacity-building strategies that move beyond administrative oversight toward relational, context-sensitive professional learning.

By situating the study within a sociocultural theoretical framework, the research has provided a nuanced understanding of how professional learning emerges from mediated social exchanges. The findings emphasise that sustainability in teacher professional development depends on cultivating environments that nurture dialogue, reciprocity, and shared ownership of knowledge. Strengthening partnerships between universities and departments of education therefore offers a promising pathway toward systemic transformation and enduring educational resilience in resource-constrained settings. In essence, this study reaffirms that achieving SDG 4 is contingent upon recognising and empowering and investing in human agents, for example subject advisors, teachers, and facilitators, who collectively shape the quality and sustainability of educational practice in South Africa and beyond.

Beyond strengthening pedagogical practice, the reframing of subject advisors' roles also holds potential for advancing broader equity goals embedded within Sustainable Development Goal 4. By mediating curriculum implementation and professional learning, subject advisors are positioned to support more inclusive teaching practices, including sensitivity to gendered participation patterns in science classrooms and responsiveness to learners with diverse educational needs. While this study did not empirically examine gender equity or special educational needs, the collaborative model foregrounds relational support and contextual responsiveness as foundational principles for inclusive education. In this sense, subject advisors' mediational roles extend beyond content and pedagogy to encompass ethical commitments to equity, inclusion, and social justice within rural schooling contexts.

It is important to declare that this chapter limitation is that it was based on an in-depth qualitative case study of two Life Sciences subject advisors working in rural districts of Northern KwaZulu-Natal and is intended to offer contextually grounded insights rather than generalisable claims across all educational settings.

REFERENCES

- Boughey, C. (2024). Conditions constraining the potential of Educational Development to impact on the transformation of teaching and learning. *Critical Studies in Teaching and Learning (CriSTaL)*, 12(2), 44-59.
- Eun, B. (2023). Teachers learning to teach: Professional development based on sociocultural theory for linguistically and culturally diverse classrooms. *Professional Development in Education*, 49(5), 914-924.
- Johnson, K. E., & Golombek, P. R. (2011). A sociocultural theoretical perspective on teacher professional development. In K. E. Johnson, & P. R. Golombek (Eds.), *Research on second language teacher education* (pp. 15-26). New York: Routledge.
- Maphosa, C., & Jita, L. C. (2020). The role of professional learning communities in supporting teacher development in South African schools. *South African Journal of Education*, 40(3), 1-10.
- Mavhunga, E. (2020). Revealing the structural complexity of component interactions of topic-specific PCK when planning to teach. *Research in Science Education*, 50(3), 965-986.
- Mutemeri, J. (2023). Rethinking teacher professional development in the Global South: Towards transformative and sustainable models. *African Journal of Research in Mathematics, Science and Technology Education*, 27(1), 78-93.
- Obi, U. N., & Ticha, I. K. (2020). Involvement of teachers and subject advisors in the curriculum development process in South Africa: Evidence from the Fort Beaufort Education District in Eastern Cape. *Gender & Behaviour*, 18(4), 16551-16566.
- Shabani, K. (2016). Applications of Vygotsky's sociocultural approach for teachers' professional development. *Cogent Education*, 3(1), 1252177.
- Sithole, S., & Tachie, S. A. (2024). Enhancing teacher development through subject advisor support in South African schools. *International Journal of Educational Sciences*, 40(2), 120-132.
- Spaull, N., & Jansen, J. D. (2019). *South African schooling: The enigma of inequality*. Springer Nature.
- UNESCO. (2023). *Education for sustainable development goals: Learning objectives*. Paris: UNESCO Publishing.
- United Nations. (2015). *Transforming our world: The 2030 Agenda for Sustainable Development*. New York: United Nations.
- Van der Westhuizen, G. J., & de Beer, J. (2021). Teacher professional development for sustainable education in South Africa: Challenges and possibilities. *Journal of Education Studies*, 20(2), 35-52.
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Xaba, N., & Sondlo, A. (2022). Using a learner-based activity approach in developing science teachers' readiness in inquiry-based learning. *Education and new developments* (pp. 340-343). <https://doi.org/10.36315/2022v1end077>
- Xaba, N. (2025). Examining the role of Life Sciences subject advisors in collaborative teacher professional workshops: A multiple case study of northern KwaZulu-Natal. *Education and New Developments* (pp. 190-194). <https://doi.org/10.36315/2025v2end040>

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Chapter # 18

THE USE OF 3D PRINTING AS A DIDACTIC TOOL IN TECHNICAL DRAWING EDUCATION WITH AN EMPHASIS ON ECODESIGN

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ABSTRACT

This chapter explores the use of 3D printing as a didactic tool in the teaching of technical drawing, with an emphasis on ecodesign. 3D printing offers an innovative approach to education, enabling students to better understand complex geometric shapes and constructions through interactive and tangible models. At the same time, it provides hands-on experiences that significantly support the development of spatial imagination and technical skills. The chapter also highlights key aspects of ecodesign and sustainability in modern education. The use of ecological materials for 3D printing, such as biodegradable plastics, contributes to environmental protection and encourages sustainable practices. Furthermore, the efficient use of resources inherent to 3D printing can help reduce waste and material consumption compared to traditional production methods. Practical applications are illustrated through specific project examples in which 3D-printed models have been successfully integrated into technical drawing instruction. Feedback from students and teachers shows that this technology can enrich the learning process and increase interest in technical subjects. The chapter additionally provides an overview of essential software and hardware tools required for 3D printing, along with a discussion of challenges and possible solutions related to its implementation. Overall, the chapter offers a comprehensive view of the potential of 3D printing as a tool for modern and sustainable technical drawing education.

Keywords: 3D printing, didactic tool, technical drawing, ecodesign, sustainable education.

1. INTRODUCTION

In recent years, educational methods have undergone a significant transformation due to the integration of modern technologies into teaching across disciplines. One innovation that has found a firm place, especially in technical and engineering education, is 3D printing. This tool allows the conversion of digital designs into physical form, thereby opening up new possibilities for a better understanding of spatial relationships, geometric structures and design principles.

In the teaching of technical drawing, 3D printing brings a shift from theoretical diagrams to practical, interactive learning. This supports the development of spatial imagination, technical reasoning and problem-solving skills - skills crucial for future experts in technical professions. In addition, the inclusion of eco-design principles in projects leads students to a sustainable approach and responsible use of materials, which is increasingly important in the context of current environmental awareness.

This chapter focuses on the educational potential of 3D printing in the field of technical drawing, with an emphasis on sustainability and eco-design. It presents theoretical foundations, offers concrete examples from practice, and analyzes the benefits and challenges associated with implementing this technology in teaching. 3D printing has become an important tool in education, especially in the field of technical drawing (Song, 2018; Pearson & Dubé, 2022; Abu Khurma, Ali, & Swe Khine, 2023; Anđić et al., 2023). This chapter focuses on the use of 3D printing as a didactic tool with an emphasis on ecodesign (Bravo-Díaz & Gutiérrez-Yurrita, 2015; Neto, 2019; Bedmar et al., 2024; Tomášková, Duda, Krotký, & Honzíková, 2024a; Tomášková, Duda, Krotký, & Honzíková, 2024b; Tomášková, Duda, Krotký, & Honzíková, 2025a; Tomášková, Duda, Krotký, & Honzíková, 2025b; Morales Méndez, del Cerro Pérez, & del Cerro Velázquez, 2024; Favi & Marconi, 2025). 3D printing brings an innovative approach that allows students to better understand complex geometric shapes and structures through interactive and tangible models.

2. DIDACTIC AIDS PRINTED ON A 3D PRINTER IN TECHNICAL DRAWING EDUCATION

The integration of 3D printing into the teaching of technical drawing represents a significant shift from traditional methods based on two-dimensional representations towards interactive and hands-on learning. This technology allows students to convert digital designs into physical models, opening up space for a deeper understanding of complex geometric structures, spatial relationships and design principles. The tangibility of 3D printing outputs brings a new dimension to teaching, which encourages active student engagement and the development of their technical thinking. From a pedagogical perspective, 3D printing has the potential to significantly enrich teaching strategies. It allows students to not only visualize but also physically manipulate objects, leading to a better understanding of abstract concepts. This form of learning supports the development of spatial imagination, which is key for technical disciplines, while also developing practical skills such as working with CAD (Computer-Aided Design) software, analyzing design solutions and the ability to iterative design.

Another significant benefit is the possibility of linking the teaching of technical drawing with the topics of sustainability and eco-design. Incorporating these concepts into teaching not only expands students' technical knowledge but also supports their environmental awareness and responsible behavior when designing products. The conference paper Ecodesign as a new possibility in teaching technical subjects in secondary schools (Tomášková, Duda, Krotký, & Honzíková, 2024b) presents ecodesign primarily as a new possibility to enrich the teaching of technical subjects with an environmental dimension. It emphasizes the basic principles of ecodesign and its importance for the development of sustainable thinking, while offering inspiring examples of integration into curricula. On the other hand, the book chapter Ecodesign as an innovative approach to teaching in secondary schools (Tomášková, Duda, Krotký, & Honzíková, 2025a) goes much deeper and shows ecodesign as a comprehensive innovative approach that connects technical drawing with practical projects, life cycle assessment (LCA) methodology and specific recommendations for teachers. It contains structured scenarios on how to implement project tasks, such as the design and production of teaching aids on a 3D printer, while assessing their ecological impacts. The conference paper Life cycle assessment of a product from 3D printer as a new tool for school (Tomášková, Duda, Krotký, & Honzíková, 2024a) focuses on the basic principles of LCA and its use as an educational tool, while the book chapter Innovative education and life cycle assessment of 3D printed products (Tomášková, Duda, Krotký,

& Honzíková, 2025b) develops this issue into practical methodological recommendations, including connections with innovative forms of teaching and project work. Thanks to this, technical drawing becomes not only a means for developing spatial imagination, but also a platform for integrating sustainability, critical thinking and digital competences.

From a didactic point of view, it is also important to reflect on the challenges associated with implementing 3D printing in teaching. These include, for example, the need for technical equipment, the time required to prepare models, the need to train teachers and integrate this technology into existing curricula. Nevertheless, it turns out that with appropriate methodological guidance, 3D printing can be a powerful tool for supporting active learning, project-based learning and interdisciplinary connection of technical and environmental topics. A few studies demonstrate that 3D printed products are used not only in the creation of teaching aids, but also in real experiments. For example, Krotký, Honzíková, & Moc (2016) investigated the deformation of PLA samples printed on a 3D printer at different substrate temperatures. Duda et al. (2019) used 3D printed models in experiments in fluid mechanics, which allowed for the visualization of flow and measurement of turbulence. Similarly, Duda, Yanovych, and Uruba (2022) applied printed components in rheoscopic experiments for teaching flow. The latest work by Duda et al. (2024) then shows how complex physical phenomena, such as time symmetry breaking in flow, can be didactically grasped through a device assembled from 3D printed elements.

Although the integration of 3D printing into technical drawing teaching brings a number of pedagogical benefits, it is also necessary to reflect on environmental and technological challenges. As Tomášková, Duda, Krotký, & Honzíková, 2024a; Tomášková, Duda, Krotký, & Honzíková, 2024b; Tomášková, Duda, Krotký, & Honzíková, 2025a; Tomášková, Duda, Krotký, & Honzíková, 2025b; state, the life cycle of a 3D printed tool includes all phases from the acquisition of raw materials and their processing, through production operations in the company including input and output control, to logistics, use and finally disposal or recycling. Energy consumption during printing itself is not negligible, especially for more complex models, and becomes an important factor in assessing the ecological footprint. Another aspect is the origin of materials, which often come from primary sources, which increases the environmental burden. Therefore, it is appropriate to include a discussion in the teaching about the possibilities of using recycled filaments and about the principles of ecodesign that minimize negative impacts on the environment. The recyclability of printed materials is crucial not only from a sustainability perspective, but also as a practical example for students of how to connect technical thinking with a responsible approach to natural resources. These challenges open up space for the application of the LCA (Life Cycle Assessment) methodology, which allows for a comprehensive assessment of the ecological impacts of a product and its integration into the educational process.

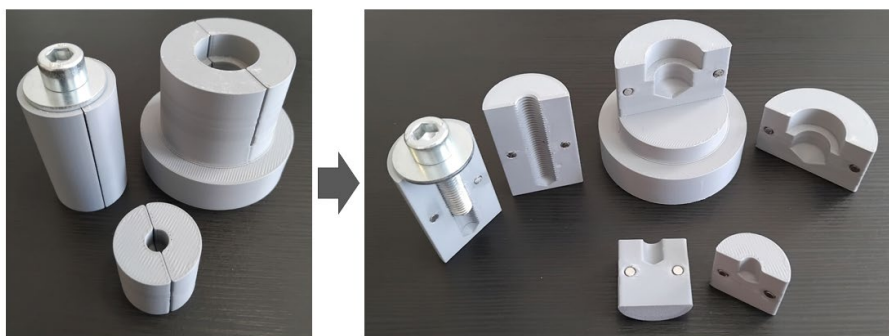
Another important aspect of implementing 3D technologies in education is the development of students' creativity. Fadrhonic, Honzíková, & Tomášková (2025) emphasize in their monograph that 3D modeling in elementary schools is not only a technical skill, but above all a means of supporting creative thinking and problem solving. The authors show that working with 3D models allows students to experiment with shapes, proportions and functionality of objects, which leads to a deeper understanding of the principles of design and technology. At the same time, it is confirmed that the inclusion of 3D modeling in teaching supports an interdisciplinary approach - it connects elements of mathematics, computer science, art education and technical education, i.e., areas covered by the STEM concept (Science, Technology, Engineering and Mathematics). This approach not only develops creativity, but also increases students' motivation for active learning and project work, which is in line with modern trends in STEM didactics.

2.1. Benefits of 3D Printing in Technical Drawing Teaching

3D printed models allow students to physically manipulate objects, which increases their engagement and interest in technical drawing, for example, models of machine components can be easily created and used in teaching, see Figure 1 (Fadrhonic, Honzíková, & Tomášková, 2025).

3D printing technology has become an integral part of modern technical education in recent years. Its application in the school environment allows students not only to master the principles of spatial design and technical drawing, but also to understand the properties of various materials, including ecological and recyclable ones. This opens up space for connecting technical skills with environmental aspects, which is in line with the requirements for sustainable development in education. One of the key benefits of 3D printing is the possibility of using a wide range of materials that differ not only in mechanical properties, but also in their ecological footprint. Among the most commonly used materials is PLA (polylactide), which is produced from renewable resources such as corn starch. Thanks to its biodegradability and low melting point (usually between 180–220 °C), PLA is ideal for educational purposes, especially when making models, prototypes and structural parts with lower demands on mechanical resistance. Another frequently used material is PETG, which combines good mechanical strength with chemical resistance. Its advantage is the possibility of recycling, which makes it suitable for projects focused on the circular economy. In more advanced stages of education, work with ABS can also be included, which is mechanically very resistant, but its printing requires higher temperatures (approx. 230–250 °C) and a controlled environment due to vapor emissions. A specific area that is developing dynamically is the use of filaments made from recycled materials - for example, from PET bottles, old CDs or electronic waste. These materials not only reduce teaching costs, but also allow students to reflect on the environmental impacts of technologies. As part of project education, students can design functional products, such as wall clocks from recycled printed circuit boards, thereby learning to apply the principles of eco-design in practice.

Figure 1.
Didactic aids printed on a 3D printer in technical drawing education.

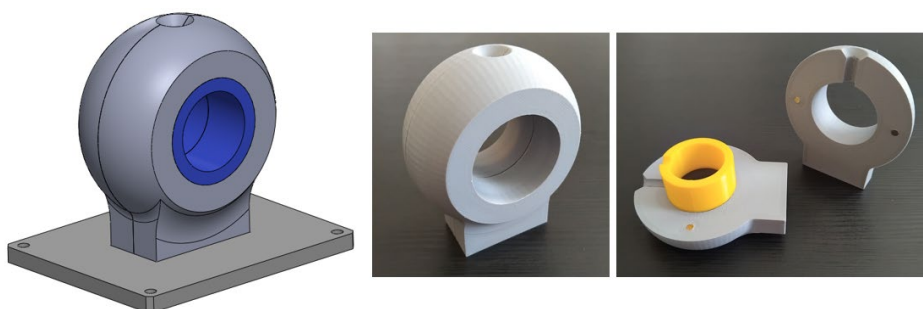


From a technical point of view, it is important for students to understand the basic physical and chemical properties of individual materials. This includes, for example, tensile strength, elasticity, thermal conductivity, UV resistance and dimensional stability. These parameters have a direct impact on the quality of the resulting product and are key in the design of technical drawings, load calculations and structural optimization. The teaching should also include working with CAD software (e.g., Fusion 360, Tinkercad, SolidWorks),

which allows for accurate modeling and preparation of data for printing. Students learn to convert technical drawings into digital form, work with tolerances, scale and structural elements. Subsequently, using a slicer (e.g., PrusaSlicer, Cura) they prepare print files, where they set parameters such as layer height, fill density, print speed or support.

Integrating 3D printing into teaching not only develops technical competencies, but also fosters creativity, critical thinking and environmental awareness. Students learn to make decisions based on technical and ecological criteria, which is important for their future professional orientation in the field of engineering, design and sustainable development. This approach also allows them to connect theoretical knowledge with practical application, which increases students' motivation to learn. Thanks to 3D printing, space is opened for interdisciplinary cooperation, for example between technical and artistic disciplines, and students adopt the principles of the circular economy, as they can use recyclable materials and minimize waste. The educational process becomes more interactive and attractive, which supports the active involvement of students and the development of their creativity. Students gain valuable practical experience in designing and manufacturing their own models, which they then print on a 3D printer, and this process supports technical skills important for future careers in engineering and technology (see Figure 2; Fadrhonic, Honzík, & Tomášková, 2025). The integration of modern technologies, such as 3D printing, prepares students for the demands of the job market, where innovation and sustainability are key factors.

Figure 2.
Didactic aids printed on a 3D printer (modelling in SOLIDWORKS).



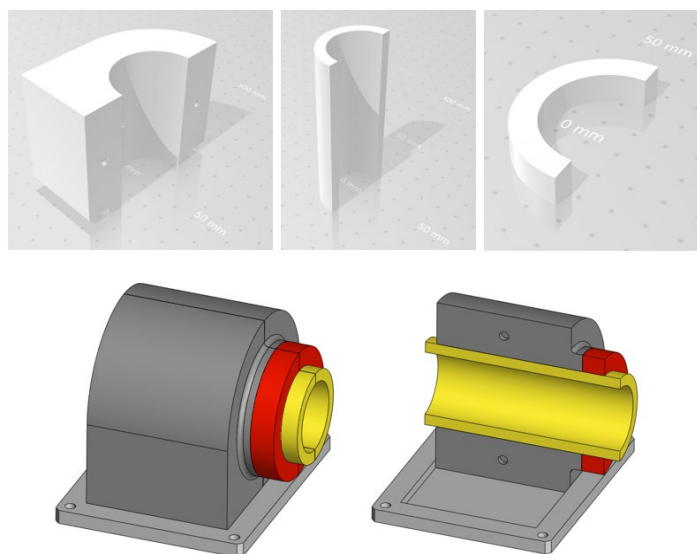
3D printed models of geometric shapes and structures can help students better understand abstract concepts and relationships between different shapes, see Figure 3.

Models of various machine components can be used to teach technical drawing and engineering, allowing students to study and understand their design and function in detail. Students can design and print their own technical drawings and models, providing them with hands-on experience in technical drawing and engineering processes, see Figure 4. The use of 3D models and visualizations allows you to connect theoretical knowledge with practical applications, which increases student motivation and engagement in the lesson.

Part of the modern approach is the opportunity for students to design and print their own technical drawings and models. This process includes working with CAD software, creating drawing documentation and subsequent implementation using 3D printing. Students thus gain practical experience not only with technical drawing, but also with the entire engineering process from design to optimization to production. Such an activity develops their creativity, technical thinking and ability to solve real problems, which is key for their

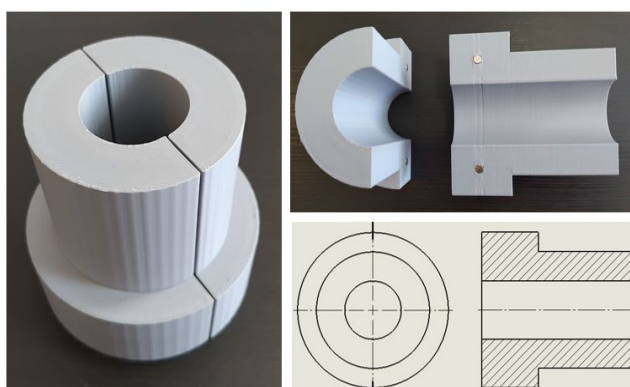
future professional application. As described by Fadrhonc, Honzíková, & Tomášková, 2025, connecting design with production through 3D printing allows students to better understand the relationships between design parameters, material properties and environmental impacts.

*Figure 3.
Model of didactic aids (modelling in SOLIDWORKS).*



The authors emphasize the importance of integrating life cycle assessment (LCA) methods and carbon footprint calculation, which leads to awareness of the ecological aspects of technical solutions. This approach supports not only technical competences, but also the development of responsible engineering oriented towards sustainability.

*Figure 4.
Model of didactic aid and technical drawing.*



3. FUTURE RESEARCH DIRECTIONS

Given the rapid technological development and increasing demands for sustainability, it is expected that the use of 3D printing in education will continue to expand and deepen. Several promising directions are opening up in the field of technical drawing, which can fundamentally influence both the content of education and its methodological approach. One of the key trends is the expansion of the material base with new types of ecological filaments, including composite materials with wood, metal particles or recycled polymers. These materials allow not only the expansion of technical teaching options, but also a deeper integration of environmental topics. Students can thus learn to evaluate materials not only in terms of their technical parameters, but also in terms of their impact on the environment, throughout the product's life cycle. Another direction is the personalization of teaching aids through parametric modeling. Using advanced CAD tools, students can create their own variants of models that correspond to their individual design solutions. This supports creativity, technical precision and the ability to iteratively improve the design. In combination with 3D printing, these designs can be quickly verified in practice, which significantly increases the effectiveness of teaching. From a pedagogical point of view, the development of project-oriented teaching that connects technical drawing, structural design, environmental analysis and digital manufacturing appears promising. Students can work on complex tasks that include the design of a functional product, the selection of suitable materials, the creation of technical documentation, printing a prototype and the subsequent evaluation of its functionality and ecological footprint. Such an approach supports interdisciplinarity and the development of key competencies for the 21st century. Last but not least, greater integration of simulation tools into teaching is expected, which will allow students to analyze the mechanical behavior of designed parts in advance, optimize their geometry and minimize material consumption. In combination with methods such as LCA (Life Cycle Assessment), technical drawing teaching can be enriched with systems thinking and the ability to comprehensively evaluate technical decisions. From an institutional development point of view, it is important to support the creation of open databases of teaching models that will be shared between schools and educational institutions. This will facilitate access to proven teaching aids and support collaboration between educators in the field of technical and environmental education. Overall, it can be stated that the future of 3D printing in technical drawing education lies in its deeper integration into teaching processes, the expansion of the ecological dimension and the connection with digital tools for design, simulation and evaluation. This technology has the potential to become not only a means for the development of technical skills, but also a tool for the formation of responsible and sustainably oriented technical thinking.

4. CONCLUSION/DISCUSSION

The integration of 3D printing into technical drawing education represents a significant step towards the modernization of technical education. This technology allows for the transformation of abstract geometric concepts into tangible form, thereby supporting the active involvement of students, the development of spatial imagination and technical skills. At the same time, it opens up space for connections with the principles of eco-design and sustainability, which is in line with current requirements for education oriented towards the responsible use of resources.

A key benefit is the possibility of connecting technical competencies with environmental thinking. Students learn not only to work with CAD tools and 3D printing technologies, but also to reflect on the choice of materials, the energy intensity of production and the impacts of the entire product life cycle. This makes technical drawing a platform for the development of systemic and critical thinking, interdisciplinary connections and digital skills.

From a sustainability perspective, it is essential to highlight the challenges that this technology brings: the need to optimize energy consumption, use recycled filaments, and incorporate environmental impact assessment methods (e.g., LCA) into the educational process. These aspects not only reduce the environmental burden but also provide students with a practical framework for applying the principles of the circular economy.

Based on simple studies and practical experience, we can conclude that without didactic aids, students achieved an average improvement in understanding and application of technical drawing of around 15%. When didactic aids printed on a 3D printer were used, students achieved an improvement in understanding and application of technical drawing by up to 35% due to the interactive and practical approach. If didactic aids are effectively integrated into the teaching and students have enough opportunities to use them, 3D printed models can significantly increase student engagement, their spatial imagination and technical skills, which leads to better learning outcomes. The percentage improvement values are based on a comparison of the pre-test and post-test results, which were carried out for the control and experimental groups. Students in both groups took a test before the start of the lesson (baseline), which verified their initial level of understanding of technical drawing. After the end of the lesson block, the same or equivalent test was administered, the results of which allowed to determine the level of improvement. The average improvement was calculated as the relative difference between the pre- and post-lesson scores, which provided an objective basis for the values of 15% and 35%.

Future research should focus on developing methodological approaches for effectively integrating 3D printing into the curriculum, verifying long-term impacts on learning, and finding ways to minimize the ecological footprint of this technology. Sharing open databases of models, using recycled materials, and integrating LCA into project-based learning are promising directions that connect technical education with sustainable development goals.

REFERENCES

- Abu Khurma, O., Ali, N., & Swe Khine, M. (2023). Exploring the impact of 3D printing integration on STEM attitudes in elementary schools. *Contemporary Educational Technology*, 15(4), ep458 <https://doi.org/10.30935/cedtech/13568>
- Andić, B., Ulbrich, E., Dana-Picard, T., et al. (2023). A Phenomenography Study of STEM Teachers' Conceptions of Using Three-Dimensional Modeling and Printing (3DMP) in Teaching. *Journal of Science Education and Technology*, 32, 45-60. <https://doi.org/10.1007/s10956-022-10005-0>
- Bedmar, J., Artigas-Arnavadas, J., Vázquez-López, A., Cifuentes, S.C., Calderón-Villajos, R., Muñoz, M. (2024). Using Technological Tools to Teach Arts and Design Students About Materials Science and Manufacturing. *EDULEARN24 Proceedings*, 4130-4135. doi: 10.21125/edulearn.2024.1040.
- Bravo-Díaz, B., & Gutiérrez-Yurrita, P. J. (2015). Eco-design as a tool to implement the new approach of the education model by competencies in engineering courses. *ICERI2015 Proceedings*, 6578-6587.

- Duda, D., Klimko, M., Skach, R., Uher, J., & Uruba, V. (2019). Hydrodynamic education with rheoscopic fluid. *Experimental Fluid Mechanics 2018 (EFM18)*, 213, 02014. Proceedings from the 13th International Conference on Experimental Fluid Mechanics. <https://doi.org/10.1051/epjconf/201921302014>
- Duda, D., Yanovych, V., & Uruba, V. (2022). Simple Rheoscopic Flows Used in Teaching Fluid Mechanics. *Topical Problems of Fluid Mechanics*. Proceedings from the Conference on Topical Problems of Fluid Mechanics, 37-43. <https://doi.org/10.14311/TPFM.2022.006>
- Duda, D., Tomášková, T., Yanovych, V., Krotký, J., & Uruba, V. (2024). Demonstration of time-symmetry breaking in a jet flow. *Education and New Developments 2024*, 313-315. Porto: inScience Press,
- Fadrhonic, J., Honzíková, J., & Tomášková, T. (2025). *3D Modeling in Elementary Schools and its Use in Testing Creativity* (1st ed.). Puttur, India: BP International. <https://doi.org/10.9734/bpi/mono/978-93-49238-87-9>.
- Favi, C., & Marconi, M. (2025). Product Eco-Design in the Era of the Circular Economy. *Sustainability*, 17(1), 213. <https://doi.org/10.3390/su17010213>
- Krotký, J., Honzíková, J., & Moc, P. (2016). Deformation of Print PLA Material Depending on the Temperature of Reheating Printing Pad. *Ústí nad Labem: UJEP, FVTM [Manufacturing Technology]*. 16(1), 140-144.
- Morales Méndez, G., del Cerro Pérez, A., & del Cerro Velázquez, F. (2024). Prototype Pultrusion of Recycled Polyethylene Terephthalate Plastic Bottles into Filament for 3D Eco-Printing: Education for a Sustainable Development Project. *Sustainability*, 16(19), 8347. <https://doi.org/10.3390/su16198347>
- Neto, V. (2019). Eco-design and Eco-efficiency Competencies Development in Engineering and Design Students. *Education Sciences*, 9(2), 126. <https://doi.org/10.3390/educsci9020126>
- Pearson, H. A., & Dubé, A. K. (2022). 3D printing as an educational technology: theoretical perspectives, learning outcomes, and recommendations for practice. *Education and Information Technologies*, 27, 3037-3064. <https://doi.org/10.1007/s10639-021-10733-7>.
- Song, M. J. (2018). Learning to teach 3D printing in schools: how do teachers in Korea prepare to integrate 3D printing technology into classrooms? *Educational Media International*, 55(3), 183-198. <https://doi.org/10.1080/09523987.2018.1512448>
- Tomášková, T., Duda, D., Krotký, J., & Honzíková, J. (2024a). Life cycle assessment of a product from 3D printer as a new tool for school. *Education and New Developments 2024* (pp. 316-318). Lisbon: inScience Press. <https://doi.org/10.36315/2024v2end068>
- Tomášková, T., Duda, D., Krotký, J., & Honzíková, J. (2024b). Ecodesign as a new possibility in teaching technical subjects in secondary schools. *Education and New Developments 2024* (pp. 199-203). Lisbon: inScience Press. <https://doi.org/10.36315/2024v2end042>
- Tomášková, T., Duda, D., Krotký, J., & Honzíková, J. (2025a). Ecodesign as an innovative approach to teaching in secondary schools. In M. Carmo (Ed.), *Education Applications & Developments X* (pp. 279-289). Lisbon, Portugal: inScience Press.
- Tomášková, T., Duda, D., Krotký, J., & Honzíková, J. (2025b). Innovative education and life cycle assessment of 3D printed products. In M. Carmo (Ed.), *Education Applications & Developments X* (pp. 384-393). Lisbon, Portugal: inScience Press.

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Chapter # 19

LEADERSHIP OF PLACE TO BUILD ANTHROPOLOGIES OF PRESENCE: AN ALTERNATIVE EDUCATIONAL RESPONSE TO DISINFORMATION

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ABSTRACT

This study contends that the limitations of the current educational responses to disinformation underscore the need for a complementary educational approach. In this context, the chapter stresses the importance of moving from a correctional paradigm to one that frames combating disinformation as a political action, focusing on how young people engage in digital spaces. To support this shift, this study draws on the spatial characteristics of youth political participation and highlights the spatial dimensions of political engagement through Arendt's concept of space of appearance and de Certeau's distinction between strategies and tactics. A thematic analysis of 40 semi-structured interviews with Greek secondary education students aged 13 to 17 years revealed limited student engagement with the digital information space, societal issues, and informed opinions. The analysis also found that students received limited resources to navigate the digital space, and an equal number of students perceived safety in both the school and digital environments. Based on these findings, the chapter uses Riley's conceptualization of place leadership to propose a complementary educational response that could foster anthropologies of presence at school as a prerequisite for place-making in digital spaces.

Keywords: disinformation, anthropologies of presence, space of appearance, strategies, leadership of place, Greece.

1. INTRODUCTION

In the Global Risks Report 2025 of the World Economic Forum (Elsner et al., 2025), disinformation is, for the second consecutive year, the top-ranked short-to medium-term concern across all risk categories. Educational responses to disinformation have drawn on the correctional paradigm, placing emphasis on the one hand on curricula designed to promote information, media literacy, and critical thinking, as well as raising awareness through proactive (prebunking) and reactive (debunking) interventions (Chinn et al., 2021; Barzilai & Chinn, 2020).

The correctional approach to disinformation has two shortcomings. First, it seems to take for granted that young people are interested in social affairs and willing to invest the time needed to identify logical fallacies, check source credibility, and address inaccuracies required for responsible news consumption. However, this assumption is challenged. Recent studies show that young people today participate less in institutional politics than other age groups and less than young people did decades ago (Deželan, 2023, p. 14). They also show negative trends in political engagement, which often becomes significant during adolescence (Zhang, 2022; Janmaat et al. 2022). Second, although political actions are always related to a territory of action and are therefore always related to space (Sack, 1983; Sassen, 2013; Cresswell, 2015), space has not yet been considered in educational responses to

disinformation. In fact, the quantification and categorization of young people's forms of digital participation (Eurobarometer, 2024) do not address if and if so, in what ways the digital space is used as an information space for political participation. This latest remark resonates with de Certeau's (1984, p. 35) argument that counting "what is used" does not represent "the ways of using."

Given that "the ways of using" are ways of presence – signaling physical, mental, and emotional engagement with the world, this study aims to explore the following two questions: (a) how Greek secondary education students' use digital space, and (b) their interest in acquiring information on social issues and the geographical range of this interest. Additionally, to provide context, the study also examines the support systems available to Greek students that assist them in navigating the digital information space.

The rationale of this chapter is based on the position that combating disinformation is a conscious political choice and, therefore, requires presence in a territorial space of action. The first subsection provides a brief overview of how the transitions in youth political participation are related to transitions in different spaces of action. The second subsection draws on Arendt's (1958) concept of *space of appearance* and de Certeau's (1984) distinction between *strategies* and *tactics* to outline ways of performing political presence in space. After presenting the results of qualitative research in Greece, this chapter draws on Riley's (2013) framework of leadership of place to propose the enactment of anthropologies of space in schools as a complementary educational response to disinformation.

2. BACKGROUND

This section presents two objectives. The first is to highlight that young people's new forms of political action occur in different forms of space. The second is to emphasize the importance of territorial space, as a condition for political action to occur.

2.1. New Forms of Youth Political Participation and New Types of Political Spaces

Currently, young people's choice of political participation seems to be linked to distrust and dissatisfaction with institutional political actors and growing skepticism toward representative democracy (Bárta et al., 2021). Young people appear to prefer non-electoral and non-institutionalized forms of participation (Sloam, 2013; Yurttagüler & Deželan 2021), such as protesting, boycotting goods, community activism, and sit-ins. These new forms of political participation are increasingly turning to issue-based engagement, which is more personally meaningful and connected to everyday life (Sloam, 2016) but also gives rise to new forms of participatory spaces.

In their study, Crowley and Moxon (2017) highlighted the emergence of participatory spaces, which prioritize participation rather than focusing on specific participation methods or structures, and identified five broad categories: a) youth councils, parliaments, boards, and other formal structures where young people participate on an ongoing basis. These can be geographic or linked to specific organizations such as schools or NGOs; b) co-management and co-production processes, which involve shared power and collaboration between young people and adults in joint decision-making; c) deliberative youth participation, referring to structured public debates or dialogues about specific decisions, often organized as one-time events or series, with outcomes fed directly to decision makers; d) youth activism and protests, involving formally organized or loosely associated activists participating in campaigning groups and democratic protests aimed at influencing public decision-making; and e) young people's digital participation, referring to the use of the Internet, social media,

and mobile technology to connect young people to decision makers, either initiated by institutions or by young people themselves, such as through online petitions, consultations, or crowdsourcing ideas.

Similarly, Salto PI (2020), in distinguishing between conventional or traditional, unconventional or alternative, and individualized forms of youth political participation, also indicated that each type of political participation takes place in a different space. Conventional or traditional political participation includes institutionalized activities that take place within the electoral arena of the institutionalized system of representative democracy, such as voting in elections and referendums, joining political parties, running offices, signing petitions, and engaging in institutional mechanisms for youth participation. On the other hand, unconventional or alternative political participation activities, such as youth movements, demonstrations, strikes, boycotts, and petitions, use out-of-system approaches to achieve their goals and move from the institutionalized space of the political arena to the more fluid and emergent space of youth movements. In fact, prefigurative politics involve constructing alternatives and embodying future social relations in current practices (Törnberg, 2021), creating alternative models of democracy and decision-making within movements (Bárta et al., 2021), as a form of "constructive resistance" that seeks to build a new society within the shell of the old by embodying desired social relations and practices in the present (Törnberg, 2021). Finally, individualized political participation occurs at the restricted individual level and does not necessarily require group, community, or mass action. It is primarily associated with individual activities that carry political meaning in various areas as well as other personalized political actions that may not fit neatly into conventional or unconventional categories. Lifestyle politics is a form of individualized political participation in which, every day, individual choices are forms of political action (Bennett, 1998; de Moor, 2017).

2.2. Political Presence is Territorial Presence: Space of Appearance, Strategies and Tactics

These new ways of youth political participation resonate with Arendt's (1958, 1971) and de Certeau's (1984) thinking of the relation between space as territory, politics, and presence.

Although Arendt did not specifically refer to disinformation, she placed great emphasis on the devastating effects of lying in politics and the subsequent crises of democracy (1971, 1965). What is fundamental to Arendt's work, which brings valuable insights into the fight against disinformation, is that she did not limit the distinction between lies and truth but moved forward to emphasize the importance of informed opinions that can be expressed and debated in a public space of action. For Arendt opinions, as expression of political action, are not formed in isolation, and therefore their formation is not a private activity but an action that takes place in public space through public debate, requiring what Arendt called a "space of appearance" (Arendt, 1958). For Arendt (1958, p. 199), the "space of appearance" is a visible and material expression of power and agency, an "insertion into the human world ... like a second birth," and "a relational act" (1958, p. 19). This man-made space of appearance was for Arendt fundamental. In this regard, Arendt (1965) commented on the isonomy of the Greek polis and highlighted that it was the space of appearance provided by the Greek polis that guaranteed that "men were by nature ...not equal, and needed an artificial institution, the polis, which by virtue of its laws [nomos] would make them equal.... The equality of the Greek polis, its isonomy, was an attribute of the polis and not of the men, who received their equality by virtue of citizenship, not by virtue of birth" (1965, p. 23).

De Certeau (1984), through his conceptualization of *strategies* and *tactics* that put emphasis on people's everyday practices as forms of participation and resistance, also highlighted the relation between territory, politics and presence. De Certeau examined everyday life practices to show how daily actions are "arts of doing" that offer a more complete picture of how people navigate and remake their world. In this approach, humans are active agents – “users” and not passive recipients, who, through their everyday practices, can resist and transform the dominant order while remaining within the system. In this vein, De Certeau (1984, pp. 53-54) defined territory as 'one's own space, a *lieu propre*, and made a sharp distinction between strategies, which are territorial, and tactics, which are pure practices. A strategy assumes that a place can be circumscribed as a *lieu propre*. Unlike strategies, tactics, as the “art of the weak,” have no space of their own; they cannot encompass the entire space of the system and are included in the space of the other (de Certeau, 1984, p. xix). Strategies establish relations with the power that supports them within a space, whereas the rationality of tactics is realized through pleasures attached to the agent's daily practices (Certeau, 1984, pp. 37-38). Because tactics lack their own spatial domains, they must constantly manipulate events to turn them into opportunities, achieved in propitious moments when they can combine heterogeneous elements (Certeau, 1984, p. xix). Their only advantage lies in the ability “to make use of the cracks that particular conjunctions open in the surveillance of the proprietary powers” (Certeau, 1984, pp. 37-39).

3. METHODS

This study explores students' digital participation through three research pillars. Pillar 1 sought to explore the time spent online, main activities, and reasons for the attractiveness of the digital space. Pillar 2 sought to explore students' interest in social issues, their area of interest in relation to social issues, their favorite sources of information, and their perception of the impact of their choices. Finally, Pillar 3 aimed to explore whether students have support that would facilitate their navigation in the digital space.

Regarding ethical compliance, the research was conducted in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent forms were created in compliance with the European Code of Conduct for Research Integrity (revised edition, 2017) and General Data Protection Regulation (GDPR, EU, 2016/679). The interviews were conducted after both the students and their parents signed an informed consent form, with the duration varying between 20 and 35 minutes. Interviews were conducted via Zoom during school hours.

To increase the information power of our sample, purposive sampling was used to recruit public secondary education students aged 13–17 years from three Greek regions. The sample was divided into urban and suburban areas of Greece. At this level of stratification, students from urban areas comprised two-thirds of the sample, thus reflecting the initial population distribution. The sample was further stratified to include participants from a wide range of backgrounds and capture diverse perspectives. The final sample consisted of 20 girls, 12 boys, and 8 LGBTQ+ students. Twenty-eight students were from low socioeconomic backgrounds (low or unstable income, lower educational attainment, and limited social mobility), and 12 were from upper socioeconomic backgrounds (high and stable income, medium to high educational attainment, and intergenerational continuity).

To ensure adequacy of the sample size, data saturation was determined empirically when no relevant new data emerged for either code or category. In this case, the code and category matrix had already stabilized during the initial 20 interviews across all sociodemographic categories. To provide strong empirical confirmation of data saturation, this number was doubled to forty interviews.

Figure 1.
Sample's sociodemographic characteristics.



4. ANALYSIS

Semi-structured interviews were transcribed, and an open coding strategy (Strauss & Corbin, 1990) was applied to the collected data. Thematic analysis using the MAXQDA coding system was conducted to perform reflexive thematic analysis (Braun & Clarke, 2022). Several rounds of refinement, definition, and naming of themes yielded the following results for each research pillar.

Pillar 1: Use of digital space

Findings in Pillar 1 revealed that students were almost equally divided between those who spent more than three hours and less than three hours per day online (Figure 2). They used the digital space primarily for communication and socialization (32 cases), followed by entertainment (15 cases) and information seeking (6 cases) (Figure 3). These findings are corroborated by the following question: Figure 4 shows that the majority are attracted to the digital space, with the main reasons being: a) for communication, students mentioned that they “feel more protected by the anonymity of the digital space” (S5) and “can express their concerns and questions more freely as they are not physically exposed” (S18); and b) for socialization, because “it can compensate for the lack of socialization in real life” (S34). Of the thirteen students who do not find the digital world attractive, nine clearly stated their lack of attraction, one cited social pressure because “everyone is online now” (S7), and three responses ascribed the code “a solution when I am bored” (S26).

Figure 2.
Time spent online.

▼	☐ TIME SPENT ONLINE	0
>	☐ <3 hours	21
>	☐ 3-7 hours	13
>	☐ >7 hours	6

Figure 3.
Use of digital space.

▼	☐ USE OF DIGITAL SPACE	0
>	☐ Opportunities for communication & socialisation	32
>	☐ Opportunities for entertainment	15
	☐ Find information	6
	☐ Openess to a transnational space	5
>	☐ Watch the lives of others/gossip	4
	☐ I don't like the digital space	2
	☐ The opportunity to have a private space	1
	☐ Opportunities to learn	1

Figure 4.
Attractiveness of the digital world.

▼	☐ ATTRACTIVENESS OF THE DIGITAL WORLD	0
▼	☐ No, I don't find the digital space attractive	0
	☐ Because everybody is online	1
	☐ I do not find the digital world attractive	9
>	☐ A solution when I am bored	3
▼	☐ Yes, I find the digital space attractive	0
>	☐ Communication & social media	8
>	☐ It is easier and quicker to find information	7
>	☐ Provides safer communication/expression without exposure	6
>	☐ Enhances/provides socialisation	5
>	☐ Provides opportunities for entertainment	5
>	☐ Provides opportunities for transnationality	3
>	☐ Provides opportunities to learn	2
	☐ More shopping opportunities	1

Pillar 2: Social awareness, information practices and impact of choices

Findings in Pillar 2 showed that students were almost evenly split between those who were interested in current social issues and those who were not; they were most interested in their country in relation to these social issues; their favorite source of information was the Internet, and they were divided regarding the perceived impact of their personal choices (Figure 5).

Figure 5.
Social awareness: information practices and perceived agency.

▼ ☒ Social awareness	0
▼ ☒ I LIKE TO BE INFORMED	0
☒ No	19
> ☒ YES	21
▼ ☒ RANGE OF INTEREST	0
☒ Europe	5
☒ The world	10
☒ My country	16
☒ My school	5
☒ My city	6
☒ My friends and family	3
☒ No specific answer	2
☒ I am not interested	10
▼ ☒ PREFERRED INFORMATION SOURCES	0
☒ Internet	28
☒ People: school, friends, family	11
☒ TV	8
☒ Nothing	7
☒ It happens by accident, It is not a conscious choice	6
▼ ☒ OUR CHOICES MAKE A DIFFERENCE	0
☒ Yes	13
☒ Not always	16
☒ No	11

Pillar 3: Conversion factors

Pillar 3 examines the support students have received in relation to the digital space, their ability to recognize disinformation online, and their perceived safety in the digital space and at school. Figure 6 shows that a) parents are the most important source of support in relation to the digital space, b) students are almost equally divided between those who believe they can recognize disinformation and those who do not, and c) the number of students is identical in the three questions examining their ability to recognize disinformation, perceived safety online, and perceived safety at school.

Figure 6.
Conversion factors.

Conversion factors	0
SUPPORT IN THE DIGITAL SPACE	0
Parents	18
School	15
Friends	2
No support	13
I CAN TELL IF AN INFORMATION IS REAL OR NOT	0
Yes	15
Not always	13
No	12
FEELING SAFE ONLINE	0
Yes	15
Not always	13
No	12
FEELING SAFE AT SCHOOL	0
Yes	15
Not always	13
No	12
PEOPLE I TRUST IN CASE OF CRISIS AT SCHOOL	0
Friends & schoolmates	25
> The school	23
> Parents	12
> Other	4
PEOPLE I TRUST IN CASES OF BULLYING AT SCHOOL	0
> Parents	37
> Friends	20
> The school	10

5. DISCUSSION

The findings of the thematic analysis are important because they support our argument that it is necessary, first, not to confuse “what is used” with “the ways of using,” and second, to view the fight against disinformation as political presence situated in a territorial space of action. In fact, although this generation of adolescents is a true digital native inclined to search for information online (Dimock, 2019), the findings of the study showed that students rarely use digital spaces for information purposes (Pillar 1), a considerable percentage were not interested in current social issues, none of the students mentioned engagement with any social issue (Pillar 2), and they received little or no support from the school on how to navigate the digital space (Pillar 3).

The results of Pillars 1 and 2 confirm Sloam’s (2016) cumulative data on Greece. Sloam’s (2016) study, covering waves 1–5 (2002–2010) of young people (aged 15–24) across 15 EU member states (EU15), found that the overall level of youth participation in five political activities – voting in national elections, displaying badges or stickers, signing petitions, joining boycotts, and participating in demonstrations – is very low in Greece. Specifically, although youth electoral participation in Greece is within 10% of the average, youth turnout remains low. Greece was among the countries with moderate-to-high levels of engagement in electoral politics but comparatively low participation rates in issue-based forms of political action. Sloam’s (2016) study also showed that countries with the lowest youth participation—Italy, Greece, Ireland, the United Kingdom, and Portugal—are those where income inequality and child poverty are among the highest.

Moreover, the findings in Pillar 3 also align with previous concerns that informed and meaningful youth digital participation require young people to have sufficient digital, data, and media literacy skills and the ability to exercise their human rights both offline and online (Pawluczuk, 2020). These findings are also important because non-participation in the digital world could lead to a feeling of social exclusion, whereas a feeling of social inclusion may be induced by having access to the Internet as well as the willingness and skills to use it (Seifert & Rössel, 2019).

However, although our findings align with those of previous studies, we consider the above findings under Arendt's and de Certeau's (1984) approach, and new insights emerge. First, Greek students' absence of digital participation, interest, and engagement, and consequently a lack of informed opinions on social issues, suggests a lack of presence in the space of appearance. This lack of appearance in a public space where opinions are expressed, formed, and debated is crucial. For Arendt, this "shift from rational truth to opinion implies a shift from man in the singular to men in the plural" (1971, p. 14). As she argued, "*While all aspects of human condition are somehow related to politics, this plurality is specifically the condition-not only the *conditio sine qua non*, but the *conditio per quam*- of all political life*" (1958, p. 7). Moreover, if we view the above results under de Certeau's (1984) distinction between strategies and tactics, we realize that the rare use of digital space for information practices and the lack of engagement with any social issue reveals not only the absence of strategies, but also an absence of tactics. Furthermore, the identical numbers of students' perceived safety in the digital and school spaces (Figure 5) suggests that the absence of *lieu-propre* may be transferred across different forms of space. To provide a broader context for understanding the significance of this absence of interest in social affairs, we need to note that besides the ongoing social and financial issues of the country that have a direct impact on people's everyday lives, the interviews took place during a period (spring 2024) when femicides were the number one topic in the news the period the interviews were conducted (Kissas & Koulaxi, 2025; Zamfir, 2025).

In sum, students' lack of presence and engagement with the digital information space suggests the absence of Arendt's (1958) "space of appearance," and de Certeau's (1984) *lieu-propre*. This suggestion also resonates with compelling evidence that young people are not apathetic or disinterested outside institutional politics, but rather insufficiently informed and disempowered due to the obstacles they face, or increasingly skeptical because of mistrust in the political class (Deželan, 2023, p. 26).

6. LEADERSHIP OF PLACE TO BUILD ANTHROPOLOGIES OF PRESENCE: THE SPATIAL APPROACH TO DISINFORMATION

The spatial paradigm brings forward a different kind of educational response to disinformation that moves away from the correctional paradigm applied so far. The three predominant forms of the correction paradigm consist of a) fact-based rectifications that directly address inaccuracies in disinformation while providing accurate information, b) the identification of logical fallacies common in certain types of disinformation, and c) the discrediting of the plausibility of the disinformation or the credibility of its source (Ecker et al. 2022). In contrast, the spatial lens against disinformation puts forward the need to build anthropologies of presence at schools as a precondition for fighting disinformation.

Our suggestion is that this precondition be enacted at school by combining the framework of the leadership of the place. Leadership of place has been theorized by Riley (2013, 2017, 2022) as a dynamic, relational, collaborative, and research-informed form of leadership that centers on place, belonging, and student agency to create environments of

inclusion or exclusion at school. In Riley's theorization, school leaders act as "place-makers" who have the power and influence to shape the culture and climate of a school, are actively involved in creating healthy, welcoming school cultures, and foster a sense of belonging, safety, trust, and positive relationships.

Leadership of place puts forward the creation of what Arendt conceptualized as a space of appearance in which opinions can be debated and formed, and de Certeau (1984) described it as a *lieu-propre*, a space in which strategies can be developed. The enactment of this *lieu-propre* could take the form of participation spaces in school communities, enhancing students' voices at school, and engaging students in research activities on the conditions that shape their lives to foster their sense of belonging. In other words, leadership of place focuses on creating opportunities to make school what de Certeau (1984, p. 117) called "a practiced place."

This enactment of the space of appearance into *lieu-propre* could materialize by creating opportunities for students to engage with prefigurative and lifestyle politics at the school's microscale. On one hand, prefigurative politics are deeply related to placemaking, producing a *lieu-propre* through repeated actions, emotional intensity, and symbolic meaning (Yates, 2021; Dussault, 2022). On the other, lifestyle politics put forward students' tactics as a form of "hidden production" on creating their own meanings and practices by re-interpreting and repurposing what is offered to them (de Certeau, 1984, pp. 37-39).

The enactment of prefigurative and lifestyle politics at school seems to be critical if we consider that students express very low levels of interest in social issues related to their city and school (Figure 5). It is also particularly crucial during adolescence, since adolescence is a vital stage for shaping individuals' long-term participatory habits (Chan et al., 2014), a crucial time for the development of political thinking (Deželan, 2023, p. 26).

The need to approach disinformation through the lens of space has also emerged when considering how the dynamics of space and place have changed over the last few decades. This generation of young people is not only the first to operate in a media environment in which the lines between truth and lies, facts, and rumors are blurred to this degree (Ball, 2017; D'Ancona, 2017). This generation has also witnessed, or in some cases, affected by, the 2008 global financial crisis, pandemic, migration, refugee crisis, energy crisis, and war. They are also the first generation to realize that their lives depend on transnational and global phenomena, and the first, in the aftermath of the global financial crisis and the pandemic, to have been called twice in their lifetime the "lost generation" (World Bank, 2022).

7. CONCLUSION

These findings are significant because they indicate an alternative educational response to disinformation that goes beyond the limitations of the correctional paradigm. This study argues that young people's interest in combating disinformation is a multifaceted phenomenon that is deeply connected not only to literacy but also to the spatial and digital dimensions of belonging and agency. From this perspective, this chapter offers an alternative and complementary educational response to disinformation by combining Arendt's (1958) conceptualization of the *space of appearance*, de Certeau's (1984) post-structural approach to space, and Riley's (2013) leadership of place to put forward students' prefigurative and lifestyle politics as placemaking mechanisms at the school microscale.

Our professional experience in Greek public education during the early stages of our careers, our current academic positions and credentials in human geography and school leadership, and our personal experience with rising institutional distrust and increasing disinformation tactics in Greece place us in a valuable position to gain insights into the research questions.

8. FUTURE RESEARCH DIRECTIONS

This study relied on semi-structured interviews, which provided rich contextual insights into the Greek context but had inherent limitations regarding the generalization of results. Although the findings are consistent with previous research, the argument of this chapter could benefit from comparative studies across countries, longitudinal designs to track youth digital participation over time, or mixed-method approaches that integrate surveys and interviews.

REFERENCES

- Arendt, H. (1958). *The human condition*. Chicago: University of Chicago Press.
- Arendt, H. (1965). *On Revolution*. New York: The Viking Press.
- Arendt, H. (1971). Thinking and moral considerations: A lecture. *Social research*, 417-446.
- Ball, J. (2017). *Post-truth: How bullshit conquered the world*. London: Biteback Publishing.
- Bárta O., Boldt G., & Lavizzari A. (2021), *Meaningful youth political participation in Europe: concepts, patterns and policy implications*. EU-Council of Europe Youth Partnership, Council of Europe Publishing, Strasbourg. Retrieved from <https://edoc.coe.int/en/youth-in-europe/10301-meaningful-youth-political-participation-in-europe-concepts-patterns-and-policy-implications-research-study.html>
- Barzilai, S., & Chinn, C.A. (2020). A review of educational responses to the “post-truth” condition: Four lenses on “post-truth” problems. *Educational Psychologist*, 55(3), 107-119. <https://doi.org/10.1080/00461520.2020.1786388>
- Bennett, W. L. (1998). The uncivic culture: Communication, identity, and the rise of lifestyle politics. *PS: Political Science & Politics*, 31(4), 741-761.
- Braun, V., & Clarke, V. (2022). Conceptual and design thinking for thematic analysis. *Qualitative Psychology*, 9(1), 3-26. <https://doi.org/10.1037/qup0000196>
- Chan, W. Y., Ou, S. R., & Reynolds, A. J. (2014). Adolescent civic engagement and adult outcomes: An examination among urban racial minorities. *Journal of Youth and Adolescence*, 43(11), 1829-1843. <https://doi.org/10.1007/s10964-014-0136-5>
- Chinn, C.A., Barzilai, S., & Duncan, R. G. (2021). Education for a “post-truth” World: New directions for research and practice. *Educational Researcher*, 50(1), 51-60. <https://doi.org/10.3102/0013189x20940683>
- Cresswell, T. (2015). *Place: An introduction*. Oxford: Wiley Blackwell.
- Crowley, A., & Moxon, D. (2017). *New and innovative forms of youth participation in decision-making processes* (pp. 15-18). Strasbourg, France: Council of Europe. Retrieved from <https://edoc.coe.int/en/youth-in-europe/7625-new-and-innovative-forms-of-youth-participation-in-decision-making-processes.html>
- D'Ancona, M. (2017). *Post-truth: The new war on truth and how to fight back*. New York: Random House.
- De Certeau, M. (1984). *The practice of everyday life*. California: University of California Press.
- De Moor, J. (2017). Lifestyle politics and the concept of political participation. *Acta Politica*, 52(2), 179-197. <https://doi.org/10.1057/ap.2015.27>

- Deželan, T. (2023). *Young people's participation in European democratic processes. How to improve and facilitate youth involvement*. European Union. Retrieved from [https://www.europarl.europa.eu/thinktank/en/document/IPOL_STU\(2023\)745820](https://www.europarl.europa.eu/thinktank/en/document/IPOL_STU(2023)745820)
- Dimock, M. (2019). Defining generations: Where Millennials end and Generation Z begins. *Pew research center*, 17(1), 1-7. Retrieved from <https://www.pewresearch.org/short-reads/2019/01/17/where-millennials-end-and-generation-z-begins/>
- Dussault, J. (2022). The prefigurative politics of place-making: Analysis of a neighbourhood-based campaign for a social centre. *Emotion, Space and Society*, 44(2), 100901. <https://doi.org/10.1016/j.emospa.2022.100901>
- Ecker, U. K., Lewandowsky, S., Cook, J., Schmid, P., Fazio, L. K., Brashier, N., ... & Amazeen, M. A. (2022). The psychological drivers of misinformation belief and its resistance to correction. *Nature Reviews Psychology*, 1(1), 13-29. <https://doi.org/10.1038/s44159-021-00006>
- Elsner, M., Atkinson, G., & Zahidi, S. (2025). *Global Risks Report 2025*. Retrieved from <https://www.weforum.org/publications/global-risks-report-2025/>
- Eurobarometer Flash 545. (2024). *Youth and democracy Report*. European Union. Retrieved from https://ec.europa.eu/commission/presscorner/detail/en/ip_24_2569
- Janmaat, J. G., Hoskins, B., & Pensiero, N. (2022). *The development of social and gender disparities in political engagement during adolescence and early adulthood: what role does education play?*. Retrieved from <https://www.understandingsociety.ac.uk/research/publications/publication-557819/>
- Kissas, A., & Koulaxi, A. (2025). The Platformized Communication of Femicide in Greece: A Populist Critique of Gendered Violence from Feminist Community Pages on Social Media. *Violence Against Women*, 0(0). <https://doi.org/10.1177/10778012251401890>
- Pawluczuk, A. (2020). Digital youth inclusion and the big data divide: examining the Scottish perspective. *Internet Policy Review*, 9(2), 1-18. <https://doi.org/10.14763/2020.2.1480>
- Riley, K. (2013). *Leadership of place*. London: Bloomsbury Publishing.
- Riley, K. (2017). *Place, belonging and school leadership: Researching to make the difference*. London: Bloomsbury Publishing.
- Riley, K. (2022). *Compassionate leadership for school belonging*. London: UCL Press.
- Sack, R. D. (1983). Human territoriality: A theory. *Annals of the Association of American Geographers*, 73(1), 55-74. <https://doi.org/10.1111/j.1467-8306.1983.tb01396.x>
- Salto - Participation and Information. (2020). *Youth Participation Strategy*. Retrieved from <https://participationpool.eu/resource/youth-participation-strategy/>
- Sassen, S. (2013). When territory deborders territoriality. *Territory, Politics, Governance*, 1(1), 21-45. <https://doi.org/10.1080/21622671.2013.769895>
- Seifert, A., & Rössel, J. (2019). Digital Participation. In D. Gu, & M. E. Dupre (Eds.), *Encyclopedia of Gerontology and Population Aging* (pp. 1-5). Cham: Springer. https://doi.org/10.1007/978-3-319-69892-2_1017-1
- Sloam, J. (2013). 'Voice and equality': Young people's politics in the European Union. *West European Politics*, 36(4), 836-858. <https://doi.org/10.1080/01402382.2012.749652>
- Sloam, J. (2016). Diversity and voice: The political participation of young people in the European Union. *The British Journal of Politics and International Relations*, 18(3), 521-537. <https://doi.org/10.1177/1369148116647176>
- Strauss, A., & Corbin, J. (1990). *Basics of qualitative research*. Thousand Oaks, CA: SAGE.
- Törnberg, A. (2021). Prefigurative politics and social change: A typology drawing on transition studies. *Distinktion: Journal of Social Theory*, 22(1), 83-107. <https://doi.org/10.1080/1600910X.2020.1856161>
- World Bank. (2022). *World Bank blogs. We are losing a generation: The devastating impacts of COVID-19*. Retrieved from <https://blogs.worldbank.org/en/voices/we-are-losing-generation-devastating-impacts-covid-19>
- Yates, L. (2021). Prefigurative politics and social movement strategy: The roles of prefiguration in the reproduction, mobilisation and coordination of movements. *Political Studies*, 69(4), 1033-1052. <https://doi.org/10.1177/0032321720936046>

- Yurttagüler, L., & Deželan, T. (2021), Shrinking democratic civic space for youth. *Council of Europe*, 1-35. Retrieved from cb8643c1-2707-0f1b-3f81-f13704dc9081.
- Zamfir, I. (2025). *Violence against women in the EU. State of play in 2025*. EPRS, European Parliamentary Research Service. PE 772.921. Retrieved from [https://www.europarl.europa.eu/RegData/etudes/BRIE/2025/772921/EPRS_BRI\(2025\)772921_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2025/772921/EPRS_BRI(2025)772921_EN.pdf)
- Zhang, W. (2022). Political disengagement among youth: A comparison between 2011 and 2020. *Frontiers in Psychology*, 13, 809432. <https://doi.org/10.3389/fpsyg.2022.809432>

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Chapter # 20

A RELATIONAL FRAMEWORK FOR PROFESSIONAL DEVELOPMENT IN RURAL SCIENCE EDUCATION: Integrating Ubuntu, indigenous knowledge, & inquiry-based practice

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ABSTRACT

This chapter examines how collaborative professional development can enhance Life Sciences teachers' practical work competencies in rural South African schools by integrating Indigenous Knowledge Systems, Ubuntu, and inquiry-based practice. The qualitative case study involved 25 Grade 10 and 11 teachers from twelve resource-constrained rural schools who were both convenient and purposively sampled. Data was generated through video and audio recorded observations, fieldnotes, focus group discussions, and written artefacts, which were all analysed thematically using constant comparison and triangulation. Findings reveal that teachers reconceptualised practical work when exposed to culturally grounded, embodied activities, such as *ingoma* (Zulu song/singing) and *ukugida* (Zulu dance), which linked communal cultural practices to scientific inquiry. Collaborative mapping of Indigenous Knowledge System-based practicals fostered professional creativity, epistemic engagement, and teacher agency, while Ubuntu principles underpinned relational learning, emphasising collective reflection, mentorship, and shared responsibility. Structural constraints, including workload, limited resources, and policy rigidity, were identified as barriers to sustained innovation. The chapter argues that sustainable PD in rural contexts requires recognising learners, teachers and subject advisors as pedagogical partners and knowledge brokers, creating relational, culturally responsive spaces that transform both teacher practice and the enactment of practical work in Life Sciences classrooms.

Keywords: life sciences education, teacher professional development, indigenous knowledge systems, rural education, Ubuntu; inquiry-based learning.

1. INTRODUCTION

Practical investigations are central to the South African Life Sciences curriculum because they cultivate learners' inquiry skills, scientific reasoning, and capacity to interpret empirical data (Department of Basic Education (DBE), 2011). Despite this emphasis, provincial diagnostic reports and school assessments consistently show underperformance in questions requiring experimental design, data analysis, and interpretation. Resource scarcity, teacher isolation, and short-term, exam-oriented workshops are frequently cited as contributing factors (Chuene & Xaba, 2024; Xaba et al., 2022, 2025), yet less attention has been paid to how professional development (PD) interacts with local epistemologies and the daily routines of rural classrooms. Rural teachers often negotiate between formal scientific knowledge and learners' cultural beliefs, practices, and lived experiences, resulting in practical work that is decontextualised or fails to leverage learners' prior knowledge and cultural capital.

Meaningful integration of IKS into Life Sciences education requires more than the addition of content, it demands pedagogical strategies that are inquiry-driven, contextually responsive, and culturally sensitive (Mlotshwa & Tsakeni, 2024). Such strategies foster collaboration, reflective learning, and ubuntu, emphasising relationality and collective growth among teachers and learners. However, rural teachers frequently lack targeted PD that equips them to enact these strategies effectively, limiting their ability to create meaningful, contextually relevant learning experiences. This chapter reports an empirical investigation that addresses these gaps by examining how a collaboratively designed PD programme influenced teachers' abilities to enact practical work in resource-constrained rural contexts.

The guiding research question for this empirically oriented chapter is the following: How can Life Sciences teachers' practical work competencies be enhanced through a collaboratively designed professional development programme that draws on inquiry practice, local indigenous knowledge, and ubuntu-informed relations, and what evidence demonstrates that change has occurred? This chapter proposes a relational professional development framework that is conceptually distinct from skills-based or compliance-oriented PD models. Rather than treating Ubuntu, IKS, and inquiry-based practice (IBP) as separate or additive approaches, the chapter theorises their integration as an ethical-epistemic-methodological configuration shaping how teachers learn, collaborate, and enact practice in rural science classrooms. Drawing from empirical evidence from a collaboratively designed PD initiative, the chapter demonstrates how relational conditions (Ubuntu), epistemic grounding (IKS), and pedagogical process (IBP) operate together to support meaningful and sustainable teacher learning and PD in under-resourced contexts.

2. THEORETICAL FRAMEWORK: SITUATING PROFESSIONAL DEVELOPMENT IN RURAL CONTEXTS

PD in rural South African contexts cannot be understood solely as formal workshops or policy compliance (Xaba, 2025). Scholars increasingly argue that teacher learning in these settings is relational, socially situated, and mediated by local knowledge systems (Hoadley & Jansen, 2018; Reddy & Motala, 2020). Rural teachers negotiate professional growth within resource constraints, cultural norms, and daily classroom practices, suggesting that effective PD must extend beyond technical skill-building to encompass ethical, epistemic, and pedagogical dimensions. In this chapter, a relational lens is adopted to conceptualise PD as emergent through collaborative, inquiry-oriented, and contextually responsive practices, integrating Ubuntu as an ethical framework, IKS as an epistemic resource, and Inquiry-Based Practice (IBP) as a methodological approach.

2.1. Ubuntu: Relational-Ethical Orientation

Ubuntu, commonly articulated as *umuntu ngumuntu ngabantu*, which translates as "a person is a person through others" and foregrounds interdependence, mutual respect, as well as collective responsibility in human interactions (Ngubane & Makua, 2021; Ramose, 1999). Within African philosophical thought, Ubuntu is both an ethical orientation and a social ontology, highlighting relationality as the foundation of knowledge, identity, and moral responsibility. In education scholarship, Ubuntu has been increasingly theorised as informing humanising pedagogies, culturally responsive teaching, and relationally grounded professional learning (Letseka, 2012; Radebe, 2023; Swanson, 2012).

Applied to teacher PD, Ubuntu reframes learning as a socially mediated process, where professional growth emerges through interactions, peer networks, mentorship, and collective reflection. In rural contexts, where teachers often face professional isolation, limited resources, and socio-cultural constraints, Ubuntu offers a framework for understanding how collaboration, trust, and mutual support can sustain teacher learning (Chikoko, 2013; Sayed, 2017). Empirical studies suggest that Ubuntu-informed PD cultivates relational resilience, encourages reflective practice, and fosters a sense of communal responsibility in education, enabling teachers to negotiate challenges collaboratively rather than individually (Radebe, 2023; Swanson, 2012).

2.2. Indigenous Knowledge Systems: Contextual and Epistemic Grounding

IKS encompass the locally rooted knowledge, practices, beliefs and technologies of communities, transmitted across generations and embedded within ecological, medicinal, agricultural and social contexts (Ahanonye, 2021; Hlalele, 2019). Such systems offer an epistemological foundation for situating science teaching within the cultural and ecological lifeworld's of learners (Mlostwa et al, 2024). In science education literature, IKS has been shown to enhance curricular relevance, learner engagement and epistemic diversity by legitimising forms of knowledge commonly marginalised in Western-centric schooling paradigms (Blackie, 2024; de Beer, 2012). For example, studies in South Africa reveal that integration of IKS can help bridge learners' everyday knowledge with formal scientific inquiry, thereby supporting stronger conceptual connections (Elekwa, 2022, 2024). Within PD contexts, IKS provides educators with tools to integrate local knowledge such as medicinal plants, agricultural knowledge, and traditional food preparation methods into Life Sciences instruction, not as superficial add-ons but as legitimate knowledge forms that complement scientific inquiry (Ahanonye, 2021; Handayani et al., 2019). By adopting IKS as a theoretical lens, PD can empower teachers to validate learners' cultural and social knowledge, thereby fostering pedagogical confidence and agency in rural contexts. In effect, IKS addresses both the "what" (the content grounded in local knowledge) and the "why" (the relevance and legitimacy of that content) of teaching and professional learning. For rural Life Sciences classrooms, where learners and teachers often operate within resource-constrained and culturally complex settings, integrating IKS means positioning teachers as custodians and translators of community knowledge into scientifically informed practice.

2.3. Inquiry-Based Practice: Methodological Dimension

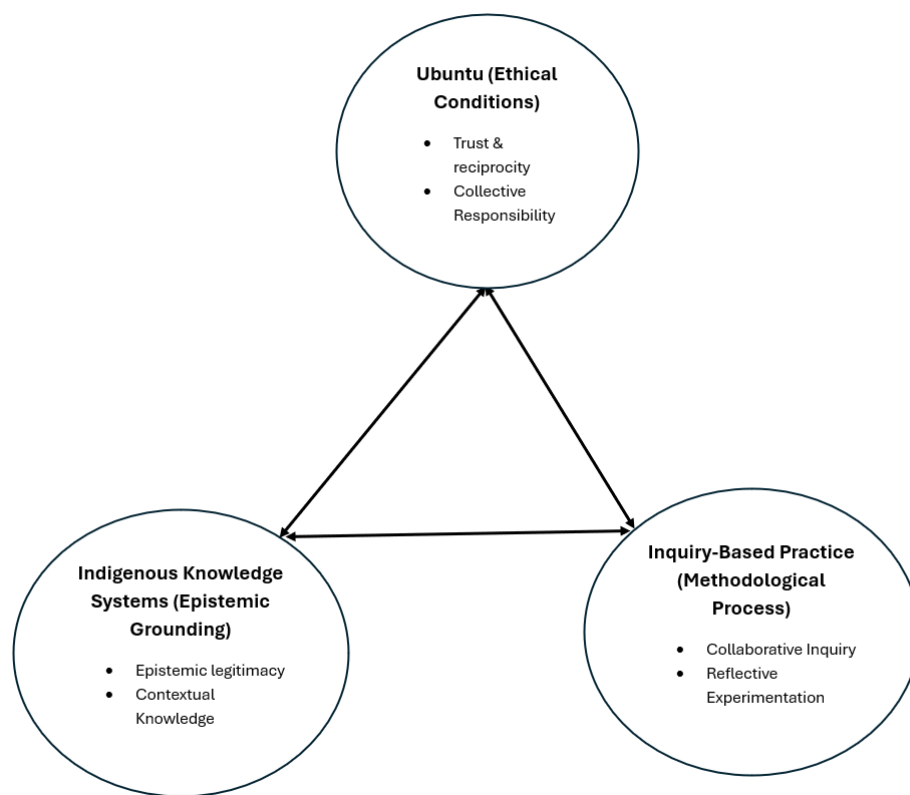
IBP positions teacher learning as an iterative, reflective, and participatory process that emphasises active engagement with content, learners, and the classroom environment (Scheurman & Marcon-Toutant, 2021). Rooted in constructivist principles, IBP frames knowledge construction as a dynamic cycle of questioning, experimentation, observation, reflection, and refinement (Crawford & Capps, 2018; Tal et al., 2019; Van Dusen et al., 2012). In the context of professional development, IBP shifts the focus from passive knowledge transmission to participatory, teacher-centred learning, where educators collaboratively explore pedagogical strategies, test classroom interventions, and reflect on outcomes to inform future practice (Kang & Kim, 2020; Krajcik & Blumenfeld, 2006).

Research indicates that IBP enhances both teacher and learner engagement by fostering critical thinking, and problem-solving skills (Crawford, 2014). In rural and resource-constrained settings, IBP is particularly valuable because it encourages teachers to co-design investigations using locally available materials and to adapt lessons to cultural and

environmental contexts (Tal et al., 2019; Van Driel et al., 2014). Such approaches not only support culturally responsive pedagogy but also empower teachers to integrate IKS into science teaching, bridging formal scientific concepts with learners lived experiences (Handayani et al., 2019; Mlotshwa et al., 2024).

In this chapter, Ubuntu (ethical condition), IKS (epistemic grounding), and IBP (methodological process) are conceptualised as mutually constitutive dimensions of PD rather than parallel theoretical lenses as illustrated in Figure 1 below.

Figure 1.
The relationship between Ubuntu, IKS and IBP as frameworks situating PD in rural contexts.



Together, these perspectives frame PD as relational, contextually grounded, and inquiry-driven, informing both the design of programme and the interpretation of empirical findings.

3. METHODOLOGY

This study adopted a Participatory Action Research (PAR) design embedded within a larger PD initiative facilitated by the University of Zululand in collaboration with the KwaZulu-Natal Department of Education. PAR was chosen because it prioritises collaboration, reflexivity, and shared ownership of knowledge, which are key principles that

resonate with Ubuntu and inquiry-based learning. The design followed iterative cycles of planning, action, observation, and reflection (Creswell, 2014), allowing the project to remain responsive to teachers' evolving needs and contextual realities.

Twenty-five Grade 10 and 11 Life Sciences teachers from twelve rural secondary schools in Zululand District participated in the study. Selection was purposive, focusing on schools characterised by resource scarcity, poor learner performance in School-Based Assessments (SBAs) for practical work, and geographic isolation. Teaching experience ranged from one to twenty-five years, capturing both novice and experienced perspectives. Four workshop cycles were conducted over one academic year, each comprising two-day sessions. Data was collected through:

- i. Observations and filed notes which were taken during the workshop sessions
- ii. Focus group sessions where participants and facilitators discussed ideas shared during the workshops
- iii. Reflective discussions following each workshop cycle, where teachers evaluated activities and suggested improvements
- iv. Written artefacts from groups which provided insights into teacher collaborative thinking and/or ideas

All the data was video and audio-recorded, transcribed verbatim, and analysed thematically. Qualitative data were summarised descriptively to identify broad patterns of teacher development across the year. Ethical clearance was granted by the University of Zululand Research Ethics Committee and the KwaZulu-Natal Department of Education. Informed consent was obtained from all participants, pseudonyms were used, and confidentiality was maintained throughout.

4. RESULT AND FINDINGS

To answer the research question which guided the study: How can Life Sciences teachers' practical work competencies be enhanced through a collaboratively designed PD programme that draws on inquiry practice, local indigenous knowledge, and ubuntu-informed relations, and what evidence demonstrates that change has occurred?

Three interrelated themes emerged from the data as follows:

- i. Re-imagining practical work through cultural lenses
- ii. Professional growth through collaborative inquiry and reflection
- iii. Ubuntu as a foundation for transformative PD

These themes collectively illustrate how inquiry-based learning, IKS, and ubuntu can serve as interdependent frameworks for advancing teacher PD in rural Life Sciences education.

4.1. Re-imagining Practical Work Through Cultural Lenses

Across all data sources, participants demonstrated a profound epistemic shift in how they conceptualised Life-Sciences practical work particularly after engaging with a video recording of an Honours student conducting a culturally grounded practical on the circulatory system. The student used *ingoma* (Zulu song) and *ukugida* (Zulu dance) as embodied pedagogical tools to explore variations in heart rate and pulse during physical activity for their assignment presentation. This demonstration operated simultaneously as a scientific experiment and a cultural artefact that provoked deep reflection on the meaning of inquiry-based learning in African rural contexts.

During the recorded session (video observation), participants measured their pulse rates and listened to their heartbeats before and after dancing, recording data at intervals of 5, 10, 15, and 20 minutes using a stethoscope as shown in figure 2.

Figure 2.
Teachers working together during a practical task.



The teachers were also asked to repeat the steps without using the stethoscope but instead using their finger and ears to count the heartbeat and pulse rate. Their visible engagement depicted by laughter, collective counting of heartbeat and pulse rates signalled a genuine shift from passive reception to participatory and embodied learning. The integration of *ukugida* (**Zulu dance**) transformed the abstract notion of ‘practical work’ into a culturally resonant, community-based activity that connected bodily experience with scientific reasoning.

In the subsequent focus group discussion, teachers reflected on whether IKS could bridge the gap in practical work. The transcripts and field notes captured powerful expressions of conceptual transformation. One teacher reflected:

“If CAPS clearly stated these guidelines, or maybe if the Department trained us to think like this, then there would be no excuse for us not to do practicals using our Indigenous Knowledge and available resources.”

This statement highlighted both systemic constraints and untapped pedagogical potential, revealing how teachers’ dependence on curriculum directives contrasts with their recognition that IKS can provide low-cost, contextually meaningful opportunities for conducting practical work in resource-limited communities. Another teacher expressed:

“Actually, this is a brilliant idea. Look at how our cultural practice such as ukugida [Zulu dance] can be used as a practical activity. My learners always sing Zulu songs and dance during break time, but it never occurred to me that I could use that in class as a practical. It requires very minimal resources; the learners themselves are a resource. I really enjoyed this, and it has opened my ears.”

Written artefacts from the group work corroborated these reflections, with teachers linking ukugida [Zulu dance] to Life Sciences topics such as the circulatory system, cellular respiration, and energy transformation. They identified other IKS-based practices such as fermenting umqombothi [African beer] and amahewu [porridge], preparing ujeqe [steamed bread], and ukubasa komlilo ngekhandlela [fire making using a candle] instead of Bunsen burners as other locally accessible alternatives to formal laboratory practicals to mention a few. These triangulated data sources (video observation, focus group discourse, and artefact analysis) collectively evidenced a paradigm shift in how teachers understood the purpose and possibilities of practical work in the IKS lens.

Interpreting these findings through the lenses of cultural inquiry-based learning and Ubuntu epistemology reveals the deep pedagogical significance of this shift. The ingoma [Zulu song/singing] practical exemplified key stages of scientific inquiry skills such as observation, prediction, testing, and explanation, yet it did so through a communal and embodied process aligned with Ubuntu principles of interdependence and shared knowledge creation. This supports Ogunniyi's (2007) assertion that African epistemologies can serve as mediating tools for scientific reasoning when engaged dialogically and resonates with Pedaste et al.'s (2015) model of inquiry as a contextual, evidence-based process of meaning-making.

However, not all responses were uncritical. Some participants raised legitimate concerns about policy alignment and assessment standards, noting that:

“We can do this, but CAPS doesn't show how to assess this IKS. We might be questioned for not following the policy strictly and sometimes time constraints are also a factor. But there is potential if all stakeholders buy into this idea, at least our subject advisor is also here....”

This tension highlights the persistent structural barriers that limit innovation in science teaching, particularly in rural contexts where accountability pressures and limited training constrain teachers' agency. The findings, therefore, shows the need for PD models that legitimise and institutionalise IKS-driven inquiry as a valid form of practical work, rather than treating it as a supplementary or informal approach.

4.2. Growth Through Collaborative Inquiry and Reflection

Building on the momentum generated by the *ingoma* and *ukugida* practical, teachers were divided into small groups and tasked with identifying ways IKS could be integrated into Life Sciences topics they currently teach as depicted by Figure 3.

Figure 3.
Teachers working in groups discussing ideas.



This activity functioned as both a collaborative reflection exercise and a practical application of the insights gained from the earlier demonstration. It provided a critical third layer of triangulation by capturing written artefacts, dialogue excerpts, and observed group interactions. The group task revealed strong evidence of emerging pedagogical innovation. Teachers drew direct connections between cultural practices and curriculum topics, generating a repertoire of contextually grounded practical ideas. For example, one group proposed linking food and nutrition to traditional foods such as ujeqe [Steamed bread], umqombothi [African beer], and usu [Tripe], suggesting these could be used to demonstrate concepts such as starch testing, fermentation, and enzymatic activity to mention a few. Another group mapped the topic of ecosystems to local indigenous plants and animals, proposing that learners investigate ecological interactions through direct observation of familiar species. Similarly, cellular respiration was connected to the fermentation of umqombothi [African beer], while photosynthesis was linked to indigenous flora such as umkhanyakude [*Vachellia xanthophloea*/yellow bark/fever tree], which could be used in simple experimental setups to test for the presence of starch in leaves.

These examples demonstrated a tangible move from theoretical endorsement of IKS to the practical re-imagining of laboratory work in resource-limited schools. What emerged across the groups was a shared realisation that authentic scientific inquiry does not rely on expensive apparatus or Western-standard laboratories; rather, it can draw meaningfully on locally available materials and lived experiences. The act of mapping their ideas collectively also revealed a social dimension to knowledge construction. Experienced teachers often took on mentoring roles, guiding novice teachers through the process of aligning indigenous practices with scientific concepts, which was an enactment of *Ubuntu* informed professional learning in real time. Field notes captured several “*aha moments*” during this phase, particularly among younger or less experienced participants who admitted they had never

considered the possibility of transforming routine cultural practices into scientific investigations. As one novice teacher noted, *“I’ve always thought practical work means having microscopes or chemicals, but now I see that practicals can start from what we already know and do in our communities.”* This insight signifies more than resourcefulness; it signals a deepened epistemological understanding of science as a living practice embedded in cultural and ecological contexts.

When analysed collectively, these artefacts and reflections suggest that collaborative IKS-based curriculum mapping not only generated practical teaching ideas but also functioned as PD that was essential in cultivating teachers’ confidence, creativity, and sense of agency. Interpreting these findings through IBP and Ubuntu frameworks, the collaborative exercise exemplified socially mediated professional learning. Inquiry, as conceptualised by Pedaste et al. (2015), is iterative, dialogic, and context sensitive. When embedded in Ubuntu-informed communities of practice, it transcends individual cognition, fostering shared meaning-making and mutual growth (Letseka, 2013). The teachers’ dialogue and artefacts reflected this relational epistemology: knowledge was not transmitted but co-constructed through collective reflection on lived experiences.

4.3. Ubuntu as a Foundation for Transformative Professional Development

Ubuntu principles were visible not only in participants’ reflections but in their interactions throughout the workshop. The video recordings captured collective singing, rhythmic unity, and spontaneous cooperation, which all are symbolic of communal learning. During focus group discussions, one teacher explained: *“We learn better when we teach each other; this reminded us that knowledge grows when it is shared and actually collaboratively, we have the potential of solving our problems.”*

Other phrases such as *“We supported each other”* and *“Our strength is togetherness”* frequently appeared in the transcripts and/or analysis. These expressions demonstrate ubuntu’s enactment as a lived professional value. Ubuntu provided moral and epistemic grounding for teachers’ engagement. It transformed PD from an externally imposed intervention into a community of care and mutual accountability, echoing Letseka’s (2013) and Waghid’s (2018) assertions that ubuntu-based education nurtures human relationships as sites of knowledge creation. By weaving ubuntu into PD, teachers positioned themselves not as recipients of expert knowledge but as *custodians of collective wisdom*. This model of PD aligns with the decolonial imperative articulated by Le Grange (2019) that African education systems must reclaim relationality and interconnectedness as legitimate epistemic values.

5. FUTURE RESEARCH DIRECTIONS

The findings of this study highlight two avenues for future research aimed at deepening understanding of relational, culturally grounded PD in rural Life Sciences education as follows: (i) **Scaling Ubuntu-Informed PD Models:** Future research should explore the applicability of Ubuntu-informed, IKS-integrated PD across diverse rural contexts. Comparative studies across provinces could illuminate how socio-cultural and ecological variations shape teachers’ adoption of inquiry-based practices and IKS and (ii) **Policy Alignment and Institutional Support:** Research should examine strategies to institutionalise culturally grounded PD including alignment with the CAPS, formal recognition of subject advisors as pedagogical partners, and integration into provincial PD frameworks. By addressing these directions, research can further consolidate a relational framework for sustainable, contextually relevant science education, promoting both professional and epistemic justice in rural South African classrooms.

6. CONCLUSION/DISCUSSION

The triangulated findings of this study point to a significant re-conceptualisation of Life Sciences practical work and, by extension, teacher PD in rural South Africa. By embedding inquiry within culturally grounded practices such as *ingoma* and *ukugida* [***Zulu singing and dancing***] or any cultural activity for that matter, the study demonstrates how IKS can serve as powerful mediating tools for fostering epistemic access, pedagogical creativity, and professional growth. The collective learning process which anchored in Ubuntu philosophy seemed to have redefined practical work not as a procedural or laboratory-bound exercise, but as a relational, embodied, and contextually meaningful experience.

At a conceptual level, these findings challenge the dominant paradigm of science education, which often privileges decontextualised, Western-oriented conceptions of inquiry (Le Grange, 2019; Jegede, 1995). The participating teachers' reflections illustrate that inquiry, when rooted in familiar cultural practices, becomes more than an instructional method, it becomes a way of knowing. The *ingoma* [***Zulu singing and dancing***] practical exemplified inquiry cycles (observation, prediction, testing, and explanation) while simultaneously invoking communal participation and embodied understanding. In doing so, it blurred the boundaries between "scientific" and "cultural" knowledge, supporting Ogunniyi's (2007) argument that African epistemologies can mediate scientific reasoning when engaged dialogically. Importantly, the PD that occurred during this process was not externally imposed but emerged organically through collective participation. The teachers' collaborative mapping of IKS-based practicals illustrated what Cochran-Smith and Lytle (2009) describe as inquiry as stance as a disposition where teachers become researchers of their own practice. Through shared dialogue and reflection, teachers co-constructed new understandings of curriculum integration and practical pedagogy that were both scientifically valid and culturally grounded. This aligns with the Ubuntu principle of "*umuntu ngumuntu ngabantu*," which is the idea that professional growth is relational, sustained through mutual recognition, and achieved collectively rather than individually.

The findings also highlight that meaningful PD must transcend the conventional workshop model that focuses narrowly on procedural skills. Instead, it should create dialogic spaces that legitimise local epistemologies and allow teachers to interrogate their own assumptions about what counts as science. The teachers' "aha moments" during the collaborative mapping exercise illustrate that empowerment arises when PD is both epistemologically inclusive and contextually relevant. As Letseka (2013) argues, Ubuntu-based learning communities cultivate moral and intellectual agency by affirming the interconnectedness of knowledge, and humanity. However, the study also exposes persistent systemic tensions. Teachers' apprehension about assessment and policy alignment reflects the structural rigidity of the CAPS, which leaves limited room for contextualised innovation. This reveals a broader institutional challenge; PD initiatives often prepare teachers to comply rather than to transform. Without explicit policy support, even the most creative and culturally relevant approaches risk marginalisation. This echoes Chisholm's (2019) critique that curriculum reform in South Africa has not sufficiently integrated indigenous epistemologies into the operational structures of teaching and assessment.

This study has several limitations, for example, the findings are based on a small group of rural Life Sciences teachers participating in a context-specific PD initiative and therefore do not claim statistical generalisability. However, the study's purpose was analytical rather than representative, aiming to generate theoretically informed insights into relationally grounded PD. The value of the framework lies in its conceptual transferability rather than direct replication. Practically, the framework offers guidance for universities, subject

advisors, and professional learning communities seeking culturally responsive and sustainable PD models. At a policy level, the study highlights the need to move beyond one-size-fit all PD approaches toward contextually responsive and collaborative teacher development.

REFERENCES

- Ahanonye, U. A. (2021). *Teachers' indigenous knowledge and the possibilities of integrating it with Life Sciences teaching and learning in the classroom context* (Doctoral dissertation, University of the Witwatersrand).
- Blackie, M. (2024). *Epistemic diversity and learner engagement: Integrating local knowledge into science classrooms*. South African Journal of Education, 44(1), 1–12. <https://doi.org/10.15700/saje.v44n1a2024>
- Chikoko, V. (2013). Teacher professional learning communities in rural schools: A study of collegial support. *Teaching and Teacher Education*, 36, 128–136. <https://doi.org/10.1016/j.tate.2013.07.004>
- Chuene, S., & Xaba, N. (2024). Teacher development and practical work in rural Life Sciences classrooms: Challenges and opportunities. *African Journal of Teacher Education*, 12(2), 77–92.
- Cochran-Smith, M., & Lytle, S. (2009). *Inquiry as stance: Practitioner research for the next generation*. Teachers College Press.
- Crawford, B. A. (2014). From inquiry to scientific practices in the science classroom. *Science Education*, 98(6), 1001–1027. <https://doi.org/10.1002/scs.21141>
- Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE Publications.
- Crawford, B. A., & Capps, D. K. (2018). Teacher cognition of engaging children in scientific practices. In Y. J. Dori, Z. R. Mevarech, & D. R. Baker (Eds.), *Cognition, metacognition, and culture in STEM education* (pp. 9–32). Springer.
- de Beer, J. (2012). Exploring indigenous knowledge for curriculum relevance in South African schools. *Journal of Education*, 56, 105–123.
- Department of Basic Education. (2011). *Curriculum and Assessment Policy Statement (CAPS): Life Sciences Grades 10–12*. Pretoria: Government Printing Works. Available at <https://www.education.gov.za>
- Elekwa, C. (2022). Integrating African knowledge systems into science education: Pedagogical strategies and challenges. *International Journal of Science Education*, 44(3), 381–398. <https://doi.org/10.1080/09500693.2022.2031102>
- Elekwa, C. (2024). Epistemic access through Indigenous Knowledge Systems: Lessons from rural classrooms. *South African Journal of Science Education*, 28(1), 59–74.
- Handayani, R. D., Wilujeng, I., Prasetyo, Z. K., & Triyanto. (2019). Building an indigenous learning community through lesson study: Challenges of secondary school science teachers. *International Journal of Science Education*, 41(3), 281–296. <https://doi.org/10.1080/09500693.2018.1548789>
- Hlalele, D. (2019). *Culturally responsive pedagogy in rural contexts: Implications for teacher development*. Springer. <https://journal.spera.asn.au>
- Hoadley, U., & Jansen, J. (2018). *Curriculum: Organising knowledge for the classroom* (3rd ed.). Oxford University Press.
- Jegede, O. J. (1995). Impact of cultural context on science teaching and learning in developing countries. *International Journal of Science Education*, 17(5), 521–534. <https://doi.org/10.1080/0950069950170507>
- Kang, H., & Kim, S. (2020). Inquiry-based learning and teacher professional development: Fostering reflective practice. *Asia-Pacific Education Researcher*, 29(3), 187–197. <https://doi.org/10.1007/s40299-019-00481-2>
- Krajcik, J., & Blumenfeld, P. (2006). Project-based learning. In R. K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 317–334). Cambridge University Press.

- Le Grange, L. (2019). *Decolonising the university curriculum*. Routledge.
- Letseka, M. (2012). Educating for Ubuntu: Lessons from African philosophy. *Journal of Philosophy of Education*, 46(3), 337–354. <https://doi.org/10.1111/j.1467-9752.2012.00872.x>
- Mlotshwa, T., & Tsakeni, M. (2024). Indigenous knowledge integration into Life Sciences: Pedagogical strategies for rural classrooms. *African Education Review*, 21(1), 45–62. <https://doi.org/10.1080/18146627.2024.1876542>
- Ngubane, N., & Makua, M. (2021). Ubuntu pedagogy—transforming educational practices in South Africa through an African philosophy: From theory to practice. *Inkanyiso: Journal of Humanities and Social Sciences*, 13(1), 1–12.
- Ogunniyi, M. (2007). Indigenous knowledge and science education in Africa: Cognitive, cultural, and pedagogical implications. *International Review of Education*, 53(5-6), 593–612. <https://doi.org/10.1007/s11159-007-9063-8>
- Pedaste, M., et al. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. *Educational Research Review*, 14, 47–61. <https://doi.org/10.1016/j.edurev.2015.02.003>
- Radebe, T. (2023). Ubuntu-informed professional learning communities in rural schools. *South African Journal of Education*, 43(1), 1–13.
- Reddy, V., & Motala, S. (2020). *Teacher professional development in rural South Africa: Challenges and prospects*. HSRC Press.
- Scheurman, G., & Marcon-Toutant, H. (2021). A review and blueprint application of the inquiry design model. *Theory and Research in Social Education*, 49(1), 1451–52.
- Swanson, D. M. (2012). Ubuntu and the ethics of teaching. *Educational Philosophy and Theory*, 44(9), 965–978. <https://doi.org/10.1111/j.1469-5812.2011.00790.x>
- Tal, T., Bar, R., & Morag, O. (2019). Inquiry-based learning in science education: Teacher development in rural schools. *Journal of Science Teacher Education*, 30(8), 897–916. <https://doi.org/10.1080/1046560X.2019.1666102>
- Van Dusen, B., et al. (2012). Inquiry-based professional development for teachers: Designing and implementing reflective cycles. *International Journal of Science Education*, 34(11), 1649–1670. <https://doi.org/10.1080/09500693.2011.650773>
- Waghid, Y. (2018). Ubuntu as a philosophy of education for democracy in Africa. *Educational Philosophy and Theory*, 50(14), 1361–1370. <https://doi.org/10.1080/00131857.2017.1407403>
- Xaba, N. (2025). Examining the role of Life Sciences subject advisors in collaborative teacher professional workshops: A multiple case study of northern KwaZulu-Natal. In *Education and New Developments* (pp. 190–194). <https://doi.org/10.36315/2025v2end040>
- Xaba, N., & Sondlo, A. (2022). Using a learner-based activity approach in developing science teachers' readiness in inquiry-based learning. In *Education and New Developments* (pp. 340–343). <https://doi.org/10.36315/2022v1end077>

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Chapter # 21

“DOES IT SAVE TIME AND MAKE YOU SMARTER?” – LESSONS LEARNED FROM A WORKSHOP DEVELOPING TEACHERS’ PROMPTING COMPETENCE WITH CHATGPT

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ABSTRACT

The use of generative AI (GenAI) such as ChatGPT highlights the need for educators to develop novel critical competencies. We present a process-oriented approach for developing teachers’ prompting competence – the ability to formulate effective instructions to GenAI tools – and our first evaluation of its implementation in a workshop for teachers in higher education. We argue for an “anti-shortcut” approach, meaning that effective AI use requires slowing down, reflecting, and collaboratively refining one’s interactions to reach desirable outcomes. 15 teachers participated in the workshop, which focused on a typical professional task (assessing student essays) using stepwise prompts in ChatGPT. The participants were instructed to use ChatGPT or similar GenAI tool to grade a short student essay, using a scoring rubric, and to write some feedback to the student. The GenAI output was then compared to a human professional assessment of the same text. As part of developing the teachers’ skills, we introduced the strategies “prompt chaining” and “few-shot prompting”. The participants were asked to revise and improve their prompts, so that the GenAI assessment matched that of the human as closely as possible. The results fueled a discussion on teachers’ use of GenAI, from which we report some key insights.

Keywords: generative AI, GenAI, teacher training, higher education, ChatGPT, prompting.

1. INTRODUCTION

There is no doubt that generative artificial intelligence, or GenAI, is drastically changing educational practices. However, users are still in the adaptation phase of embracing the technology – some with more hesitation than others, partly reflected in the title quote by one teacher – and it is becoming equally apparent that the extent and types of uses of GenAI vary widely between different academic institutions, as well as between individual teachers and students within the same institution. The academic literature can hardly keep up to date with this development. Some practice-oriented books quickly followed the unprecedented success of ChatGPT 3.5 (e.g. Hunter, 2023; as the author notes in the introduction, ChatGPT took five days to reach one million users; Instagram took 2.5 months and Netflix took 14 months).

An emerging core competence is so-called “prompt engineering” – that is, how instructions to the GenAI can be effectively formulated and improved – which inspired our present proposal for increasing teachers’ prompting competence in relation to student work (which itself may involve using GenAI). Considering that presented examples of outcomes and limitations may become outdated already at the time of publication as the technology advances, we hold that any prescribed guidelines should be combined with actual training

sessions to maintain their relevance and applicability. Therefore, rather than presenting empirical findings from our own work, or a ready-made recipe for teachers to follow, we chose a process-oriented approach in the form of a workshop, which aims to develop the participants' current knowledge of the present technology (in this case, the most used version of ChatGPT) in relation to a benchmark set by human professionals.

In this chapter, we present the outline of such a workshop, and its first implementation with teachers in higher education. There were two points we found particularly worth considering in preparation. First, we hold that human teachers remain the experts in their field, but that they may learn how to use GenAI, such as ChatGPT, for carrying out certain educational tasks, such as assessing a student text, more effectively, while maintaining their professional standards and integrity. To achieve this, teachers must learn how to prompt properly and gauge GenAI output judiciously. Second, we must consider the pitfalls associated with achieving deceptively quick results with technology that could mislead users to taking shortcuts and by-pass their critical thinking (Zhai et al., 2024). In other words, we must think before we act. The idea of a “collective anti-shortcut approach” warrants some elaboration before we describe its actual implementation and lessons learned from the workshop.

2. BACKGROUND

2.1. Rationale: The Problem of Shortcuts

Humans are wired to seek efficiency. In cognitive psychology, this tendency manifests as the use of heuristics, in the form of mental shortcuts that save time and effort. We believe that people – teachers and students included – are entitled to take shortcuts in known territories, in order to reach their goals faster and in the service of others. For students, this could mean using ChatGPT for explaining a concept they did not understand from the teacher, rather than having to ask the teacher again (if at all possible). For teachers, it could mean using ChatGPT for constructing or making an assessment, to free up their time and resources for helping students learn rather than just assessing them. In both cases, it is assumed that the user already has the required skill (asking for help, constructing a test) which has been preceded by much longer learning (going to school, taking a research degree). Importantly, what is being produced (knowledge) must not be confused with the process of production (learning).

Whereas productivity gains with GenAI can be quick, human learning is slow and requires time for reflection and adaptation. Taking shortcuts using AI can therefore become epistemic traps, bypassing critical thinking, verification, and creativity. There is overwhelming evidence that humans resist mental effort when they can (Willingham, 2009), and that hard thinking is generally associated with negative affect (David et al., 2024). This fact itself may explain what Zhai et al. (2024) refer to as users' tendency to take “cognitive shortcuts”, or heuristics, when using AI, in the face of ethical issues and at the risk of a negative impact on their cognitive abilities.

A core risk that applies to students and teachers alike is an over-reliance on the AI output, without proper questioning and verification (including factors such as AI hallucination, algorithmic bias, plagiarism, privacy concerns, and transparency issues, and how over-reliance impacts decision-making, critical thinking, and analytical thinking). In short, taking shortcuts with AI may lower educational quality (Ahmad et al., 2023), unless careful attention is given to such issues. In our case, we specifically target how teachers may avoid taking invalidated shortcuts to assessment by carefully examining and reconstructing their prompts, while acknowledging that AI can be highly useful for this kind of task.

For example, good prompt engineering has been highlighted as critical to avoid and mitigate the weaknesses of using GenAI, with reference to ChatGPT specifically (Johnson, 2024).

Hence, in order to mitigate the negative effects of taking delusive shortcuts, we presented the idea of taking an “anti-shortcut” approach for teachers to learn better prompting (Sjödén & Lievens, 2025). When training prompting skills in a group, we considered that users would benefit from deliberately slowing down and reflect upon both the specific formulation of prompts and their generated output. This would entail first engaging together in possibly effortful but rewarding thinking, before actual and productive shortcuts can be created to facilitate teachers’ work.

2.2. Related Empirical Work and Present Educational Needs

A growing body of empirical research investigates the pedagogical implications of GenAI, like ChatGPT, and the large language models (LLMs) they are based on. While several studies emphasize its potential to foster critical thinking and analytical skills when integrated thoughtfully into learning designs (Guo & Lee, 2023; Dobre & Popescu, 2024), others highlight significant risks, particularly when these tools are used without proper scaffolding.

A recent preprint study by researchers at the MIT Media Lab raises important concerns about the cognitive cost of relying on ChatGPT. In the study, Kosmyna et al. (2025) asked participants to complete SAT-style essay tasks under three conditions: unaided (“brain-only”), using a search engine, or using ChatGPT. The researchers tracked participants’ brain activity using EEG and found that those in the ChatGPT condition showed significantly lower levels of neural connectivity (an indication of reduced mental engagement) compared to those using their own cognitive resources or traditional search. These participants also had weaker recall of their writing and reported lower feelings of authorship. Over time, their essays became increasingly homogenous and reliant on copy-paste behavior, leading the researchers to suggest that unreflective use of LLMs may incur a “cognitive debt” that undermines deeper learning and original thought. Although the study has not yet been peer-reviewed, it provides early empirical support for the hypothesis that LLMs, if not critically integrated into pedagogy, may erode the very cognitive skills they are meant to support.

Beyond cognitive engagement, another key concern is the widespread misunderstanding of how LLMs function. Students and educators often interpret LLM responses as factually grounded or authoritative, even when they are merely plausible-seeming predictions based on training data (Woodland, 2023; Yang, 2024). This unpredictability can be attributed to the probabilistic mechanisms underpinning generative models, yet many users assume deterministic behavior akin to earlier rule-based software systems.

Given these findings, it becomes clear that educational institutions must not only train students in how to use LLMs but also develop their understanding of how these models work. This includes fostering critical awareness of output variability, potential bias, and the limits of LLM-generated knowledge. Aligning ourselves with, e.g. Royer (2024), we argue that such AI literacy should be extended to faculty and staff as well, particularly in the light of growing institutional reliance on generative AI for teaching, assessment, and communication.

3. WORKSHOP DESIGN AND IMPLEMENTATION

Our overarching goal was to provide a structured training opportunity for teachers that targeted how they could avoid taking invalidated shortcuts to assessment, by carefully examining and reconstructing their own prompts. This seemed particularly apt for a workshop format, which included practice and perspective-taking, unlike what could be achieved by users following instructions from a book or article on their own. Next, we elaborate on the requirements for carrying out effective workshop tasks and how these were carried out in practice.

3.1. Developing Teachers' Prompting Competence

Prompting competence refers to the ability to design, test, and refine instructions to an AI model in ways that yield valid, transparent, and educationally meaningful outputs. In this context, the workshop participants were teachers who were guided through a task simulating authentic assessment of a student essay. Each group was asked to prompt ChatGPT to grade a student text and provide feedback, using a scoring rubric familiar to most higher education teachers. Our aim was not only to compare GenAI results with human grading but also to examine how prompt phrasing influenced the AI's reasoning.

Referring to what we further labeled a “collective anti-shortcut design”, we assigned participants to work in small teams, iteratively revising their prompts, observing the AI's responses, and reflecting on what made certain prompts more effective. This exercise served to reveal that prompting is a form of pedagogical reasoning, which requires hypothesis testing, analytical thinking, and ethical sensitivity.

3.2. Techniques for Improving Prompts

Recent research highlights two particularly effective methods for improving AI prompting: few-shot prompting and prompt chaining (Gilardi et al., 2023). These methods help educators structure their interactions with AI tools more deliberately, reducing superficiality and bias.

Few-shot prompting involves showing the AI a few examples of good and poor outputs before it performs a new task. This contextual “training” helps align the AI's reasoning with human expectations. For instance, before grading a student essay, a teacher might provide examples of what counts as “good use of theory” and “weak use of theory”, so that ChatGPT learns from these standards.

Prompt chaining involves decomposing a complex task into smaller, sequential steps. For example, when assessing a student essay, the first prompt might ask ChatGPT to identify the essay's sections, the second to summarize each section's argument, and the third to evaluate the text against given criteria such as theoretical use or coherence. Each stage builds on the previous one, helping the AI avoid generic responses and enabling the teacher to monitor reasoning transparency.

Combining few-shot prompting and prompt chaining – starting with few-shot examples and then chaining prompts step-by-step – may significantly improve reliability. This hybrid method trains the AI to understand evaluative criteria while guiding it through a transparent reasoning process.

3.3. Workshop Structure and Procedure

The workshop was designed as a 45-minute, hands-on session combining brief instruction, collaborative experimentation, and collective reflection. A preliminary outline of the workshop was presented in a previous publication (Sjödén & Lievens, 2025). Here follows a refined description in retrospect, with respect to how the workshop was carried out in practice with the participating teachers.

The workshop took place as part of the END conference in Budapest, June 2025. The participants were 15 teachers in higher education (all conference attendees) who joined the session as part of the conference program. The session began with a short introduction outlining the concept of prompting competence and why it matters for higher education. The two facilitators (the present authors) emphasized that while generative AI can accelerate many routine academic tasks, its pedagogical use requires critical awareness to avoid over-reliance and unreflective “cognitive shortcuts”. Participants were then introduced to the challenge: to use ChatGPT (or similar tool) to assess a short student essay as accurately and transparently as a professional human grader (an anonymous university teacher). They were provided with a (slightly revised and anonymized) student essay and a scoring rubric; their task was formulated as “Prompt the AI to: 1) suggest a grade, 2) write a comment of 5-6 lines with feedback to the student”.

Having worked in small teams (typically groups of three) with the task, the various outputs from ChatGPT were compared to an actual, human assessment of the same text (which had been done beforehand), and the differences were discussed.

Next, participants were introduced to the two prompting improvement strategies described above, prompt chaining and few-shot prompting. The same groups were asked to iteratively refine their prompts and experiment with wording, sequencing, and follow-up instructions to improve the AI’s output. Their renewed task was formulated as, “Can you specify your prompts such that the output assessment by the AI as closely as possible reaches that of the human benchmark?”.

Finally, the workshop concluded with a reflection on lessons learned, and what made some prompts work better than others. Participants discussed how deliberate prompting could improve not only AI output quality but also their own analytical and pedagogical thinking. The facilitators summarized the key takeaways.

4. RESULTS AND EVALUATION

A first notable finding – to the surprise of the workshop participants – was that the same prompt for the exact same essay using the exact same GenAI tool yielded divergent responses, ranging from weak (fail) to excellent (high pass). In our interpretation, because almost all software before LLMs was basically hard-coded, it was hard for the participants, and for teachers in general, to conceive computer-generated output as probabilistic rather than deterministic (and therefore, to a degree, random). We hold that this deeper insight into the nature of LLMs instill users with the critical attitude that is necessary for, ultimately, using such tools productively and judiciously. Therefore, we maintain that a) faculty needs to be trained for using these novel technologies in the domain of education and b) this training, rather than limiting itself to a “tips and tricks” approach, should also explore the fundamental *modus operandi* of LLM technology.

A second surprising result for the workshop participants was that, on average, the GenAI assessment tended to be milder – by a significant degree, in some cases – than the human assessment. In fact, the human assessor failed the essay that the workshop participants had submitted to the GenAI tool. By contrast, one of the GenAI tools that the workshop

participants used, awarded the same essay with the highest possible grade (“Pass with distinction”). It was only after being reminded of one the rubric’s evaluation criteria – that two theories needed to be applied in the essay – that the GenAI tool readjusted its initial assessment. This experience helped workshop participants understand the importance of good prompting techniques. Figure 1 shows the respective assessments of the GenAI tool (in the present case ChatGPT) and the human assessor, including their feedback to the student.

Figure 1.
Assessment of a student essay by ChatGPT as compared to an assessment of the same text by a human university teacher.

Initial assessment by ChatGPT: Pass with distinction (VG).

A well-structured and interesting essay with a good foundation in both theory and practice. Theoretical perspectives and scientific research are clearly integrated. Language and form are generally acceptable but need to be worked on linguistically in a few areas. The text could benefit from further deepening of the critical and problematizing reasoning.

Human assessment: FAIL

The essay lacks systematics, analysis and adequate use of concepts. The essay does not adequately apply two theories and/or perspectives from the course literature. It does not follow the instructions of the assignment; go back to the guidelines and check that all parts of the assignment are addressed. The text has good readability, but take note of comments and markings in the text to increase the academic quality of the work.

A third result to emerge from the workshop was that the implementation of proper prompting techniques, such as the above-mentioned “chain prompting” and “one-shot-prompting”, did significantly improve the GenAI tool’s evaluation in terms of aligning with the human assessor. When the prompt was broken down into simpler and consecutive steps, the GenAI tool was more fastidious in applying the rubric criteria. Likewise, the assessment quality improved when the tool was fed with examples of essay and human-made assessments of these essays. The assessments that matched the human-made assessments most closely were those that emerged from a hybrid prompting approach, combining chain prompting and one-shot prompting.

Finally, the workshop participants remarked that, even when using sound prompting techniques, the LLM’s still needed human oversight. Critical follow-up questions were necessary to ensure that the pedagogical standards that the participants set for themselves were met. It was broadly concluded that while the GenAI tool can offer valuable support, it cannot be relied upon to conduct assessment independently, even when given carefully crafted prompts.

5. DISCUSSION

A key insight from our workshop was the widespread misunderstanding among the participants of how large language models in tools like ChatGPT actually function. Many educators and participants appeared unfamiliar with the idea that LLM outputs are generated probabilistically rather than deterministically. This lack of foundational knowledge often led to confusion when identical prompts produced highly divergent responses, from weak to exemplary. Future research should therefore explore how teachers’ and other users’ conceptual understanding of LLM architecture – particularly its non-deterministic, stochastic nature – influences their prompting behavior, their trust in AI-generated responses, and ability to critically assess the quality of output.

In the context of education, we maintain that shortcuts are not inherently negative. Teachers routinely use templates, rubrics, and automated systems to increase efficiency for planning lessons and assessing student work. Issues arise when shortcuts become substitutes for thinking. The “anti-shortcut” approach proposed here is not about rejecting efficiency or use of GenAI tools, but about ensuring that it serves pedagogical integrity and quality by making time for reflection.

The workshop results suggest that developing prompting competence is not primarily a technical challenge but a pedagogical and ethical one. We deem that teacher education programs should integrate GenAI training not as an add-on, but as a form of professional reasoning practice, where collaborative reflection on multiple examples (which allow for comparisons) makes a critical factor. By engaging teachers in “reverse engineering” of successful prompts, the logic of good AI interaction can be made visible. This method can foster teachers’ further professional development, as they continually learn to adapt their prompting strategies to new models and contexts.

6. FUTURE RESEARCH DIRECTIONS

Future studies should examine the role of “AI epistemic literacy” more broadly, in both student and faculty populations. While existing research has begun to document misconceptions and overreliance on LLMs (Yang, 2024; Woodland, 2023), little is known about how targeted interventions that explain the internal logic of LLMs affect educational outcomes. Experimental studies could assess whether brief instruction on LLM mechanisms enhances skills related to prompting competence, critical thinking, and metacognitive monitoring. Additionally, longitudinal research could track whether repeated, uncritical use of GenAI leads to cognitive offloading or erosion of independent reasoning skills. As institutions formulate GenAI policies, it seems pertinent that future work also evaluate which strategies most effectively support responsible and informed use, with respect to staff training and curriculum integration.

7. CONCLUSION

Developing prompting competence is essential for ensuring that AI supports, rather than supplants, human learning. Our collective anti-shortcut approach emphasized deliberate, reflective use of GenAI: slowing down to think, testing prompts collaboratively, and aligning AI use with educational values. Techniques like prompt chaining and few-shot prompting exemplify how structured interaction can enhance both AI reliability and teacher understanding. Ultimately, prompting competence is not just about mastering a tool; it is

about cultivating a mindset of critical curiosity, where the GenAI tool is treated as a partner in inquiry rather than a shortcut to definite answers.

In sum, our message to teachers from trying this out with the target group in practice, is threefold. First and foremost, never trust the GenAI's first response and be cautious of bias (which is often positive and people-pleasing). Second, refine your prompts, such as by chaining and few-shot prompting. Third, ask for explicit justifications and follow-up questions to ensure coherence and validity. Our experience is that carrying these tasks out in the form of a workshop provided concrete, added value to the participants – not the least judging by their surprise at some of the results – beyond what would have been achieved by simply reading about GenAI and LLMs in a paper or online manual.

Our overall conclusion might serve as a response to the question by the participant quoted in the title of this chapter: Using GenAI might *not* save you time, but with proper prompting competence and your attention to its peculiarities discussed in this chapter, it could well increase the quality and consistency of your work, in the *same* amount of time.

REFERENCES

- Ahmad, S. F., Han, H., Alam, M. M., Rehmat, M., Irshad, M., Arra.o-Mu.oz, M., & Ariza-Montes, A. (2023). Impact of artificial intelligence on human loss in decision making, laziness and safety in education. *Humanities and Social Sciences Communications*, 10(1), 1-14.
- David, L., Vassena, E., & Bijleveld, E. (2024). The unpleasantness of thinking: A meta-analytic review of the association between mental effort and negative affect. *Psychological Bulletin*, 150(9), 1070-1093.
- Dobre, S.-C., & Popescu, E. (2024). Exploring students' perception and experience with ChatGPT and critical thinking in a higher education context. *2024 21st International Conference on Information Technology Based Higher Education and Training (ITHET)*, 1-6.
- Guo, Y., & Lee, D. (2023). Leveraging ChatGPT for enhancing critical thinking skills. *Journal of Chemical Education*, 100(12), 4876-4883 Retrieved from https://pubs.acs.org/doi/pdf/10.1021/acs.jchemed.3c00505?ref=article_openPDF
- Hunter, N. (2023). *The Art of Prompt Engineering with ChatGPT*. Nathan Hunter: Independently published.
- Johnson, W. L. (2024). How to harness generative AI to accelerate human learning. *International Journal of Artificial Intelligence in Education*, 34(3), 1287-1291.
- Kosmyna, N., Bartley, J. E., Khan, R., & Picard, R. W. (2025). *Your brain on ChatGPT: Accumulation of cognitive debt when using an AI assistant for essay writing task* [Preprint]. MIT Media Lab. Retrieved October 23, 2025, from <https://www.media.mit.edu/projects/your-brain-on-chatgpt/overview/>
- Royer, C. (2024). Outsourcing humanity? ChatGPT, critical thinking, and the crisis in higher education. *Studies in Philosophy and Education*, 43, 479-497.
- Sjöden, B., & Lievens, J. (2025). Developing Teachers' prompting Competence Using ChatGPT: A Collective Anti-Shortcut Approach. *Education and New Developments (END) 2025* (Vol. 2, pp. 662-664). InScience Press.
- Woodland, L. (2023). ChatGPT for improving medical education: Proceed with caution. *Mayo Clinic Proceedings: Digital Health*, 1(3), 294-295.
- Yang, Y. (2024). Towards responsible use: Student perspectives on ChatGPT in university education. *Proceedings of the 23rd European Conference on e-Learning - ECEL 2024*, 23(1), 415-422. Retrieved from <https://papers.academic-conferences.org/index.php/ecel/article/view/2790>
- Zhai, C., Wibowo, S., & Li, L. D. (2024). The effects of over-reliance on AI dialogue systems on students' cognitive abilities: a systematic review. *Smart Learning Environments*, 11(1), 28.

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Section 2

Organizational Issues

Chapter # 22

PRINCIPALS' LEADERSHIP PRACTICES IN A DIGITALLY EVOLVING WORLD: A HUMAN RIGHTS PERSPECTIVE

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ABSTRACT

The rapid pace of digital revolution in education requires school principals to reconsider and adjust their leadership styles. To handle the opportunities and difficulties presented by digital transformation, this study suggests a Human Rights Leadership (HRL) action toolkit. The study emphasized human rights leadership practices necessary for promoting inclusive learning, reducing digital divides, and guaranteeing that technological improvements benefit all learners. The Human Rights-Based Approach (HRBA) was used as the theoretical framework for this paper. We qualitatively analysed stipulations from *UNICEF's Policy Guide on Children and Digital Connectivity (2018)* to show the nature and importance of fostering human rights leadership practices in an era of digital transformation. The results demonstrated that in an era of digital change, *affordable access, protection from harm and privacy and identity* can be useful tools for advancing principals' human rights leadership practices which we propose in a human rights leadership action toolkit. By integrating digital innovation with human rights imperatives, the findings advance school principals' responsibilities as agents of educational and societal transformation and digital leadership. To promote human rights leadership in the digital age, this paper recommends that principals strive to be agents of transformation to advance HRL in an era of digital transformation.

Keywords: digital transformation, human rights leadership, principals, toolkit, UNICEF.

1. INTRODUCTION

Digital transformation is changing the educational landscape by integrating technologies such as cloud-based platforms, artificial intelligence and the Internet of Things (IoT), thereby reshaping school leadership and teaching and learning worldwide. These technologies improve individualised learning and promote global connectedness (UNESCO, 2021). However, the current issues with equity and inclusion are exacerbated by these technological changes. While schools with more resources are quick to adopt these advanced tools, a staggering 1.3 billion children aged 3-17 are without internet access in underprivileged areas, thereby threatening the achievement of the United Nations Sustainable Development Goals (SDG 4) for inclusive education (United Nations, 2015). Given the foregoing, school principals face challenges in navigating a complex environment where the digital divide is worsened by socio-economic, geographic and gender disparities (Van Dijk, 2020). In addition, ethical issues such as data privacy breaches and biased AI systems pose a threat to learners' rights (Regan & Jesse, 2019; Williamson, 2017). Notably, the predominant school leadership practices are devoid of addressing human rights practices necessary for fostering digital transformation in schools. The lack of requisite human rights leadership skills could be associated with a disconnect between technological adoption and adherence

to the principles that guide its ethical use (Ross, 2022). To bridge the identified gap, this paper drew on *UNICEF's Policy Guide on Children and Digital Connectivity* (2018) to propose a digital transformation toolkit for school principals in the era of digital transformation.

Significantly, the inequality in digital access further exacerbates learners' learning experiences from disadvantaged backgrounds who risk marginalization, educational and social inequities (World Bank, 2021). Notably, the digital evolution came with ethical concerns, ranging from surveillance, violation of data privacy, and algorithmic bias, which undermine learners' autonomy, rights to safety, and identity in digital spaces (Regan & Jesse, 2019; Williamson, 2017). For school principals, these challenges warrant a shift from traditional leadership to imbibe a more encompassing, rights-based approach that incorporates technological competence.

However, the disconnect observed between leadership practices and technological adoption in schools threatens justice and the safeguarding of human dignity. Although principals embrace technological tools to support administration and classroom instruction, few possess the leadership capabilities pertinent to bring about ethical and equitable transformation (Ross, 2022). These problems are seen to involve inadequate digital rights training, poor implementation of digital policies, and exclusion of vulnerable learners from digital learning opportunities (South African Human Rights Commission [SAHRC], 2012). Failure to address these gaps would counter the possible transformative impact of technology, and this will negate learners' human and constitutional rights to dignity, equality, and information access (RSA, 1996a).

Previous studies have explored digital leadership and principals' roles in facilitating technology integration (Kaya-Kasikci, Zayim-Kurtay, & Kondakci, 2023; Raman, Thannimalai, & Ismail, 2019). Some scholars have investigated human rights education and inclusive leadership (Stefani & Blessinger, 2018; Kuknor & Bhattacharya, 2022). However, limited research have ascertained how school principals can fuse human rights and leadership in the digitally evolving world to address social, ethical, and infrastructural challenges schools experience in an era of evolving technology. *UNICEF's Policy Guide on Children and Digital Connectivity* (2018) identifies major factors such as affordable access, protection from harm, and privacy and identity as crucial elements to be considered by principals as digital world has come to stay with us.

This study addresses this gap by proposing a Human Rights Leadership (HRL) toolkit for school principals navigating digital transformation. Contrary to earlier studies, this study adopts a human rights lens to examine digital leadership, emphasising the promotion of digital equity and inclusion in schools. By using a qualitative analysis of *UNICEF's Policy Guide on Children and Digital Connectivity* (2018), this paper proposes a toolkit for principals to ensure that digital transformation promotes and not undermines learners' human rights.

The study is guided by three research questions.

1. How can principals promote affordable digital access for learners aligned to human rights leadership principles?
2. In what ways can principals implement leadership practices that protect learners from digital harm while upholding a human rights-based approach?
3. How can principals navigate and safeguard issues of digital privacy and identity in schools as well as promote inclusive and rights-based leadership in a digitally evolving world?

2. LITERATURE REVIEW

2.1. Human Rights Leadership (HRL)

Human Rights Leadership (HRL) in education is a transformative approach rooted in social justice principles that empower school principals to advocate for learners' rights and ensure equitable access to education (Robinson, 2023). It enables school principals to address systemic disparities and align school policies with the broader goals of educational equity (Dladla, 2020). HRL encompasses establishing a clear vision that prioritizes learners' rights and welfare thereby creating an environment where they feel heard and respected (National Council for Social Studies, 2021). This leadership model transcends the traditional educational management approach by emphasizing smooth interpersonal relationships practices (Smylie, Louis, & Murphy, 2016) promoting diversity and countering injustice (Santamaría & Santamaría, 2015). Additionally, it encompasses the development of responsive leadership practices (Naido, 2019) that equip school leaders to create a human right-informed atmosphere thereby contributing to a more equitable and socially just society.

2.2. Human Rights Leadership in an era of Digital Transformation

Given the cascading effects of school leadership on learning outcomes, the role of school leaders in the implementation of digital transformation is paramount as it entails the infusion of a computer-oriented approaches to learning into traditional teaching and learning processes (Karakose et al., 2023; Maisyaroh et al., 2024). Scholarly evidence suggests that digital transformation may be associated with improved instructional delivery and increased learner digital nativity (Flores & Mean, 2025; García-Penalvo, 2021). However, the rate of digital assimilation in the education sector varies across developing economies due to infrastructural deficits, government priorities and socio-economic disparities. Despite the associated benefits, adherence to human rights policy guidelines such as data privacy, equitable access and online safety remain a concern in these economies (Jogezai, Baloch, & Koroleva, 2023; Karakose et al., 2023). To mitigate these challenges, the adoption of a human rights-based approach to digital transformation could promote an agenda of inclusion, privacy protection and ethical data usage as well as the safeguard learners' rights (Flores & Mean, 2025; Maisyaroh et al., 2024).

2.3. UNICEF's Policy Guide on Children and Digital Connectivity (2018)

To ensure equitable access and offer guidelines for adoption of digital technologies, *UNICEF's Guide on Children and Digital Connectivity* (2018) serves as a blueprint for the adaptable deployment of digital connectivity in schools. The guideline provides for safe, inclusive and equitable access to digital technology for learners. Specifically, the policy document addresses the potential risks and challenges associated with digital transformation in schools via its provision for protection against harmful content, violation of data privacy and disparities in access to digital resources (UNICEF, 2018). The policy document outlines six thematic areas that serve as blueprints for the deployment of digital literacy in schools. These areas include affordable access to digital skills, protection from harm, privacy and identity, business standards and government policy. Consistent with tenets of human right leadership, the *UNICEF policy guidelines on children and digital connectivity* (2018) serve as a framework for the deployment of digital literacy in schools. The provision of the guidelines suggests that its adoption would reduce digital divides among marginalized groups including female learners, learners with disabilities and those in rural schools. It would also enable school leaders to integrate digital literacy into the curriculum as well as develop robust

data protection practices (UNICEF, 2018, pp. 12-15). Ultimately, the adoption of these policy guidelines could serve as the basis for developing human rights leadership skills among school principals.

2.4. Human Rights Legal Framework, Digital Technology and Impact on Human Rights

Human rights leadership in education is founded in international, national, and regional legal frameworks that uphold education as a human right and a community good. From a global perspective, the International Covenant on Economic, Social and Cultural Rights (United Nations [UN], 1966) and the Universal Declaration of Human Rights (UN, 1948) contain the rights to education and the responsibilities of the states to guarantee equity, dignity and access for all learners. In Africa, the African Charter on the Rights and Welfare of the Child (Organization of African Unity [OAU], 1990), and the African Charter on Human and Peoples' Rights (OAU, 1981) went further to entrench education as a right that fosters democratic participation and human development. In South Africa, the South African School Acts (RSA, 1996b) and the South African Constitution (RSA, 1996a) are policy documents that translate these global and regional insights into local commitments, ensuring principals practice equitable and inclusive education. These frameworks for the school principals are beyond compliance to represent a legal and moral compass upon which leadership decisions, especially ensuring that all learners, despite of race, gender or background, partake in a school atmosphere that honors their rights and dignity (Soudien, 2020). In other words, human rights leadership affords the principals to incorporate legal literacy, which enables them to navigate the complex intersections of social justice, policies and pedagogical responsibility.

In this contemporary time, there is a quick integration of digital technologies in all educational levels. This has reimagined how human rights leadership is carried out in schools. On one hand, it provides opportunities to promote educational rights through broad communication platforms, improved access to knowledge, and innovative instructional models (UNESCO, 2021). Similarly, on the other hand, it presents new challenges (legal and ethical) in the form of digital surveillance, cyberbullying, data privacy, and unequal opportunities to digital resources (Van Dijk, 2020). Hence, for the contemporary principals, this technological transformation requires a balance between technological access and the need to safeguard human dignity and equity. A leadership approach grounded in human rights beacons on principals to imbibe digital practices that corroborate affordability, protection from harm, and privacy (Enebe & Palmer, 2025). This is a call for the principal to guard against the tendencies of these tools deepening the existing social divide, rather it should enhance the digital empowerment of learners and teachers. Inasmuch as schools increasingly adopt a digital-driven system, principals are encouraged to apply and interpret digital policies from a human rights standpoint, which would in turn foster ethical decision-making, accountability, and transparency (Setiawan, 2024). In conclusion, this paper sought to enhance principals' human rights leadership in an era of digital transformation by reimagining human rights leadership using UNICEF's (2018) policy guide and proposes a toolkit for principals to ensure that digital transformation promotes learners' human rights.

3. THEORETICAL FRAMEWORK

This study employs the human rights-based approach (HRBA). This theory has its root in the international human rights principles and standards. Organizations such as UNICEF and the United Nations recommend that this theory incorporate human rights standards into the planning, implementation, and assessment of practices and policies across institutions, including education (UNICEF, 2018; United Nations, 2003). HRBA scholars such as Jonsson (2005) and Uvin (2007) advocate that equity and sustainable development can be attained when individual rights, especially marginalized groups are respected, and protected throughout institutions. The goal of HRBA is to make sure that human rights are actively incorporated into daily activities and decision-making, not only recognized in policies (Fitzgerald et al., 2020). In the era of digital transformation, school principals are advised to imbibe a HRBA to protect and defend the rights of learners for inclusivity, access and privacy in their daily involvement with digital devices. The Organisation for Economic Co-operation and Development (2024) posit that policies should be used to ensure that digital transformation remains human-centric and rights-oriented. A rights-based approach in a digital era is further emphasized by UNICEF (2018) which maintained that international standards and best practices must serve as the foundation for protective measures and safeguards, which must maintain a balance between protecting children's privacy and data and other rights.

The essence of choosing this theory lies in the need to imbibe an inclusive, ethical, and justice-oriented leadership in the present digitally evolving world. The educational sector is increasingly experiencing a surge in the use of digital tools in instruction, and school principals are charged with the responsibility to safeguard the rights of learners. An application of the HRBA was thus relevant because policy requires school principals to consider how they can enact human rights leadership in the age of digital transformation. Notwithstanding, some scholars criticized the HRBA on the ground that its normative and wide nature can be difficult to use in a real institutional setting (Cornwall & Nyamu-Musembi, 2004). Merry (2006) argued that its emphasis on legal framework may possibly overlook cultural and contextual divide in how human rights are implemented and understood. On the contrary, these critiques do not undermine its relevance to the present study. In this regard, HRBA is adopted as an appropriate theory for this study as it provides practical guidance, normative foundation, and ethical clarity for principals in exploring how digital transformation can be harnessed to protect and affirm the rights of learners. Through the use of HRBA, this study adds to the current discourse on right-centred educational leadership, particularly amid regions marked by digital disruption and inequality.

4. METHODOLOGY

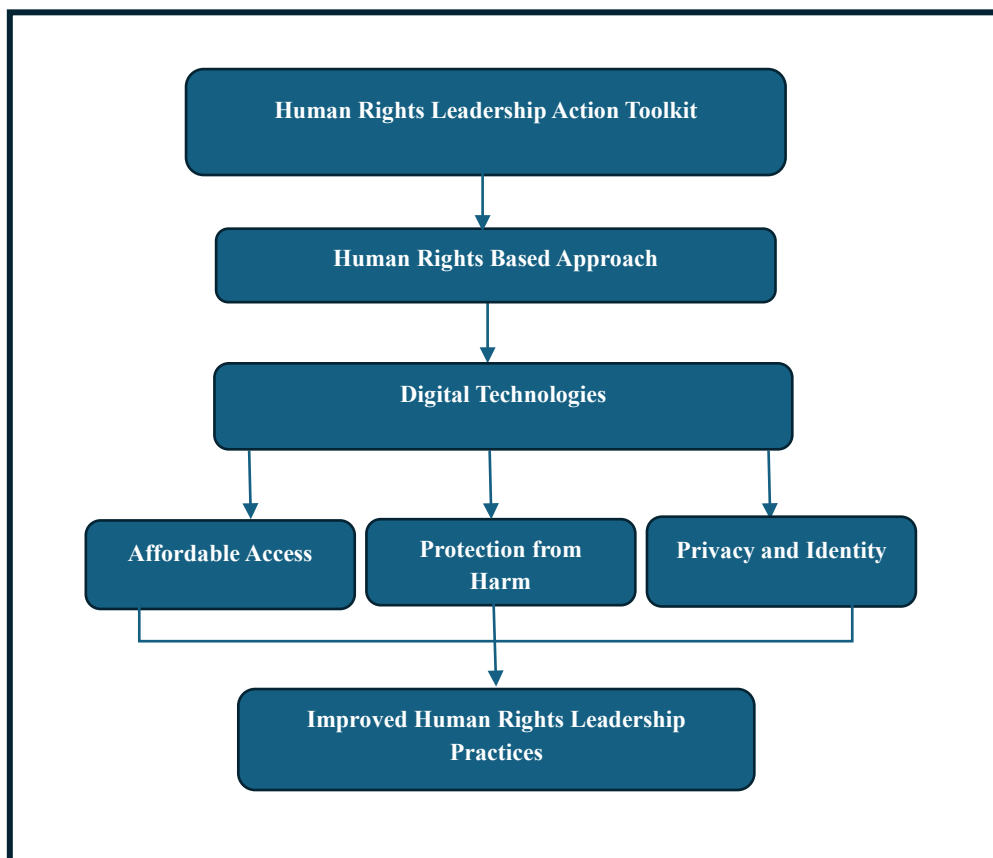
We adopted a qualitative approach in our study to explore the meaning of texts in the UNICEF (2018) *Guide on Children and Digital Connectivity* to advance principals' HRL in an era of digital transformation. A document analysis was conducted of selected texts within the Guide to interpret meanings within to obtain a deeper understanding of a specific phenomenon or problem. Due to the consistency of the data, it is advantageous to analyse pre-existing texts as the data remains unchanged (Merriam & Tisdell, 2016). In using this method, pre-existing texts are critically examined to identify meaningful trends and insights (Morgan, 2022). Complementary to a qualitative approach, we applied a conceptual research design (CRD) which focuses on scrutinizing existing concepts from texts in policies and information already in the public domain (Heinonen & Gruen, 2024). We analysed texts in

UNICEF's Policy Guide on Children and Digital Connectivity (2018) to understand new ways to advance principals' HRL in an era of digital transformation. First, we read the document to acquaint ourselves with relevant texts that have possible significance with principals' HRL in the era of digital transformation. Second, we reread and selected texts with the closest relationship and patterns with the phenomenon being studied. Third, the selected texts were coded to check their coherence and labelled with phrases that represent their content (Linneberg & Korsgaard, 2019). Afterwards, we identified three themes that strongly aligned with principals' HRL in the era of digital transformation, namely, affordable access, protection from harm and privacy and identity. We then employed thematic analysis to understand how the three selected texts communicate information about principals' human rights leadership in a digital era.

5. RESULTS AND DISCUSSION

We propose a Human Rights Leadership Action toolkit (HRLAT) that can contribute to advancing principals' HRL in an era of digital transformation (Figure 1).

Figure 1.
Human Rights Leadership Action Toolkit (HRLAT).



5.1. Affordable Access

According to UNICEF (2018) “*affordable access is defined as the availability of digital devices and internet connectivity at a rate that enables all children irrespective of their socioeconomic background, to use them effectively for communication, learning and engagement in the digital world*” (p. 9). Although the Universal Declaration of Human Rights does not specifically list internet and digital access as a human right, it is acknowledged that these resources are necessary for the exercise of other fundamental rights, including freedom of speech and right to information (Malatsi, 2025). In South Africa, the constitution emphasizes the importance of access to information and freedom of expression (RSA, 1996a). As a result, principals can further their HRL by fostering digital literacy and guaranteeing all learners and teachers have fair access to digital resources. Hamzah, Nasir, & Wahab (2021) contends that this entails offering professional development, encouraging an innovative culture and using data to guide decisions on digital integration. More so, principals promote HRL by advocating for policies that make digital devices and internet accessible, prioritizing digital training and fostering partnership to mitigate digital divide (OECD, 2022).

Importantly, these actions can be executed by the principal through advocacy. Advocacy in the form of mobilising NGOs, district officials, and governing bodies to assist in securing zero-rated educational platforms, subsidised data, community Wi-Fi solutions and refurbished devices, as their contributions to sustain and uphold the educational rights of learners. Furthermore, principals can again exercise their human rights leadership roles by partnering with libraries to build community-based digital networks. In sum, affordable access to internet and digital devices are thus relevant for advancing principals' HRL as it would foster freedom of speech and right to information. These are fundamental human rights critical to address digital divides and guarantee fair access to technology.

5.2. Protection from Harm

UNICEF (2018) advised that principals should use their leadership “*to address online risks, vulnerability and harm*” (p. 17). Protecting learners from harm in the era of digital transformation necessitates a multifaceted strategy that emphasizes digital literacy, appropriate online conduct, and strong reporting and support mechanisms. Teaching learners about online safety, privacy, and moral behaviour should be a top priority for school principals who should also set up explicit procedures for reporting instances of abuse (UNICEF, 2023). Protecting learners in school is an act of defending their human rights. This could be championed by guaranteeing a secure and welcoming learning environment free from abuse and discrimination, premised on equality and inclusion. The South African Human Rights Commission [SAHRC] (2012) discloses that protecting learners from online abuse and discrimination entails safeguarding their rights to equality, safety and non-discrimination which culminates as educational rights of learners. Further, the South African Constitution and SAHRC placed a significant interest in protecting learners from every form of harm (including in the use of digital devices) and always emphasized learners' interest. This involves defending learners' access, privacy and ensuring that abusive contents were properly reported (RSA, 1996a; SAHRC, 2012).

To embed this principle in schools, principals are encouraged to establish transparent and clear policies on responsible device use, data privacy, and cyberbullying. This, however, will protect learners from online exploitation, and can be communicated through accessible language and collaboratively developed with parents, teachers and learners. In addition, principals can also choose platforms and digital tools that conform with ethical standards, and data protection laws to ensure that digital learning does not expose learners to online

harm. In this regard, principals' HRL can be advanced when they protect learners and educators from online abuse, discrimination and harm, while ensuring digital literacy and ethical online conduct.

5.3. Privacy and Identity

The constant changes in the age of digital transformation requires school principals to search for "*appropriate strategies to avoid risks and seek support when needed*" (UNICEF, 2018, p. 13) so that individuals' privacy can be protected. Privacy and identity are pertinent safety measures to be considered when making use of digital devices as they could have a direct impact on users' safety, autonomy, and human dignity particularly for younger learners and other vulnerable populations (UNICEF, 2018). Notably, privacy and identity are fundamental human rights enshrined in the Universal Declaration of Human Right (United Nation, 1948) as freedom of expression and thinking depends on people being able to manage their personal information and choose how it is shared. Moreover, accessing services, exercising rights, and guaranteeing legal protection all depend on having a distinct and identifiable identity. In the South African context, the enactment of the constitutional rights to privacy and identity in the digital age are seen in the "Protection of Personal Information Act [POPIA]" and "Regulation of Interception of Communications and Provision of Communication-Related Information Act [RICA]" (RSA, 1996a; Staunton et al., 2020) which points to the profound attention given to the exercise of human rights.

The legal human rights frameworks as seen above, can further be enhanced by the school principal by ensuring that there are policies put in place that control data gathering, storage and sharing. Such policies would prohibit reckless data collection, usage of insecure sites, and ensure adherence to data protection laws. In line with this, principals can vet all third-party platforms and digital equipment to ensure data encryption. Again, HRL can also be extended to professional training of teachers on the ethical use of digital tools. Therefore, to advance school principals' HRL in the fast-growing digital world, a grasp of privacy and identity as fundamental human rights should be upheld to ensure dignity, safety and autonomy of learners.

6. CONCLUSION

This study advances our understanding of human rights leadership in the context of digital transformation in education. This study highlights the challenging role of school principals in navigating digital transformation in schools while upholding human rights principles. To overcome these hurdles the study proposes a human rights leadership action toolkit (HRLAT) as a framework for principals to advance human rights leadership practices during digital integration. Underpinned by the provisions of UNICEF's policy guideline on children and digital connectivity 2018, the toolkit also addresses some of the challenges associated with the implementation of digital transformation in schools. Put together, the three research questions showed that for digitally evolving schools to implement human rights leadership, an ethical approach that expresses affordability, protection from harm, privacy and identity should be considered by the principal. Firstly, through advocating for affordable digital access, principals assist in actualising the education rights of learners in an inclusively. Secondly, principals uphold dignity, safety and accountability by implementing leadership practices that safeguard learners against digital harm. Finally, principals ensure that learners' privacy and identities are protected through participatory, transparent, and legally by compliance to data protection bodies. This study contributes to the ongoing debate on best practices regarding human rights leadership in schools. Given the conceptual nature of the study, future research could focus on conducting empirical and longitudinal studies to assess its practicality and the long-term efficacy of the proposed toolkit.

REFERENCES

- Cornwall, A. & Nyamu-Musembi, C. (2004) Putting the 'rights-based approach' to development into perspective. *Third World Quarterly*, 25(8), 1415-1437. DOI: 10.1080/0143659042000308447
- Dladla, T. (2020). *Exploring ethical leadership practices in challenging township school contexts: A multiple case study* (Doctoral dissertation, University of KwaZulu-Natal, Edgewood).
- Enebe, N. B., & Palmer, J. M. (2025). Advancing principals' human rights leadership practices in an era of digital transformation. *Education and New Development*, 2, 622-626. <https://doi.org/10.36315/2025v2end134>
- Fitzgerald, S., Behan, L., McCarthy, S., Weir, L., O'Rourke, N., & Flynn, R. (2020). Translating a Human Rights-based Approach into Health and Social Care Practice. *Journal of Social Care*, 3(1), 3-17.
- Flores, E., & Mean, U. (2025). Digital transformation in Cambodian higher education: Current trends and future directions. *Edelweiss Applied Science and Technology*, 9(1), 867-878. <https://doi.org/10.55214/25768484.v9i1.4267>
- García-Peñalvo, F. J. (2021). Avoiding the Dark Side of Digital Transformation in Teaching. An Institutional Reference Framework for eLearning in Higher Education. *Sustainability*, 13(4), 20-38. <https://doi.org/10.3390/su13042023>
- Hamzah, N., Nasir, M. & Wahab, J. (2021). The Effects of Principals' Digital Leadership on Teachers' Digital Teaching during the Covid-19 Pandemic in Malaysia. *Journal of Education and e-Learning Research*, 8(2), 216-221. <https://doi.org/10.20448/journal.509.2021.82.216.221>
- Heinonen, K., & Gruen, T. (2024). Elevating conceptual research: Insights, approaches, and support. *Academy of Marketing Science Review*, 14(2), 1-6. <https://doi.org/10.1007/s13162-024-00283-9>
- Jogezai, N. A., Baloch, F. A., & Koroleva, D. (2023). Teachers' digital competence in the post COVID-19 era: The effects of digital nativeness, and digital leadership capital. *Contemporary Educational Technology*, 15(4), 450-466. <https://doi.org/10.30935/cedtech/13620>
- Jonsson, U. (2005). *A human rights-based approach to development programming*. UNICEF. <https://unhabitat.org/a-rights-based-approach-to-urban-development-urban-jonsson-the-owls>
- Karakose, T., Tülübaş, T., Polat, H., Demirkol, M., Yirci, R., & Ozdemir, T. Y. (2023). A Conversation with ChatGPT about Digital Leadership and Technology Integration: Comparative Analysis Based on Human-AI Collaboration. *Administrative Sciences*, 13(7), 157-172. <https://doi.org/10.3390/admsci13070157>
- Kaya-Kasikci, S., Zayim-Kurtay, M., & Kondakci, Y. (2023). The role of leadership in developing a climate of technology integration in public schools. *Teaching and Teacher Education*, 132, 104234.
- Kuknor, S. C., & Bhattacharya, S. (2022). Inclusive leadership: new age leadership to foster organizational inclusion. *European journal of training and development*, 46(9), 771-797.
- Linneberg, M. S., & Korsgaard, S. (2019). Coding qualitative data: a synthesis to guide the novice. *Qualitative Research Journal*, 19(3), 259-270. <https://doi.org/10.1108/QRJ-12-2018-0012>
- Maisyaroh, M., Juharyanto, J., Wiyono, B. B., Nawi, A. M., Adha, M. A., & Lesmana, I. (2024). Unveiling the nexus of leadership, culture, learning independence, passion trend-based learning, and teacher creativity in shaping digital student skills. *Social Sciences & Humanities Open*, 9(3), 100-116. <https://doi.org/10.1016/j.ssaho.2024.100884>
- Malatsi, S. (2025, March 25). OPINION | Affordable digital connectivity for all a fundamental human right. *SowetanLIVE*. Retrieved from <https://www.sowetanlive.co.za/opinion/2025-03-25-opinion-affordable-digital-connectivity-for-all-a-fundamental-human-right/>
- Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (4th ed.). Jossey Bass.
- Merry, S. E. (2006). Transnational human rights and local activism: Mapping the middle. *American anthropologist*, 108(1), 38-51.
- Morgan, H. (2022). Conducting a Qualitative Document Analysis. *The Qualitative Report*, 3(1) 1-16. <https://doi.org/10.46743/2160-3715/2022.5044>

- Naido, P. (2019). Perceptions of teachers and school management teams of the leadership roles of public school principals. *South African Journal of Education*, 39(2), 1-14. <https://doi.org/10.15700/saje.v39n2a1534>
- Organization of African Unity (now African Union). (1981). *African Charter on Human and Peoples' Rights (Banjul Charter)*. Retrieved from <https://au.int/en/treaties/african-charter-human-and-peoples-rights>
- Organization of African Unity (now African Union). (1990). *African Charter on the Rights and Welfare of the Child*. <https://au.int/en/treaties/african-charter-rights-and-welfare-child>
- Organisation for Economic Co-operation and Development [OECD] (2022). *Rights in the digital age: Challenges and ways forward*. Retrieved from https://www.oecd.org/content/dam/oecd/en/publications/reports/2022/12/rights-in-the-digital-age_d3a850de/deb707a8-en.pdf
- Organisation for Economic Co-operation and Development [OECD]. (2024). *Shaping a rights-oriented digital transformation // OECD Digital Economy Papers*. Retrieved from <https://doi.org/10.1787/86ee84e2-en>
- Raman, A., Thannimalai, R., & Ismail, S. N. (2019). Principals' Technology Leadership and Its Effect on Teachers' Technology Integration in 21st Century Classrooms. *International Journal of Instruction*, 12(4), 423-442.
- Regan, P. M., & Jesse, J. (2019). Ethical challenges of edtech, big data, and personalized learning: Twenty-first century student sorting and tracking. *Ethics and Information Technology*, 21(3), 167-179. <https://doi.org/10.1007/s10676-018-9492-2>
- Republic of South Africa c] (1996a). *Statutes of the Republic of South Africa-constitutional law constitution of the Republic of South Africa*. Retrieved from <https://www.gov.za/sites/default/files/images/a108-96.pdf>
- Republic of South Africa [RSA] (1996b). *South African Schools Act 84 of 1996*. Government Printer. Department of Basic Education. Retrieved from <https://www.gov.za/documents/south-african-schools-act>
- Robinson, R. (2023). *Centering Human Rights Through a Whole School Approach*. Retrieved from <https://rfkhumanrights.org/our-voices/centering-human-rights-through-a-whole-school-approach/>
- Ross, J. (2022). *Digital futures for learning: Speculative methods and pedagogies*. Routledge.
- Santamaria, L. J., & Santamaria, A. P. (2015). Counteracting Educational Injustice with Applied Critical Leadership: Culturally Responsive Practices Promoting Sustainable Change. *International Journal of Multicultural Education*, 17(1), 22. <https://doi.org/10.18251/ijme.v17i1.1013>
- Setiawan, A. (2024). Ethical Decision-Making in Educational Leadership: Insights from Islamic Scholars. *Edu Spectrum: Journal of Multidimensional Education*, 1(1), 15-27. <https://doi.org/10.70063/eduspectrum.v1i1.29>
- Soudien, C. (2020). Complexities of difference and their significance for managing inequality in learning: Lessons from the COVID-19 crisis. *Prospects*, 49, 59-67. <https://doi.org/10.1007/s11125-020-09486-x>
- South African Human Rights Commission (2012). *PAIA manual report 2011/12*. Retrieved from <http://www.sahrc.org.za/home/21/file/PAIA%Annual%20Report%20201112.pdf>
- Smylie, M. A., Louis, K. S., & Murphy, J. (2016). Caring School Leadership: A MultiDisciplinary, Cross-Occupational Model. *American Journal of Education*, 123(1), 1-35. <https://doi.org/10.1086/688166>
- Staunton, C., Adams, R., Anderson, D., Croxton, T., Kamuya, D., Munene, M. & Swanepoel, C. (2020). Protection of Personal Information Act 2013 and data protection for health research in South Africa. *International Data Privacy Law*, 10(2), 160-179. <https://doi.org/10.1093/idpl/ipy024>
- Stefani, L., & Blessinger, P. (Eds.) (2018). *Inclusive leadership in higher education: International Perspectives and Approaches*. New York, USA: Routledge.
- UNESCO. (2021). *AI and education: Guidance for policy-makers*. Paris: UNESCO.
- UNICEF. (2018). *Policy guide on children and digital connectivity*. New York: UNICEF.
- UNICEF. (2023). *Child protection in digital education*. New York: UNICEF.

- United Nations. (1948). *Universal declaration of human rights*. Retrieved from <https://www.justice.gov.za/vc/docs/international/UN%20Human%20Rights.pdf>
- United Nations. (1966). *International Covenant on Economic, Social and Cultural Rights*. Retrieved from <https://www.ohchr.org/en/instruments-mechanisms/instruments/international-covenant-economic-social-and-cultural-rights>
- United Nations. (2003). *The human rights-based approach to development cooperation: Towards a common understanding among UN agencies*. Retrieved from <https://unsdg.un.org/>
- United Nations. (2015). *Transforming our world: The 2030 Agenda for Sustainable Development*. Retrieved from <http://bit.ly/TransformAgendaSDG-pdf>
- Uvin, P. (2007). Human rights and development. *International Journal of Research Policy and Practice*, 1(3) 278-281.
- Van Dijk, J. (2020). *The digital divide*. John Wiley & Sons.
- Williamson, B. (2017). *Big data in education: The digital future of learning, policy, and practice*. SAGE.
- World Bank. (2021). *Reimagining human connections: Technology and innovation in education*. Retrieved from <https://www.worldbank.org/>

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Chapter # 23

KNOWLEDGE MANAGEMENT APPROACH TO REMOTE CARE COMPETENCE DEVELOPMENT

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ABSTRACT

This paper presents a Knowledge Management approach to developing competencies among nurses working in remote healthcare. The study addresses the challenges and opportunities of hybrid healthcare environments, where professionals operate remotely from patients and colleagues. Through a case study involving interviews with remote care nurses at Finnish Heart Hospital, the research identifies key competencies required for effective remote care, such as technical skills, communication, and adaptability. The study introduces a competence development model grounded in Knowledge Management principles, particularly the SECI-model, to facilitate the transformation and sharing of tacit knowledge. The model emphasizes systematic identification, assessment, and development of competencies, supported by structured orientation and continuous education. The findings highlight the importance of regular competence assessment and knowledge sharing to ensure high-quality and efficient remote care delivery.

Keywords: knowledge management, remote care, competence development, nurses, SECI-model.

1. INTRODUCTION

Healthcare is a field that goes through major changes all the time. Challenges in healthcare come from different directions, when population is ageing, prevalence of chronic diseases is increasing, and the structure of diseases is changing. (Fukada, 2018, p. 1; Paunu and Helander, 2023, p. 213) The traditional hospital-centric care is moving towards more virtual and distributed care that takes advantage of the latest digital technologies, for example artificial intelligence, data analytics, and home-based healthcare solutions (Wehde, 2019, p. 24). This means that digital technologies can be used to answer the challenges that healthcare is facing, when continuous data collection and exchange between patients and healthcare professionals reduces the need for physical visits in physical buildings (Paunu and Helander, 2023, p. 213). Despite the promises of digital technologies in healthcare, there are still many open questions that need further research, including also such aspects as data, knowledge and digital skills (Herrmann et al., 2018; Santarsiero, Schiuma, Carlucci, & Helander, 2023).

Knowledge management (KM) refers to the operating methods in which the organization's information is refined and utilized in the management of the organization's operations (Hislop, Bosua and Helms, 2018, p. 345). It also refers to ways on how documented and tacit knowledge is shared or utilized in the organization (Laihonen et al., 2013, p. 84). Knowledge management aims to improve organizations' performance and effectiveness by addressing the importance of knowledge creation, development, organization, and leveraging (Myllärniemi, Laihonen, Karppinen, & Seppänen, 2012, p. 55).

How the organizations use the means of KM can be chosen between two strategies, which are technical and human-centered approach (Maier, 2007, p. 52). The difference between these two strategies is that the technical approach emphasizes information systems and various knowledge management applications (Laihonen et al., 2013, p. 84). Utilizing information systems requires that the information needs to be explained and coded (Alves, Lima and Gaspar, 2023, p. 193). On the other hand, a human-centred approach focuses on the knowledge possessed by the individual and its sharing and use, especially in interaction situations between people (Maier, 2007, p. 92). In this approach, the organization is seen as a learning organization where the interaction between individuals and people is supported and promoted (Maier, 2007, p. 92; Laihonen et al., 2013, p. 55).

Major focus of KM has been in capturing tacit knowledge and transforming it into explicit knowledge (Mitri, 2003, p. 174). This can be done with the means of SECI-model, which comes from the terms socialization, externalization, combination, and internalization (Nonaka, 2007, p. 284). Also, KM is based on processes and ways of utilizing information resources in which using e.g. information management process model can support organizations (Choo, 2002, p. 325). The information management process is about improving organizational performance by recognizing and harvesting the knowledge needed (Laihonen et al., 2013, p. 84).

In healthcare, to provide direct care, protect individual lives, and support activities of daily living, nurses need to improve their nursing competency (Fukada, 2018, p. 1). Nurses are expected to have an adequate competence to be able to fulfil their duties safely and effectively (Kajander-Unkuri et al., 2014, p. 795). The competence of a nurse is related to professional standards, patient safety, and the quality of nursing care (World Health Organization, 2008). Nursing competency can be defined as the functional adequacy and the capacity to integrate skills, knowledge, attitudes, and values in a specific situations of practice (Kajander-Unkuri et al., 2014, p. 796). Remote care presents several persistent challenges, thus requiring new competencies from the nurses. As remote care is characterized by the limited possibilities for physical assessment and the need to make clinical evaluations without face-to-face interaction, it requires a strong reliance on nurses' tacit knowledge and experience in complex situations. Technical and communication constraints, as well as organizational factors - such as unclear roles, inconsistent workflows, and insufficient training structures - further complicate the remote-care practices. (Helander et al., 2023) These challenges highlight the importance of systematic competence development for nurses.

In this study, we aim to answer the research question: *How KM approaches can support the competence management of nurses in remote care?* Through an action-oriented case study, we form a competence development model to be used in remote care to sufficiently monitor and develop needed competencies. Current state of competence development and competencies needed are based on interviews (n=10) with the nurses who regularly work remotely from the patients. With this, we aim to find a way to support and develop competence management in remote care.

2. BACKGROUND

2.1. KM Approaches to Competence Development in Remote Care

Competencies can be defined as the ability to apply knowledge and skills to different contexts, such as work, leisure and learning (Ala-Mutka, 2011, p. 18). It is a way to put in practice one's knowledge, know-how, and attitudes, inside a specific context (Berio and Harzallah, 2005, p. 21). Competence evolves through learning and making use of acquired knowledge and skills (Medina and Medina, 2015, pp. 280, 285; Konttila et al., 2019, p. 746).

Competence management involves the specification of an organization's competence needs, competence sourcing, the identification of competence gaps, and developing competence through training and coaching (Lindgren et al., 2004, p. 436). It constitutes of, for example, selection, training and development, performance measurement, and internal promotion (Medina and Medina, 2015, p. 286).

Healthcare is a knowledge driven function which is why healthcare professionals need information and knowledge management (IKM) in their jobs for using different devices, making decisions, and sharing information (Shahmoradi, Safadari and Jimma, 2017, p. 548). As the field of healthcare works around sharing knowledge between individuals, the focus in this paper is on a human-centred approach. It is important in healthcare to plan the KM practices that enable personal interaction between people, so that learning and creating new knowledge becomes possible (Nguyen Ngoc, Lasa and Iriarte, 2022).

There is a lot of data, information, and knowledge in healthcare. Data is often described as raw, and it has no significance beyond its existence. Data can exist in any form, and it does not have a meaning by itself (Bellinger, Castro and Mills, 2004, p. 1). Information is data that has been given a meaning (Bellinger, Castro and Mills, 2004, p. 1). It is structured data that can be used in analysis and it is often both numerical and nonnumerical (Laihonon et al., 2013). Information is well defined only together with its meaning, which can lead to problems like data silos and interoperability, as the meaning is not always clear to everyone (Orthuber, 2021, p. 2188). Knowledge is a collection of information, and it has useful meaning to its user. It is more refined and abstract than information (Bellinger, Castro and Mills, 2004, p. 1). It is often based on experience, and it is what makes possible the transformation of information into instructions. On a general level, knowledge can be defined as something related to human understanding gained through experience, studying, or thinking (Rowley, 2007, p. 166).

KM refers to ways on how tacit knowledge is shared. Tacit knowledge refers to knowledge, skills, and abilities an individual gain through experience (Nonaka and Takeuchi, 1995). Tacit knowledge is context-specified and often defined as the know-how of the person (Hoe, 2006, p. 493). Tacit knowledge is highly personal and difficult to communicate to others (Orthuber, 2021, p. 2192). In the field of healthcare, there is a lot of tacit knowledge, since it is a knowledge rich domain (Abidi, Cheah and Curran, 2005, p. 193). Means of SECI-model can help the healthcare professionals in capturing tacit knowledge and transforming it into explicit knowledge (Mitri, 2003, p. 174).

Remote care is quite a new field, where nurses work without face-to-face contact (Lau, Bartle-Clar and Bliss, 2019, p. 134). It is strongly multidisciplinary practice that includes, for example, innovative methods of practice, resourcefulness, limited clinical diagnostic support, and knowledge of public health (Smith et al., 2008, pp. 159–160). Before COVID-19, the use of digital applications in medicine were restricted to the use of electronic health records (EHRs), but lately it has been allowed to expand the use of technological devices in medicine. Nowadays, different devices include for example smartphones, mobile wireless devices, wearable devices, health portals, and implantable devices. (Eurlings, Boyne, De Boer, & Brunner-La Rocca, 2019, p. 6; Konttila et al., 2019, p. 746) Monitoring symptoms remotely has the potential to improve patients' quality of life, reduce costs, and enable timely and early treatment in situations where the need for care is increasing due to advancing illness (Walker, Tong, Howard, & Palmer, 2019, p. 78; Scalvini et al., 2020, p. 155).

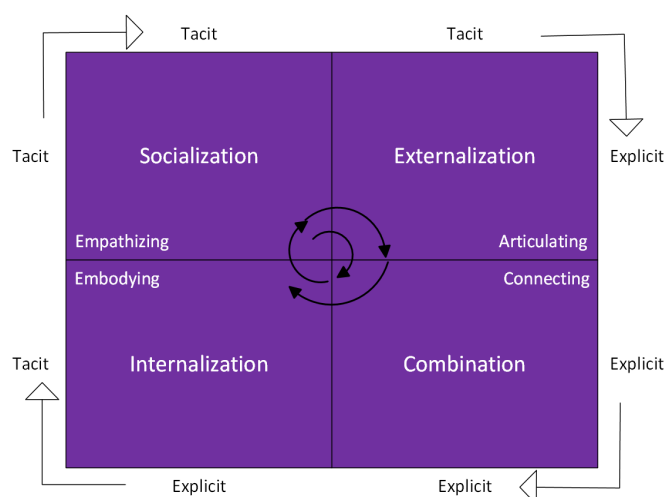
In remote care, the competencies can be seen as the skills, knowledge, and abilities required for nurses to effectively deliver healthcare services to patients remotely (Melnik et al., 2014, p. 7). These competencies include various aspects, for example technological proficiency, assessment and triage, communication skills, problem-solving, collaboration and teamwork, and professional development (Kajander-Unkuri et al., 2014, p. 799; Melnyk

et al., 2014, p. 7; Fukada, 2018, pp. 1, 3–4; Oyewunmi, 2018, pp. 430, 440; Vydrová and Bejtkovský, 2018, p. 23; Konttila et al., 2019, p. 746; Mrayyan et al., 2023, p. 6). Remote care works in a hybrid operating environment with nurses and doctors, patients, and service providers, which integrates physical and virtual care with telemedicine technologies and allows a better control of hospitals' occupancy (Pilosofo et al., 2023, p. 1). Competence in nursing is complex, relative, and variant, and a hybrid environment emphasizes all of these aspects when working through third-party systems (Nabizadeh-Gharghozar et al., 2021, p. 2).

2.2. SECI-Model Building the Base for Competence Development

SECI-model (Figure 1) describes the transformation of tacit knowledge into explicit and back to tacit knowledge in four different stages. The stages follow each other and form a spiral of knowledge, where knowledge increases as the spiral progresses. (Nonaka and Takeuchi, 1995)

Figure 1.
SECI-model (modified from Nonaka and Takeuchi (1995)).



The idea of the SECI-model is that the knowledge is socialized, so tacit knowledge is shared, and it becomes someone else's tacit knowledge (Hoe, 2006, p. 494). Then tacit knowledge is externalized, where it is shared, for example, to the whole organization, and through that, tacit knowledge becomes explicit knowledge (Laihonen et al., 2013, p. 57). After that, explicit knowledge is combined with previously known explicit knowledge (Ocholla and Adesina, 2019, p. 2). Last stage is internalization, where one adopts the knowledge on their own, and it becomes tacit knowledge again (Nonaka and Takeuchi, 1995).

SECI-model plays an important role in the field of healthcare since a significant amount of extremely vital and viable healthcare knowledge exists in tacit forms (Abidi, Cheah and Curran, 2005, p. 193). It is essential that tacit knowledge of healthcare professionals is shared in the organization, since it includes working knowledge, social knowledge, and educational discussions (Abidi, Cheah and Curran, 2005, p. 193). Tacit knowledge has a major role in improving the quality and delivery of healthcare, but it is challenging to harness and operationalize the tacit modalities of healthcare knowledge. That is why KM methods like SECI-model are needed to help to share the knowledge (Nonaka and Takeuchi, 1995).

3. RESEARCH CONTEXT AND METHOD

Empirical data was collected from the Finnish Heart hospital in Tampere and Hämeenlinna during early summer 2024. The research material consisted of 10 interviews with remote care nurses. At the same time, the literature of remote care, hybrid operating environment, and competence management was studied. The literature review formed theoretical background for this study, and the empirical research, which was done as interviews (n=10) and analysed with the means of qualitative content analysis, helped to bring the theory into practise. Combined, theoretical and empirical research formed answers to how the competence management of the nurses can be supported in remote care. Based on the analysis, a competence development model was formed.

Research interview is a conversation between two or more people, where the interviewer asks concise and unambiguous questions and listens closely the interviewee talking (Hyvärinen et al., 2017, chap. 2; Saunder et al., 2019, p. 434). The interview aims at information collecting and is therefore in advance planned goal-oriented activity (Hirsjärvi and Hurme, 2022, para. 4.1.2). The interviews were semi-structured in which the questions were basically same for everyone, but the answers were not tied to the answer options (Hirsjärvi and Hurme, 2022, para. 4.2.3). With this type of interview, the interviewer wants information about specific things and does not want to give the interviewees too much freedom. Still, the interviewer wants to clarify and deepen the answers, so there are no ready-made answer options. (Saunders et al., 2019, pp. 437–438) Interviews were held either face-to-face at the hospital or via Teams. They were conversational-like situations where the interviewees could talk freely about the topics asked. The interviewer had an interview guide to control the conversation so it would not get too off topic. Interviews were recorded so the interviewer could concentrate on the conversation and not on writing down the answers. Afterwards, interviews were transcribed, translated, and anonymized using identification numbers to strengthen the validity of our research. Translated transcriptions were coded in relation to the wanted themes, for example *Competencies*, *Hybrid operating environment*, *The amount of remote work*, and *Systems and technologies*.

4. RESULTS

In the field of healthcare, data, information, and knowledge play an important role. In the interviews, N2 said: *"We have such a big problem in the world in general that these systems produce so much data, and then we wrestle with how to find the essentials in the amount of data"*. The remote care systems produce plenty of data, and it is in nurses' hands to know which of it is meaningful. To execute safe and effective care, nurses also need knowledge. Knowledge is partly based on experience and can be gained through studying or thinking. It is needed in healthcare to provide good care and to understand how to use different systems. You also need general knowledge management to keep up with the constant changes and development, as N2 stated *"We constantly have to do some kind of knowledge management in a certain way so that we can keep up with the day-to-day work"*.

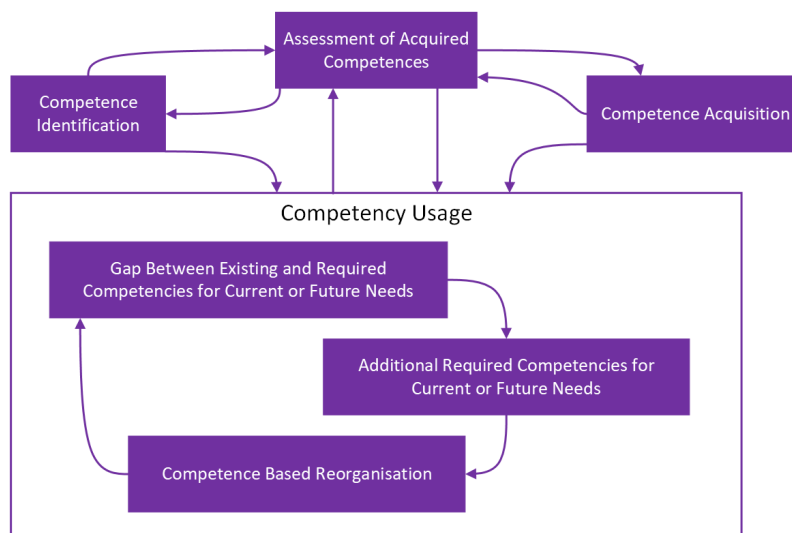
Hybrid operating environment means a wide range of things and practices in which people work. It can mean an IT infrastructure setup that combines on-premise resources with cloud-based services (Dittakavi, 2022, p. 33). It can also mean working in different places and in close collaboration with other operators (Mirbabaie et al., 2021, p. 365). In healthcare, hybrid operating environment can be seen as a use of technologies and digital solutions to implement remote care, as well as different participants working together. Hybrid operating environment needs flexibility from everyone to work properly and it allows organizations to

choose the most suitable deployment for each workload or application. (Tysowski and Hasan, 2013, p. 172; Franken et al., 2021, p. 1139) It is quite new thing in healthcare to have flexibility in work or for example where you work. Remote care allows nurses to work from home which is seen as a positive thing. *“This definitely increases work well-being, increases meaningfulness by at least 10% when you can work remotely.” (N4)*

Hybrid operating environment reduces the amount of hospital visits from patients. It gives them more freedom to live their lives although being sick. It also brings security for the patients, when they know, they are monitored all the time, and they have a backup in the hospital. Based on our research, a patient education is an important part of nurses' work and hybrid environment can be seen as an advantage with it. In the remote platforms, nurses can send messages to the patients and ensure that patients have written instructions. Also, if patients have something to ask, they can send a message to nurses via platforms. This saves both time and resources from everyone, when unnecessary calls and hospital visit are reduced, as interviewed nurses also expect.

However, hybrid operating environment set challenges also for competence management. In overall, it shifts the competence requirements towards emphasis on digital technologies and communication skills through digital channels. Competence management is the way in which organizations manage their competencies of individuals and groups. It can be organized through competence management process (Figure 2), which helps organizations to systematically develop competencies (Berio and Harzallah, 2005, pp. 21–22).

Figure 2.
Competence management process architecture (modified from Berio and Harzallah 2005).

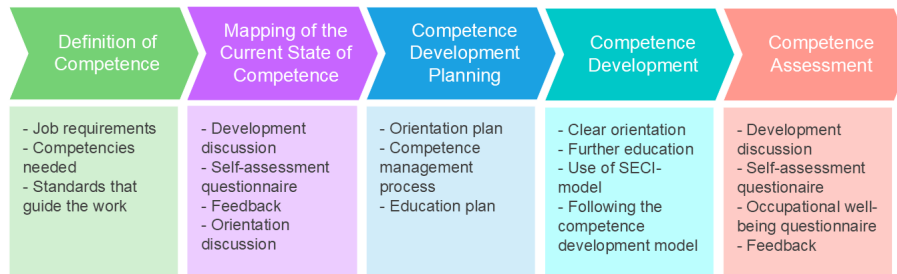


Nurses need many different competencies in remote care carried out in hybrid operation environments. 60% of the interviewed nurses mentioned technical skills and as N2 said: *“You need to know how to use all of the systems smoothly and understand their differences”*. Also, N3 said: *“Using these programs require some kind of IT skills, some kind of general knowledge of how these current systems work”*. Other competencies that were mentioned

several times, were evaluation of treatment, experience, and pharmaceutical knowledge. As N1 said: *“You have to have an eye to see, if that person fits into the program”*. Also, evaluation was seen important, since most of it is made via phone, so a nurse needs to have a competence to do the evaluation just by hearing the patient: *“You have to be able to evaluate what happens when everything isn’t quite normal”* (N8). This was also linked to experience by N3: *“Treatment evaluation, and that comes with experience. The experience is one skill.”* Experience was seen also as a knowledge from other specialties: *“It’s good that you have multidisciplinary experience, i.e., from other than the heart side”* (N1). In the interviews, nurses also pointed out adaptation to changing situations, decision-making capacity, and communication skills. As N5 said in the interview: *“It’s always easier to work so that you have a patient face-to-face”*. This emphasizes the importance of good communication skills, when interaction is limited.

Based on the literature review and the interviews from the nurses, answer to the research questions can be found. The answer consists of two paths: hearing all the remote care participants and making use of the means of knowledge management. Hearing different users gives wider perspective of what is needed when executing safe and efficient remote care. The means of knowledge management consist of systematically executing competence management process and identifying competence needs, and support in making tacit knowledge explicit. These two paths make the base for the competence developed model (Figure 3).

Figure 3.
Competence development model.



The competence development model starts by defining competencies. At this stage, the requirements of the remote care, what kind of competencies are needed in executing efficient remote care, and what standards guide the implementation of remote care are thought about. It is important to define the required competencies, so one can know what needs to be developed (Lindgren et al., 2004). Also, as healthcare is a field that is responsible for people’s lives, following standards is important. The next step is to find out what level the competencies are at the present moment. This can be done, for example, by development discussions, self-assessment questionnaires, giving and receiving feedback, or orientation discussions. By executing more than one of these, we can meet the demands of the nurses with a clear view of the current level of competencies, and what needs to be developed.

The third step is to plan competence development. At this point there should be a clear orientation plan that is used with all the new nurses who start working in remote care. Also, hospitals should pay attention to competence management model, which can help with identifying competence needs and how to develop competencies further. The model can be modified in a way that it is easy and simple to follow. It is important to follow the model

systematically. That way the hospital can ensure that the needed competencies are identified, assessed, and acquired thoroughly. The third point at this step is to have a clear education plan on how to ensure that everyone keeps their competencies up to date.

The fourth step is the actual competence development, which means the actions hospital needs to take to develop competence. This includes clear and systematic orientation to all the new nurses, further education to those who have been working in remote care longer, and the use of SECI-model. Good orientation and education will rapidly increase the competencies that are needed when implementing remote care. The hospital should have a clear orientation plan including clear steps, what new nurses need to know, and how they can acquire that knowledge. Orientation should be systematic and follow the same pattern so it could be ensured that the nurses have good enough competencies when they start working remotely by themselves.

Based on the empiria, the hospital has mechanisms for disseminating information, such as guidelines, through its platforms, but these processes are neither efficient, systematic, nor well-governed. The use of SECI-model will help nurses to spread their tacit knowledge to others and make it explicit. SECI-model also creates guidelines and instructions on how to make tacit knowledge known by everyone who works in remote care. This could be done by, for example, educating the nurses in different steps in the SECI-model and encouraging them to spread their knowledge to other nurses. The hospital could also develop a system where the nurses could share working methods that they have found effective. With this system the externalization would be easy, and many ways of working could be shared. That way everyone could find out the ways of working that fit them the best. Also, when different ways of working and knowledge acquired through time is shared in the same system, combination of explicit knowledge happens almost by itself. Thus, the internalization of knowledge is easy, since every nurse can combine their own knowledge with the knowledge others have shared and create new ways of working and increase their own competencies.

The last part in the fourth step is that the competence development model should be followed, so competence needs and gaps would be defined regularly. This means that it should be systematically taken care of that all the steps of the model are gone through regularly. Management should from time to time go through the first two steps so that they know what competencies are required and at what level they are now. Based on the results from the first two steps, the third step should be assessed, so that the orientation and education plans are up to date. The fourth step should be going all the time, so the use of SECI-model would come automatically from the nurses, and that the orientation and education would be available any time it is needed.

The last step in the model is competence assessment. Assessing competence and evaluating the development can be done by the same way that the current state of competence is done: development discussions, self-assessment questionnaire, occupational well-being questionnaire, and feedback. When assessing competencies regularly, the Heart hospital can better keep up with their current state of competency, and address deficiencies immediately. Competence development model gives them a guideline on how to assess the needed competencies and how to develop them along the way.

5. FUTURE RESEARCH DIRECTIONS

This study has its limitations, based on the location and the scope of the study. Future research opportunities include researching different fields of healthcare to give a wider look on how remote care works. It would also be meaningful to research both nurses and patients simultaneously and over longer period of time to have a better understanding of how remote

care works and what aspects need to be analysed more thoroughly. Also, it would be useful to research remote care nurses from different cities or countries, since different hospital districts may have different means for executing remote care.

As future research avenue, the role of knowledge management, especially the potential of application of SECI-model (Nonaka and Takeuchi, 1995) in competence development could be studied in more detail than in this paper. From a competence development perspective, the knowledge management approach consists of the acquisition, transformation, dissemination, and protection of knowledge and expertise (Väyrynen et al., 2015).

6. CONCLUSION/DISCUSSION

This study contributes to competence management literature by introducing a competence development model for timely context: remote care. The SECI model and the competence management process architecture have been used as the building blocks for developing the competence development model applicable in practice in remote care. The SECI model explains how nurses' tacit knowledge becomes shared and explicit, providing the foundation for learning and knowledge sharing. The competence management process architecture offers a systematic structure for identifying competence needs, assessing current capabilities, and planning development actions. Building on these, the competence development model translates both into practice by outlining concrete steps for defining competencies, assessing competence levels, planning education, supporting knowledge sharing, and conducting continuous evaluation.

With the developed model, a unified way of working can be introduced in hospitals and among them, who do remote care. Based on the interviews, there are no specific ways of developing or evaluating competencies, and sometimes even clear instructions are missing. In the future, the competence development model needs to be further developed to answer real needs of the nurses and to create concrete suggestions of working to develop remote care nurses' competencies.

Means of KM have an important role in healthcare. Nurses have much information and knowledge that is tacit, and it needs to be shared. SECI-model has many advantages, like enhanced teamwork, better organized information, it supports organizational learning (Andhika, 2025). Based on our findings, the use of the SECI model offers several benefits—such as more effective knowledge sharing for nurses and the hospital environment more broadly. Using SECI successfully is not easy, and it needs good guidelines, so the tacit knowledge can be shared effectively. Utilizing SECI in the field of healthcare would benefit all, when the knowledge gained over the years of working could be shared with everyone else, and at the same time, new knowledge that new nurses bring to the field, could be shared and combined with experience (see e.g., el Giudice et al. 2021). To help with knowledge sharing and utilization of the SECI-model, the information management process model (Choo, 2002) can be used. All organizations have information needs, but it can be hard to know what the information needs really are. Identifying knowledge gaps and that way being able to acquire knowledge would help healthcare organizations to keep up with new information that comes all the time. One part of Choo's model is information distribution, that goes hand in hand with SECI-model. Important part of both models is to distribute the information and knowledge gained to all healthcare workers so the information can be used more widely. The last part of Choo's model is adaptive behavior, and this one is important in the field of healthcare. When acquiring new information, it is not enough to get it and use it. The use of the information must lead, if necessary, to the change of behavior. That way organization can learn and keep

up with the changes. Changing behavior is necessary when the field changes as rapidly as healthcare does.

In overall, using the means of KM can lead to an efficient competence management. Based on our research it is obvious that competence management is required in remote care, since most of the work is done separately from the patient and colleagues. Especially the individual competence is needed, since it guides nurse's work and decreases the number of errors. It consists of tacit and explicit knowledge, skills, and behaviors, which is also why the different KM models are needed. Knowing one's own competencies enables the development of them, but recognizing own competence needs is not easy, which is why a competence development model is needed.

When studying the field of healthcare, ethical issues are very relevant. This research was carried out in a way that no harm, significant risks, damage or disadvantages came to the researched people. Any information from the interviewees was discussed as valuable and confidential. The research plan, data protection notice, and consent form were sent before the interviews, and each interviewee signed a consent form before the recording started. All the recordings and transcriptions were kept only until the original study was finished and only the people who contributed to this study had access to them. Also, recordings were anonymized as soon as possible to protect the identity of the subjects.

REFERENCES

- Abidi, S.S.R., Cheah, Y.-N., & Curran, J. (2005). A knowledge creation info-structure to acquire and crystallize the tacit knowledge of health-care experts. *IEEE Transactions on Information Technology in Biomedicine*, 9(2), 193–204. Available at: <https://doi.org/10.1109/TITB.2005.847188>.
- Ala-Mutka, K. (2011) *Mapping Digital Competence: Towards a Conceptual Understanding*. Available at: <https://doi.org/10.13140/RG.2.2.18046.00322>.
- Alves, J., Lima, T. M., & Gaspar, P. D. (2023). Is Industry 5.0 a Human-Centred Approach? A Systematic Review', *Processes*, 11(1), p. 193. Available at: <https://doi.org/10.3390/pr11010193>
- Andhika, L.R. (2025). The Implementation of the SECI Model in Knowledge Management Adoption Within Local Governments to Foster Innovation. *Journal of STI Policy and Management*, 10(2), 68-80. [heerps://www.stipmjournal.org/infex.php/stipm/article/view/423/pdf](https://www.stipmjournal.org/infex.php/stipm/article/view/423/pdf)
- Bellinger, G., Castro, D. & Mills, A. (2004). *Data, Information, Knowledge, and Wisdom*. Available at: <https://homepages.dcc.ufmg.br/~amendes/SistemasInformacaoTP/TextosBasicos/Data-Information-Knowledge.pdf>
- Berio, G. & Harzallah, M. (2005). Knowledge Management for Competence Management. *Journal of Universal Knowledge Management*, 0(1), 21–28.
- Choo, C.W. (2002) *Information management for the intelligent organization: the art of scanning the environment* (3rd ed.) Medford, NJ: Information Today (ASIS monograph series).
- Dittakavi, R. S. S. (2022). Evaluating the Efficiency and Limitations of Configuration Strategies in Hybrid Cloud Environments. *International Journal of Intelligent Automation and Computing*, 5(2), pp. 29–45.
- Eurlings, C. G., Boyne, J. J., De Boer, R. A., & Brunner-La Rocca, H. P. (2019). Telemedicine in heart failure—more than nice to have?. *Netherlands Heart Journal*, 27(1), 5–15. <https://doi.org/10.1007/s12471-018-1202-5>
- Franken, E., Bentley, T., Shafaei, A., Farr-Wharton, B., Onnis, L., & Omari, M. (2021). Forced flexibility and remote working: opportunities and challenges in the new normal. *Journal of Management and Organization*, 27(6), 1131–1149. <https://doi.org/10.1017/jmo.2021.40>
- Fukada, M. (2018). Nursing Competency: Definition, Structure and Development. *Yonago Acta Medica*, 61(1), pp. 1–7. Available at: <https://doi.org/10.33160/yam.2018.03.001>

- Helander, N., Pundziene, A., Sermontyte-Baniule, R., Carrabina, J., Mathieu, C., Boethius, S., & Georgescu, I. (2023, October). Digital healthcare platforms enabling remote care value creation: The patient perspective. In *2023 IEEE International Conference on Technology and Entrepreneurship (ICTE)* (pp. 38-43). IEEE.
- Herrmann, M., Boehme, P., Mondritzki, T., Ehlers, J. P., Kavadias, S., & Truebel, H. (2018). Digital transformation and disruption of the health care sector: internet-based observational study. *Journal of medical internet research*, 20(3), e104.
- Hirsjärvi, S. & Hurme, H. (2022) *Tutkimushaastattelu: teemahaastattelun teoria ja käytäntö [Research interview: theory and practice of thematic interviewing]*. (2nd ed.). Helsinki: Gaudeamus. Available at: <https://www.elliblibrary.com/book/9789523458123/tutkimushaastattelu>
- Hirsjärvi, S., Remes, P., & Sajavaara, P. (2009) *Tutki ja kirjoita. [Research and write]*. 15th ed. Helsinki: Tammi.
- Hislop, D., Bosua, R., & Helms, R. (2018) *Knowledge Management in Organizations: A Critical Introduction*. Oxford University Press.
- Hoe, S.L. (2006). Tacit knowledge, nonaka and takeuchi seci model and informal knowledge processes. *International Journal of Organization Theory & Behavior*, 9(4), 490–502. Available at: <https://doi.org/10.1108/IJOTB-09-04-2006-B002>
- Hyvärinen, M., Nikander, P., & Ruusuvoori, J. (2017). *Tutkimushaastattelun käsikirja [Research interview manual]*. Tampere: Vastapaino. Available at: <https://www.elliblibrary.com/book/9789517686112/tutkimushaastattelun-kasikirja>
- Kajander-Unkuri, S., Meretoja, R., Katajisto, J., Saarikoski, M., Salminen, L., Suhonen, R., & Leino-Kilpi, H. (2014). Self-assessed level of competence of graduating nursing students and factors related to it. *Nurse Education Today*, 34(5), 795–801. Available at: <https://doi.org/10.1016/j.nedt.2013.08.009>
- Konttila, J., Siira, H., Kyngäs, H., Lahtinen, M., Elo, S., Kääriäinen, M., ... Mikkonen, K. (2019). ‘Healthcare professionals’ competence in digitalisation: A systematic review - *Journal of Clinical Nursing*, 28(5–6), 745–761. <https://doi.org/10.1111/jocn.14710>
- Laihonen, H. et al. (2013) *Tietojohdaminen [Information and knowledge management]*. Tampere: Tampere University of Technology. Department of Information and Logistics.
- Lau, F., Bartle-Clar, J. A., & Bliss, G. (2019). *Improving Usability, Safety and Patient Outcomes with Health Information Technology: From Research to Practice*. Amsterdam, Netherlands, The: IOS Press, Incorporated. Available at: <http://ebookcentral.proquest.com/lib/tampere/detail.action?docID=5775655>
- Lindgren, R., Henfridsson, O., & Schultze, U. (2004). Design Principles for Competence Management Systems: A Synthesis of an Action Research Study. *MIS Quarterly*, 28(3), 435–472. Available at: <https://doi.org/10.2307/25148646>
- Maier, R. (2007). *Knowledge Management Systems: Information and Communication Technologies for Knowledge Management* (3rd ed.). Berlin, Heidelberg: Springer-Verlag. Available at: <https://doi.org/10.1007/978-3-540-71408-8>
- Medina, R. & Medina, A. (2015). The competence loop: Competence management in knowledge-intensive, project-intensive organizations. *International Journal of Managing Projects in Business*, 8(2), 279–299. Available at: <https://doi.org/10.1108/IJMPB-09-2014-0061>.
- Melnyk, B. M., Gallagher-Ford, L., Long, L. E., & Fineout-Overholt, E. (2014). The Establishment of Evidence-Based Practice Competencies for Practicing Registered Nurses and Advanced Practice Nurses in Real-World Clinical Settings: Proficiencies to Improve Healthcare Quality, Reliability, Patient Outcomes, and Costs. *Worldviews on Evidence-Based Nursing*, 11(1), 5–15. <https://doi.org/10.1111/wvn.12021>
- Mirbabaie, M., Stieglitz, S., & Frick, N. R. J. (2021). Hybrid intelligence in hospitals: towards a research agenda for collaboration, *Electronic Markets*, 31(2), 365–387. <https://doi.org/10.1007/s12525-021-00457-4>
- Mitri, M. (2003). Applying tacit knowledge management techniques for performance assessment. *Computers & Education*, 41(2), 173–189. [https://doi.org/10.1016/S0360-1315\(03\)00034-4](https://doi.org/10.1016/S0360-1315(03)00034-4)

1. Mrayyan, M. T., Abunab, H., Khait, A. A., Rababa, M. J., Al-Rawashdeh, S., Aljunmeeyn, A., & Saraya, A. A. (2023). Original research: Competency in nursing practice: a concept analysis. *BMJ Open*, 13(6). <https://doi.org/10.1136/bmjopen-2022-067352>
- Myllärniemi, J., Laihonen, H., Karppinen, H., & Seppänen, K. (2012). Knowledge management practices in healthcare services. *Measuring Business Excellence*. Edited by A. Lerro, 16(4), pp. 54–65. Available at: <https://doi.org/10.1108/13683041211276447>
- Nabizadeh-Gharghozar, Z., Alavi, N. M., & Ajorpaz, N. M. (2021). Clinical competence in nursing: A hybrid concept analysis. *Nurse education today*, 97, 104728–104728. Available at: <https://doi.org/10.1016/j.nedt.2020.104728>
- Nguyen Ngoc, H., Lasa, G., & Iriarte, I. (2022). Human-centred design in industry 4.0: case study review and opportunities for future research. *Journal of Intelligent Manufacturing*, 33(1), 35–76. Available at: <https://doi.org/10.1007/s10845-021-01796-x>
- Nonaka, I. (2007). The Knowledge-Creating Company: Harvard Business Review. *Harvard Business Review*, 85(7/8), pp. 162–171.
- Nonaka, I. & Takeuchi, H. (1995). *The knowledge-creating company: how Japanese companies create the dynamics of innovation*. New York: Oxford University Press.
- Ocholla, D. N. & Adesina, A. O. (2019). The SECI Model in knowledge management practices: past, present and future. *Mousaion*, 37(3), 1–34. Available at: <https://doi.org/10.25159/2663-659X/6557>
- Orthuber, W. (2021). Global definition of information for global communication. In *2021 IEEE 23rd Int Conf on High Performance Computing & Communications; 7th Int Conf on Data Science & Systems; 19th Int Conf on Smart City; 7th Int Conf on Dependability in Sensor, Cloud & Big Data Systems & Application (HPCC/DSS/SmartCity/DependSys)*. 2021 IEEE 23rd Int Conf on High Performance Computing & Communications; 7th Int Conf on Data Science & Systems; 19th Int Conf on Smart City; 7th Int Conf on Dependability in Sensor, Cloud & Big Data Systems & Application (HPCC/DSS/SmartCity/DependSys), pp. 2188–2193. Available at: <https://doi.org/10.1109/HPCC-DSS-SmartCity-DependSys53884.2021.00326>
- Oyewunmi, A. E. (2018). Normalizing Difference: Emotional intelligence and diversity management competence in healthcare managers. *Intangible Capital*, 14(3), 429–444. Available at: <https://doi.org/10.3926/ic.1050>
- Paunu, A. & Helander, N. (2023). *Remote monitoring of heart failure patients treatment programme: Customer experience, expectations, barriers and conditions*. SCITEPRESS. Available at: <https://doi.org/10.5220/0012195800003598>
- Pilosof, N. P., Barrett, M., Oborn, E., Barkai, G., Zimlichman, E., & Segal, G. (2023). Designing for flexibility in hybrid care services: lessons learned from a pilot in an internal medicine unit. *Frontiers in medical technology*, 5, 1223002–1223002. Available at: <https://doi.org/10.3389/fmedt.2023.1223002>
- Rowley, J. (2007). The wisdom hierarchy: representations of the DIKW hierarchy. *Journal of Information Science*, 33(2), 163–180. Available at: <https://doi.org/10.1177/0165551506070706>
- Santarsiero, F., Schiuma, G., Carlucci, D., & Helander, N. (2023). Digital transformation in healthcare organisations: The role of innovation labs. *Technovation*, 122, Article 102640. <https://doi.org/10.1016/j.technovation.2022.102640>
- Saunders, M., Lewis, P., & Thornhill, A. (2019). *Research Methods for Business Students*. Harlow, UK: Pearson Education.. Available at: <http://ebookcentral.proquest.com/lib/tampere/detail.action?docID=5774742> (Accessed: 19 April 2024).
- Scalvini, S., Comini, L., & Bernocchi, P. (2020). How can multidisciplinary management with remote monitoring improve the outcome of patients with chronic cardiac diseases?. *Expert Review of Medical Devices*, 17(3), 153–157. Available at: <https://doi.org/10.1080/17434440.2020.1720510>
- Shahmoradi, L., Safadari, R., & Jimma, W. (2017). Knowledge Management Implementation and the Tools Utilized in Healthcare for Evidence-Based Decision Making: A Systematic Review. *Ethiopian Journal of Health Sciences*, 27(5), 541–558.

- Smith, J. D., Margolis, S. A., Ayton, J., Ross, V., Chalmers, E., Giddings, P., ... Love, C. (2008). Defining remote medical practice', *Medical Journal of Australia*, 188(3), pp. 159–161. <https://doi.org/10.5694/j.1326-5377.2008.tb01561.x>
- Tysowski, P. K. & Hasan, M. A. (2013). Hybrid Attribute- and Re-Encryption-Based Key Management for Secure and Scalable Mobile Applications in Clouds | IEEE Journals & Magazine | IEEE Xplore. *IEEE transactions on cloud computing*, 1(2), pp. 172–186.
- Vydrová, J. & Bejtkovský, J. (2018). The importance of the individual pillars of social maturity of workers in healthcare organizations in the hierarchy of pillars of competence in management. *Administratie si Management Public*, (31), 21–35. Available at: <https://doi.org/10.24818/amp/2018.31-02>.
- Walker, R. C., Tong, A., Howard, K., & Palmer, S. C. (2019). Patient expectations and experiences of remote monitoring for chronic diseases: Systematic review and thematic synthesis of qualitative studies. *International journal of medical informatics (Shannon, Ireland)*, 124, 78–85.
- Wehde, M. (2019). 'Healthcare 4.0'. *IEEE Engineering Management Review*, 47(3), 24–28. Available at: <https://doi.org/10.1109/EMR.2019.2930702>
- World Health Organization (2008). *Summary of the evidence on patient safety: implications for research*. Available at: <https://www.who.int/publications-detail-redirect/9789241596541>
- Väyrynen, H., Helander, N., & Jalonen, H. (2015). Tietämyksenhallinta osana organisaation toimintaa–hallintaa vai hämmennystä? [Knowledge management as part of organization's operations – management or confusion?]. *Hallinnon tutkimus*, 34(4).

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Chapter # 24

PARTICIPATORY DESIGN OF A HEALTH-PROMOTING UNIVERSITY – THE PROJECT MINDFUL CAMPUS AT LEIBNIZ UNIVERSITY HANNOVER

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ABSTRACT

This article presents the project “Mindful Campus – Strengthening Mental Health Literacy among Students” (MinCa), which aims to establish a student health management system (SHM) at Leibniz University Hannover (LUH). The overarching objective of MinCa is to develop a participatory concept and strategy for establishing SHM through measures at the curricular and structural level. Participation is understood as the individual or collective involvement of individuals in health-related decisions. This is considered as a central principle of health promotion at universities. The project is being funded by Techniker Krankenkasse, a German health insurance, for the period from January 2025 to December 2026. MinCa examines how the organizational structures of the LUH can contribute to supporting students in their individual learning of Mental Health Literacy (MHL). This question will be investigated in a qualitative accompanying study. The article explains the conceptual approach of the project and the design of the study. In addition, initial findings and conclusions will be presented and opened up for discussion.

Keywords: mental health literacy, micro degree, setting approach, student health management, university development.

1. INTRODUCTION

The general health of students has deteriorated significantly between 2015 and 2023 (Techniker Krankenkasse [TK], 2023, p. 8). This is reflected, for example, in a significant increase in mental health disorders. A key problem is the increased emotional stress experienced by students, which can be seen as a warning sign for burnout (cf. *ibid.*, p. 9-17). Due to the extensive changes in the German higher education system, e.g., the Bologna reform, but also internationalization and digitization processes, the perception of complexity and stress as well as emotional exhaustion among university members has increased significantly. This includes students as the largest status group. In addition to direct study-related factors such as exam pressure, competition, and student financing, social and political phenomena such as the COVID-19 pandemic, the global climate crisis, and the Middle East conflict are also having an increasing impact on the psychosocial stress experienced by students (cf. Brock et al., 2024). Brock et al. (2024) point out that the perceived psychosocial stress increases due to the constant presence of these topics.

In addition, many students experience intersectional health inequalities or injustices in the higher education context, as various socio-structural characteristics such as disabilities, chronic illnesses, immigrant background, sexual orientation, or care responsibilities, e.g., childcare or caring for relatives, influence the development and maintenance of mental health (cf. *ibid.*). In this way, a conglomerate of challenges can arise for affected students

that is usually invisible to the outside world and can have a negative impact on their ability to study (Banek, Gillen, Michele, & Steuber, 2025a). This initial situation results in a growing need for individual mental health literacy (MHL) and for a structurally anchored, university-wide student health management (SHM) similar to the existing occupational health management at Leibniz University Hannover (LUH) (Banek, Michele, & Steuber, 2025b). A sustainably anchored SHM aims to systematically promote the health of students and strengthen their health-related resources (Brock et al., 2024; Kompetenzzentrum Gesundheitsfördernde Hochschulen, 2024).

This is where the project “Mindful Campus – Strengthening Mental Health Literacy among Students” (MinCa) comes in. MinCa aims to strengthen the mental health literacy of students (and partly also for academic staff) as an important skill or literacy for the future. The development and strengthening of health literacy as a fundamental life and future literacy is, in our view, of particular importance in university teacher training, as teachers later act as multipliers in schools. The project embeds MHL into university structures and curricula and uses a participatory, student-centred approach.

MinCa initially focuses on vocational education and training (VET) students. In the course of the project, it is planned to extend this focus to students from other departments. VET students are a diverse, often under-represented population group, e.g., in terms of categories such as age, caring responsibilities and part-time employment. They are often ‘first generation students’ and at higher risk of academic dropout due to prior occupational qualification (Gillen et al., 2021). Furthermore, the teaching profession ranks among the most mentally taxing careers: Schools are high-demand psychosocial environments requiring emotional labour and resilience.

The training of VET students at LUH is based on the principle of reflective action. According to this model, teacher training students should be enabled to deal with the open and highly complex situations of everyday professional life, to shape these situations, and to critically question their own role and decisions in terms of underlying systemic and structural conditions, their significance, and their appropriateness (cf. Dannemann et al., 2019). Essential factors for this include the competent handling of health information, reflection on organizational health literacy in vocational training institutions, and the ability to maintain one's own health.

For these reasons, the promotion of MHL among future teachers can be seen as both: preventative and transformative for the culture of health in educational institutions such as universities and schools. Teachers are multipliers for the development and maintenance of mental health and health literacy in later professional life.

2. BACKGROUND

MinCa is an internal university and structure-building cooperation project. The project objective is to develop participatory strategies to promote MHL and establish a SHM.

The basic idea behind the project is a salutogenetic understanding of health, which is detached from the normative concept of being healthy, in which health is understood as a continuum. Analogous to this understanding of health, physical, psychological and social factors are included as conditions of origin and development factors for the individual state of health (Antonovsky, 1991). In this way, the promotion of MHL can develop constructive mechanisms for coping with stress as well as the cognitive, social and motivational abilities and skills of an individual that help them to independently access health-related information that contributes to coping with illness, disease prevention and/or health promotion (Sørensen et al., 2012).

The MinCa project focuses on curricular integration and structural university changes. The theoretical approach is based on two central principles: The first principle is the *setting approach*. This means that the university can be understood as a socio-spatial system in which health-promoting measures and processes can be implemented in both: working and learning contexts. The second principle is *participation*, which is understood in the narrower sense as the individual or collective involvement of individuals in health-related decisions affecting their lives (cf. Wihofszky, Hartung, & Narimani, 2020). Both principles are briefly explained below.

2.1. The Setting Approach

More recently, universities have increasingly seen themselves as actors in health promotion (cf. Okanagan Charter, 2015) and are anchoring the associated values in their self-image, e.g., in the form of an SHM (cf. Brock et al., 2024). Its goal is to “create a health-promoting university environment for all students and strengthen the individual health resources of students. It is recommended that SHM be implemented systematically and integrated into university structures in a sustainable manner” (Kompetenzzentrum Gesundheitsfördernde Hochschulen 2024, n.p.). According to the Techniker Krankenkasse, a German health insurance fund, “the setting approach [...] can be the core strategy for health promotion and networking is its most important development tool” (TK 2020, p. 43) at universities.

The setting approach refers to two levels: The structural level and the behavioural level. At the *structural level*, the project aims to establishing a SHM to contribute to the long-term improvement of health-promoting university structures. A steering group (cf. 3.2) was set up for this purpose, which is responsible for the coordination, consolidation and further development of (mental) health expertise.

At the *behavioural level*, the project aims to promote individual MHL prevention and intervention programmes and the theoretical qualification of students. For this purpose, health-related topics are integrated into the curriculum of vocational teacher training programmes. From a more long-term perspective, health-related training programmes are being implemented, targeting all hierarchical levels involving students as well as lecturers, professors and administrative staff.

2.2. Participation

In addition, the project MinCa follows Wright's (2020) stages of participation in health promotion. Participation is considered the ideal way to successfully implement health-promoting measures and structures at universities. According to Wright, it is crucial to involve all individuals whose living and/or working conditions are affected by such measures in the research process from the outset and on an equal footing.

Wright defined nine levels of participation. The levels of the ‘ladder of participation’ range from ‘non-participation’ to ‘beyond participation’ (ibid.). The project is at one of the higher levels, as it grants decision-making powers to the members of the target group: MinCa provides for the involvement of students in the needs analysis and the facilitation of co-determination. Moreover, students are involved in all stages of data collection and evaluation. Students also acted as co-researchers in a pilot course in the summer semester of 2025 on participatory knowledge transfer focussing on mental health in higher education.

During the course of the project, the program coordinators involved in the vocational teaching degree program will be also included in the needs assessment in the form of a problem-centred survey in order to gain the perspective of those actors who are primarily involved in advising students.

The aim of the participatory approach is to identify content-related and structural factors that influence students' subjective mental health in the university environment.

3. OBJECTIVES, DESIGN AND METHODS

MinCa's core goals and actions can be categorized into medium- and long-term. These include both the promotion of individual MHL and the anchoring of health-related content in the curriculum, as well as the development of an SHM and networking within and outside the university and, finally, the consolidation of the offerings as part of a micro degree in MHL. On this basis, a curricular and structural plan of actions was developed that enables the promotion of MHL at LUH on an individual and organizational level (Banek et al., 2025a).

3.1. Curricular Level

MinCa currently investigates how the organizational structures of the LUH can facilitate students' development of individual MHL. To this end, various content-related offerings to promote MHL among vocational teacher training students were designed at curricular level with the help of the university didactic approach of innovative forms of teaching and learning.

The courses on MHL were piloted in the 2024/25 winter semester as preliminary work based on an initial participatory needs analysis, i.e. the seminar concepts were developed based on the results of a workshop with students. This corresponds to the participatory research approach of the project. Two regular courses were planned for this purpose in the program of courses for master's students at the Institute for Vocational Education and Adult Education. Since the 2025 summer semester, the courses have been implemented in the institute's regular program of courses.

In order to enable a sustainable continuation of the pedagogical content to promote students' MHL, MinCa is aiming to expand the curricular modules in the long term. In order to make these modules certifiable, a general LUH-wide micro degree system is currently being developed (cf. 3.3). This will enable the introduction of a micro degree not only in the vocational teaching profession for MHL, but also in other subject areas such as natural sciences for other content. The corresponding preparatory work, e.g., the necessary LUH-wide structural and organizational changes, is currently being carried out.

3.2. Structural Level

In addition to the individual promotion of students' MHL at a curricular level, MinCa has set itself the long-term goal of recognizing the effects of crises and disadvantages within its organizational structures and taking them into account by designing its university culture in a correspondingly responsive manner. As a result, LUH increasingly sees itself as an actor in health promotion, which leads to the associated values being anchored in its self-image and becoming visible in the form of a newly established SHM analogous to the existing occupational health management at LUH. The aim of the SHM, analogous to the setting approach, is to create a health-promoting university environment for everyone by expanding the existing internal structures beyond the institutes and central university health promotion facilities. This includes systematic implementation and sustainable integration of the services into the university structures. As a further measure at a structural level, a steering committee was formed to coordinate and strategically develop the various activities to promote health literacy at LUH under the leadership of the Centre for University Sports. The steering committee, which consists of representatives of LUH's internal health stakeholders, two

student assistants and the responsible university advisors from TK, will continue to work on the development of the SHM throughout the duration of the project and – in cooperation with the occupational health management – on the development of a university health management in the long term. In this way, it enables the use of synergies of existing measures and initiatives of university facilities and institutions.

Further project measures include cross-institutional, internal networking as well as cross-university, external networking, e.g. since August 2024 as part of the membership of the Healthy Universities North network, as well as accompanying research and evaluation on the topic of MHL (Banek et al., 2025b).

3.3. Micro Degree System

In a long-term perspective, the project also aims to expand the current internal structures beyond the institutes and central university facilities involved in health promotion (Banek et al., 2025a). In order to achieve this goal, a micro degree system is being developed, consisting of micro credentials. Micro credentials refer to certificates of learning outcomes that students have acquired after completing a smaller volume of learning. These learning outcomes are assessed using transparent and clearly defined criteria. Learning experiences that lead to micro credentials are designed to impart specific knowledge, skills, and competencies that meet current social, personal, cultural, or labour market needs. Micro credentials can be standalone or combined into larger qualifications, such as micro degrees. They are substantiated by quality assurance based on agreed standards in the relevant sector or field of activity (EU Council, 2022).

A key advantage of micro credentials is their high degree of flexibility. This applies to the type of event, the scope of the self-contained learning units, their inclusiveness, and, where applicable, their polyvalence. All micro credentials are designed to be competency-based, i.e., the learning outcomes are at the forefront. Micro credentials can be used in various learning environments, both online and in physical presence or in a mixed format; they can also take place in virtual or digital spaces and encompass formal, non-formal, and informal learning (Wittich & Gruber, 2024).

A micro degree is made up of several micro credentials, i.e., smaller course units with 5 credit points (CP) each, which are designed to be competence-oriented and can be taken flexibly by students from all subject areas. The long-term goal is a permanently embedded additional certificate in form of a micro degree in MHL with 30 CP, which can be taken across all degree programs at LUH (Banek et al., 2025b).

3.4. Design and Methods

The realisation of these goals is flanked by accompanying research and the publication of interim results. In a first step, ten qualitative, semi-structured and problem-centred interviews were conducted with students according to Witzel (2000) for the needs analysis. In addition to advertising via a news tile on the LUH homepage and via social media, in particular the LUH Instagram channel, advertising flyers were developed to select interview partners via the snowball system, providing information about the project and calling for participation in the interviews. The flyers were distributed on campus in the current *Zeit Campus Mental Health* 2024 and 2025 magazines. Furthermore, ten interviews were conducted with doctoral students in order to supplement the resulting needs analysis with the needs of doctoral students (Banek et al., 2025b).

The core objective of the interviews with the students was to identify content-related and structural factors that influence the subjective mental health perception of students in their living environment and thus in the university setting at LUH. The interviews conducted

were then transcribed and analysed using the theoretical coding method according to Flick (2017). The results of the ongoing data analysis will be presented using individual case descriptions and in the form of a cross-case category system.

In a next step, the course coordinators involved in the vocational teaching degree program were also included in the needs assessment in the form of a problem-centred survey in order to gain the perspective of those actors who are primarily involved in advising students.

An essential factor in this process is the close involvement of students as co-researchers in all research-related theoretical and operational decision-making processes. The involvement of students as co-researchers is accompanied by systematic ethical reflection that foregrounds equitable participation, clearly defined procedures for informed consent, and rigorous data protection measures governing all stages of the research process.

4. FUTURE RESEARCH DIRECTIONS

At the end of the project, a symposium will be held to make the results available to a wider audience. In addition, the project results will be published in an anthology. The MinCa anthology examines the topic of participatory design of health promotion measures at LUH. The focus is on promoting mental health literacy. The different perspectives of the participating status groups and actors are included in order to highlight commonalities in content, but also differences and areas of tension in the university development process.

In the long term, there are plans to expand the university's internal structures – in the sense of an approach to university health management that promotes health literacy – beyond the institutes and central institutions of LUH that have been involved to date.

5. CONCLUSION/DISCUSSION

Initial findings from the needs analysis interviews include requirements and needs, such as the need for individual, curricular and organizational support and structural integration of students, as well as perceived study-related stress factors. The initial insights gained from this needs analysis were incorporated into the curricular development of the MHL offerings so that they can be continuously developed and adapted to the current needs of students. As a result of the need for low-threshold counselling services frequently expressed in the interviews, for example, training was organized for mental health first aiders, in which various LUH employees and student assistants are trained to support students as the first point of contact in mental and psychological crisis situations (Banek et al., 2025b).

Furthermore, the initial results of the needs analysis indicate that adapting study and examination conditions plays a key role. MinCa's primary target group are VET students who attend various faculties at LUH, e.g., engineering sciences and vocational education. These are faculties with very different subject cultures and their own examination boards. It is therefore necessary to critically discuss the results against the backdrop of different subject cultures at the university.

In order to ensure sustainability beyond the end of project funding by TK, the results, particularly those concerning SHM, will be institutionally embedded within LUH's existing health management structures and further advanced through long-term strategic partnerships and targeted capacity-building measures.

The high complexity of implementation, which requires good coordination of all LUH stakeholders, is addressed by the established steering committee (cf. 2.1). The changing student body and the constantly changing conditions at the university are challenges for long-term impact measurement, just as scalability and transferability to other international universities is still open (Banek et al., 2025b).

REFERENCES

- Banek, N., Gillen, J., Michele, J., & Steuber, A. (2025a). Mentale Gesundheit von Studierenden – die Hochschule als Setting für Gesundheitskompetenzförderung. *berufsbildung, Zeitschrift für Theorie-Praxis-Dialog*, 79(1), 51-53.
- Banek, N., Michele, J. & Steuber, A. (2025b). Development of student health management – the university as a setting for mental health literacy promotion. In M. Carmo (Eds.), *Proceedings of the International Conference on Education and New Developments 2025 (END 2025), Volume 2*, 627-631. Retrieved September 3, 2025, from https://end-educationconference.org/wp-content/uploads/2025/07/Education-and-New-Developments_2025-_Vol_II.pdf
- Brock, Einig, Gostmann, Hildermeier, Özden, Schuhr, Steffens, & Basner (2024). Blickpunkt: Student Mental Health im digitalen Hochschulstudium. Handlungsempfehlungen für die Lehr- und Hochschulgestaltung. *Hochschulforum Digitalisierung*. Retrieved April 18, 2025, from https://hochschulforumdigitalisierung.de/wp-content/uploads/2024/07/HFD-Blickpunkt_Student-Mental-Health-im-digitalen-Hochschulstudium.pdf
- Dannemann, S., Gillen, J., Krüger, A. & v. Roux, Y. (2019). Reflektierte Handlungsfähigkeit als Leitbild – Konzepte und Projekte für die Lehrer*innenbildung. Ein Vorwort. In S. Dannemann, J. Gillen, A. Krüger & Y. v. Roux (Eds.), *Reflektierte Handlungsfähigkeit in der Lehrer*innenbildung. Leitbild, Konzepte und Projekte* (pp. 4-9). Berlin: Logos.
- Flick, U. (2017). *Qualitative Sozialforschung. Eine Einführung*⁸. Reinbek bei Hamburg: Rowohlt.
- Gillen, J., Michele, J., Schäfers, J., Steuber, A. & Wende, J. (2021). Digitalisierung als Chance für eine diversitätssensible Hochschullehre im Rahmen berufs- und wirtschaftspädagogischer Studiengänge? *bwp@ Berufs- und Wirtschaftspädagogik – online*, 40, 1-22. Retrieved September 3, 2025, from <https://www.bwpat.de/ausgabe/40/gillen-et-al>
- Kompetenzzentrum Gesundheitsfördernde Hochschulen (2024). *Studentisches Gesundheitsmanagement*. Retrieved April 18, 2025, from <https://www.kompetenzzentrum-gesunde-hochschulen.de/studentisches-gesundheitsmanagement>
- Okanagan Charter (2015). *An International Charter for Health Promoting Universities and Colleges*. Retrieved April 18, 2025, from <https://xn--gesundheitsfrdernde-hochschulen-idd.aau.at/wp-content/uploads/2021/07/Okanagan-Charta-2018-DE.pdf>
- Sørensen, K. et al. (HLS-EU) Consortium Health Literacy Project European (2012). Health literacy and public health: A systematic review and integration of definitions and models. *BMC Public Health*, Ausgabe 12, Artikel 80, 1-13. <https://doi.org/10.1186/1471-2458-12-80>
- Techniker Krankenkasse (2020). *Gesundheitsförderung an Hochschulen*. Retrieved April 18, 2025, from <https://www.tk.de/resource/blob/2096542/1d075e15516172ff8321c34b72d539e2/201103barrier-efrei-tk-gfanhs-data.pdf>
- Techniker Krankenkasse (2023). *Gesundheitsreport 2023. Wie geht's Deutschlands Studierenden*. Retrieved April 18, 2025, from <https://www.tk.de/resource/blob/2149886/e5bb2564c786aedb3979588fe64a8f39/2023-tk-gesundheitsreport-data.pdf>
- The Council of the European Union (EU Council) (2022). *Council Recommendation of 16 June 2022 on a European approach to micro-credentials for lifelong learning and employability* (2022/C 243/02). Retrieved April 18, 2025, from [https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32022H0627\(02\)](https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32022H0627(02))

- Wihofszky, P., Hartung, S., & Narimani, P. (2020). Ethische Reflexion in der Gesundheitsförderung: Partizipation und Partizipative Gesundheitsforschung. In A. Riedel, & S. Lehmeyer (Eds.), *Ethik im Gesundheitswesen* (pp. 1-17). Springer Reference Pflege – Therapie – Gesundheit. Berlin: Springer. https://doi.org/10.1007/978-3-662-58685-3_89-1
- Wittich, & Gruber (2024). *Micro Credentials at EULiST Universities*.
- Witzel, A. (2000). Das problemzentrierte Interview. *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*, 1(1), Art. 22, 1-13. https://doi.org/10.1007/978-3-8349-9441-7_29
- Wright, M. (2020). Partizipative Gesundheitsforschung: Ursprünge und heutiger Stand. *Bundesgesundheitsblatt - Gesundheitsforschung - Gesundheitsschutz*, 64, 140-145. <https://doi.org/10.1007/s00103-020-03264-y>
- Wyrwal, M., & Zinn, B. (2018). Vorbildung, Studienmotivation und Gründe eines Studienabbruchs von Studierenden im Lehramt an berufsbildenden Schulen. *Journal of Technical Education*, 6(2), 9-23. <https://doi.org/10.48513/joted.v6i2.127>

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Chapter # 25

DEVELOPMENT OF THE UNIVERSITY RESEARCH CENTER AND TRANSFER OF ITS RESULTS AND NEW KNOWLEDGE INTO TEACHING

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ABSTRACT

Education is an important area of the socio-economic life of any country, which serves to accumulate knowledge, experience and skills and to ensure the individual's intellectual development. Professional application of existing forms and teaching methods and active dissemination of new forms of education within the process of higher education is an important issue. For the successful implementation of new methods in higher education, it is necessary to define the requirements for the student, e.g., communication skills, technological skills and personality traits. No less important are the requirements for the qualifications of university teachers. E.g., technical skills, technological skills, consulting skills, lifelong learning skills, a process approach to solving different situations, and personal characteristics. The research and development in which they participate significantly contributes to the development of university pedagogues, as well as their institutions. The organisational structure of research and development plays an important role and can impact the educational process differently. The contribution deals with this in general and on the example of a specific technical faculty. The case study presents 3 main periods of the existence of one mechanical engineering research center at a technical faculty in an industrial region (from 2010 to the present). An overview of the main research results achieved, including income from contract research, is presented. An organisational change is suggested, which should bring about an improvement in the transfer of new research findings into student education.

Keywords: organising research and development, research centre, research institute, professor chair, research results, education.

1. INTRODUCTION

Education is a long-term process of shaping and developing a personality's cognitive, social and psychomotor components (a method based on progress in student development); educational results are confirmed by, e.g., diplomas and certificates (Neumann, 2002).

Studying can be characterised by using thought processes in learning about a given subject or topic. As part of the study, students research, search, analyse and verify through observation and experiment, use critical thinking, reflect and argue. Studying leads to developing intellectual abilities, problem-solving skills, the ability to communicate effectively, the ability to see mutual relationships between individual areas and realise studies in broader perspectives. Studying in educational institutions takes place in full-time (full-time), distance (remote) or combined form, and the study program at universities has three levels: bachelor's, master's and doctoral. All study degrees include programs offered by a specific educational institution (within the Czech Republic, accredited by the Ministry of Education, Youth and Sports for a certain period).

Teaching can then be described as a process based on the interaction of a teacher and a student. Teaching is not only concerned with imparting knowledge but also with developing skills and strategies for further learning (McKeachie et al., 1985). This view is also confirmed by Beutel's (2010) study, which shows that pedagogical interactions have different levels of complexity. Phenomenographic research has identified five categories: information transfer, instruction, facilitation, guided participation and mentoring. These categories form a continuum from simple knowledge transfer to complex partnership relationships, where the teacher acts as a "significant other" in the student's life. While lower levels focus on content and performance, higher levels emphasize active engagement, metacognition, trust and long-term development. Mentoring, as the highest form of interaction, goes beyond the school and supports lifelong learning, motivation and personal growth. The study thus shows that quality teaching requires not only knowledge, but also the ability to build relationships and support student autonomy. In this context, it is important to mention the analytical approach to teaching described by Schoenfeld (1999). His model of the teaching process characterizes the teacher's decision-making as a function of his knowledge, goals and beliefs. This approach emphasizes that teaching is not just the transmission of information, but a complex interaction in which the teacher chooses strategies based on pedagogical content, social aspects and value orientations. The model allows for detailed observation of how goals and action plans translate into specific classroom practices and provides a framework for understanding why teachers act in a certain way.

University teaching has specifics and assumes that a university student is intellectually mature and independent, interested in studying, thinking, discovering, and educating himself, and wants to achieve a university diploma. A university teacher should focus on questions about the quality and effectiveness of his teaching. An important aspect of the professionalism of university pedagogues is interest in students and respect for their personality. The decisive criterion for designing the teaching should be the student, which is a very demanding area of the pedagogical work of a university teacher. Given the subject he teaches, each university teacher should have created a certain set of teaching methods based on student activity. A prerequisite for success is deep knowledge of one's field, thorough preparation, communicative and management skills, and the ability to motivate and improvise. If the university teacher can create suitable conditions, the students can bring innovative ideas and propose solutions to the teaching. For example, Bligh (1993) and Ramsden and Ramsden (2003) formulated the main principles of higher education. These principles are followed by a modern approach, AlAfnan's Taxonomy, which emphasizes that effective teaching must develop not only students' cognitive abilities, but also their affective and psychomotor skills. This framework includes six levels from knowledge and understanding, through synthesis, evaluation and ethical reasoning, to application, creativity and lifelong learning and provides teachers with specific action verbs for goal setting and assessment. The integration of these domains supports not only intellectual growth, but also emotional intelligence, collaboration, adaptability and practical competence, which are key to preparing students for the complex challenges of today's world (AlAfnan, 2025). In line with these principles, recent research underscores that embedding sustainability into higher education curricula is equally critical for preparing graduates to address global challenges. The UAE (United Arab Emirates) provides a compelling example: guided by Vision 2021 and Energy Plan 2050, its universities integrate sustainability into teaching, research, and campus operations. Institutions such as Masdar Institute and Zayed University have launched interdisciplinary programs and experiential learning initiatives, while national strategies promote SDG alignment across curricula. These efforts aim to equip students with knowledge, values, and practical skills for sustainable development, foster collaboration with

industry, and leverage technology for innovative solutions. Despite challenges—such as resource constraints and the need for faculty training—the UAE experience demonstrates how higher education can become a catalyst for ecological responsibility and global competitiveness (Abo-Khalil, 2024). These approaches are in line with the recommendations of UNESCO (United Nations Educational, Scientific and Cultural Organization), which emphasize the need to transform higher education through interdisciplinary research, strengthening partnerships and integrating sustainability into all areas of academic activity. Moreover, the UNITWIN (University Twinning and Networking Programme)/UNESCO Chairs programme demonstrates that international cooperation and knowledge sharing are key to a just and sustainable future, with universities playing a role as centres of innovation and social responsibility (UNESCO et al., 2022; UNESCO, 2023).

These principles are consistent with current demands for higher education in the context of artificial intelligence, as shown by Chan (2023). The integration of AI into university teaching must not weaken the role of the teacher, but on the contrary, support his ability to develop critical thinking, creativity and ethical reasoning in students. The proposed ecological framework for AI policy emphasizes that technologies should be a complement to pedagogical methods, not a substitute for them. Universities should create conditions for equal access to AI tools, transparent rules for their use, and support the development of digital and social competences so that students are prepared for the complex challenges of today's world.

Based on the above, it can be stated that learning can be defined as the process of changing the knowledge, skills, attitudes and other personal characteristics of an individual. Learning does not have to be associated only with studies, but continues throughout life. Through learning we gain experience and skills in areas that we are actively involved in; it can concern both university teachers and students, as well as technical or economic workers (Barrie, 2007).

Research conducted by the faculty enables students, including doctoral students, to solve scientific problems and develop the ability to apply theoretical knowledge in practice. This process is increasingly being implemented through cooperation between universities, businesses and other external partners, which brings a number of benefits. Joint projects create an environment where academic excellence is linked to the real needs of industry, and doctoral students learn a “bilingual” approach – orientation in both academic and business contexts. Such cooperation supports interdisciplinary research, the development of transferable skills (e.g., project management, communication, entrepreneurial thinking) and increases the employability of graduates outside academia. Key elements of successful schemes are joint planning, clearly defined objectives, the involvement of practitioners in supervision and the creation of trust between partners. These models not only ensure high quality scientific work, but also contribute to innovation, regional development, and long-term partnerships between universities and industry (Borrell-Damián, EUA - European University Association, 2009; Borrell-Damián, Morais, & Smith, EUA, 2015). Cooperation between universities and industry is important in the organization of scientific research activities, which includes practices such as collaborative research, contract research, consultancy or support for innovative companies (Johnson & Onwuegbuzie, 2004). As Breznitz and Feldman (2010) state, universities today fulfill the so-called “third role” in addition to teaching and research, they actively participate in the economic and social development of regions. This is manifested not only in technology transfer, commercialization of results and establishment of spin-off companies, but also in creating partnerships with businesses, supporting incubators and engaging in community projects. The current understanding of knowledge transfer between universities and industry is

increasingly oriented towards the concept of “co-creation”, which goes beyond traditional linear models of research transfer towards interactive and two-way relationships. This approach includes not only joint research teams, laboratories and spin-off companies, but also wider ecosystems of cooperation, in which academic institutions, businesses and often the public sector or civil society are interconnected. The Organisation for Economic Co-operation and Development OECD (2019) emphasizes that effective knowledge transfer requires a comprehensive policy that combines financial, regulatory and “soft” instruments. In addition to technical mechanisms such as grant programs for joint projects, tax incentives or support for researcher mobility, the institutional autonomy of universities and public research institutions is key, allowing them to create their own transfer strategies. Current trends include the emergence of intermediary organisations (e.g., technology centres, incubators), the use of digital platforms for open innovation and the development of policies supporting spin-offs, in particular with an emphasis on the quality and sustainability of entrepreneurial activities. The OECD also draws attention to the importance of interaction between individual policy instruments – their synergies can enhance efficiency, while excessive complexity or conflicting regulations can hinder the transfer process. In this context, knowledge transfer becomes not only a technical but also an institutional and cultural process, the success of which depends on long-term strategic management and the ability to respond to digital transformation and global innovation networks.

At the same time, universities must address needs in two main areas: (1) establishing relationships between universities, research organizations and companies and (2) organizing and managing collaborative relationships in research and development (Perkmann & Walsh, 2007). These activities not only increase the innovative capacity of companies, but also contribute to job creation, the development of regional clusters and overall competitiveness.

As practice shows, the methods of organizing research and development at technical faculties are not uniform. They differ not only in their structure, but also in the degree of connection with teaching, the possibilities of using specialized capacities and the ability to support interdisciplinary cooperation. Each of these approaches has its advantages and limitations - from a close connection to the content of teaching to a wider connection with industrial practice. For better orientation, it is appropriate to present the three most common models that are applied at technical faculties. These models show how research teams can be formed, what organizational structures are proven and how research results are reflected in student education. The following part of the chapter provides a brief description of them and draws attention to the key advantages and risks that need to be considered when choosing them. After the general characteristics of R&D organization models, it is useful to show how these principles are applied in practice. Therefore, the text includes a case study that documents the gradual transformation of the research and development system at the Faculty of Mechanical Engineering of the University of West Bohemia in Pilsen. The study provides specific data on organizational changes, infrastructure, personnel, results and impacts on teaching and cooperation with industry.

The objective of this chapter is to analyze how different organizational models of research and development (R&D) at technical faculties influence the transfer of new knowledge into university teaching, and to evaluate the effectiveness of these mechanisms using the example of the Faculty of Mechanical Engineering of the University of West Bohemia in Pilsen.

Specific research questions:

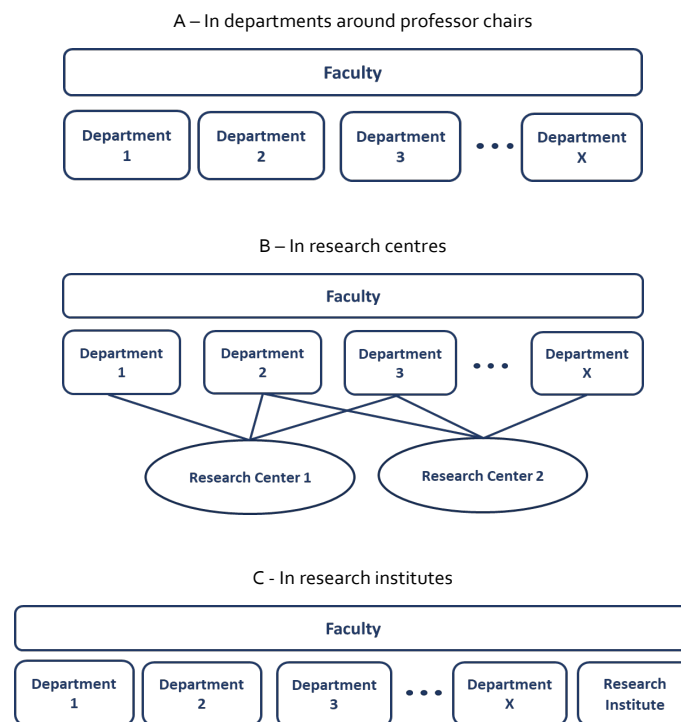
- What are the main characteristics, advantages and limitations of models A, B and C in terms of knowledge transfer into teaching?
- How did the establishment and development of the Regional Institute of Technology (RTI) affect the integration of R&D results into study programs and student involvement?
- Which organizational and managerial factors support or, conversely, hinder systematic cooperation between research teams and teachers?
- Which practical mechanisms (e.g., joint management of qualification theses, student involvement in applied projects, use of research infrastructure) are most effective for integrating R&D results into teaching?

2. ORGANIZATION OF R&D AT TECHNICAL FACULTIES

Fig. 1 generally shows three common ways of organising (and implementing) R&D at technical faculties.

Figure 1.

Scheme of organisation and implementation of research and development within the faculty.



2.1. Model A

R&D is organised within departments, and the research team is usually centred around a key professor or several key professors if the department has several partial units. The advantage of this arrangement is the closeness of the implemented R&D to the teaching

content provided by a specific department. Disadvantages include a certain professional monothematic nature and closedness and the necessity to organise ad hoc cooperations in a more complex project/contract assigned to the department.

2.2. Model B

The need to solve more complex R&D tasks leads to establishing research centres. Employees from various departments put their specialised competencies and capacities into them. Or equipment. This leads to the intermingling of knowledge and approaches from several scientific fields. In some cases, this can lead to a certain "weakening" of the departments in terms of capacity, on the other hand, the feedback from the implemented R&D is directly transferred to the teaching by specific personalities. An indisputable advantage of research teams organised this way is an interdisciplinary approach to solving specific research and development projects. Research centres are often product-oriented, so it is necessary/practical to be managed by an expert with deep professional knowledge and respect in the given industry. Such an expert is sometimes not easy to find. Its education takes many years and requires close cooperation with practice (if we are discussing applied research and industrial development).

2.3. Model C

In some cases, faculties build their autonomous research institutes. These institutes differ from the above-mentioned research centres because they are larger and have a specific management and internal organisational structure similar to independent research organisations. Research institutes are mainly devoted to R&D and are organizationally next to the departments. It is advantageous if the structure of the laboratories of the research institute corresponds as much as possible with the teaching provided by the departments. In such a case, verbal methods, which are always the basic starting point for teaching students, can easily be supplemented with demonstration methods within the framework of a nearby research institute. The best students can then be enabled for practical active work, typically within the framework of doctoral studies or even during the preparation of diploma theses.

2.4. Linking Organizational Models with Knowledge Transfer to Teaching

The organizational structure of R&D fundamentally influences the intensity and quality of knowledge transfer to the educational process.

Model A, where transfer is natural because professors conduct both teaching and research, which allows for the immediate incorporation of current knowledge into lectures and seminars. However, this transfer is limited to narrow professional areas, as research takes place within a single department and has a monothematic character, without broader interdisciplinary cooperation.

Model B brings an interdisciplinary approach - research centers bring together experts from multiple departments, which allows for the enrichment of teaching content with new knowledge from different fields. The advantage is a wider scope and the possibility of involving students in complex projects that connect multiple disciplines. The disadvantage is that transfer depends on the personal involvement of researchers in teaching; if researchers focus only on projects, the connection with teaching weakens.

Model C achieves high research performance thanks to independent institutes, but without targeted measures there is a risk of isolation of research from teaching. Therefore, systematic involvement of researchers in the pedagogical process is necessary, for example through joint projects, syllabi editing and the supervision of qualification theses.

Practical mechanisms include the joint supervision of diploma and dissertation theses, the involvement of students in applied projects, the use of R&D results in lectures and the publication of technical monographs. These approaches correspond to the EUA international recommendations (DOC-CAREERS), which emphasize the importance of university-industry cooperation for the development of competences and employability of graduates (Borrell-Damián, 2009; Borrell-Damián et al., 2015), and to the UNESCO recommendations, which call for the connection of research, teaching and sustainable development through interdisciplinary approaches and global networks (UNESCO et al., 2022; UNESCO, 2023).

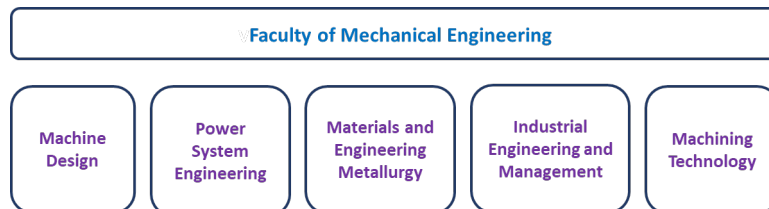
3. CASE STUDY

The previous paragraphs generally characterise 3 typical schemes of organising research and development. The case study gives a concrete example of its transformation over the years at the Faculty of Mechanical Engineering of the University of West Bohemia in Pilsen, Czech Republic

3.1. Model A

Until 2004, R&D was carried out at the Faculty of Mechanical Engineering of the West Bohemian University in Pilsen according to the classic model A, Fig. 2. It was primarily focused on working with doctoral students, and each department had its disciplinary council established to manage it. Specific R&D projects took place only sporadically, and orders from industry had a short-term character and were handled as a so-called supplementary activity.

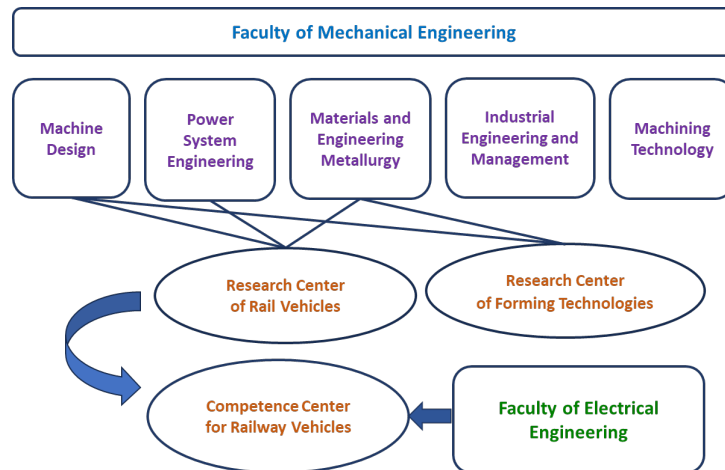
*Figure 2.
Model A for the faculty.*



3.2. Model B

In addition to the continuing original approach A, 2 research centres were established at the faculty in 2005-2006, to which the departments transferred part of their capacities, schematically see Fig. 3.

Figure 3.
Model B for the faculty.



Research Center of Rail Vehicles that only dealt with the mechanical parts of locomotives, vehicle units, wagons, trams and metros. The research center had two other external research organisations and one rolling stock manufacturer as partners. Research Center of Forming Technologies dealt with hot and cold forming technologies and surface and volume forming. It was intensively devoted to improving the useful properties of metals by thermomechanical processes. The research center had two other research organisations as partners. The main goal of both research centers was to achieve application results, i.e., patents, utility models, functional samples and verified technologies. For example, the high-strength hollow shaft was awarded a gold medal for the best innovation at the International Engineering Fair in Brno. Of course, publication activities also took place, but they did not determine the centres' success in their evaluation by the subsidy provider, the Ministry of Education, Youth and Sports.

In 2009, the Technological Agency was established in the Czech Republic, which centralises state support for applied research and development (which until then was fragmented among many providers). In connection with this, the Research Center of Rail Vehicles was transformed into the Competence Center for Railway Vehicles, and research was already focused on the vehicle as a whole, i.e. not only on its mechanical part but also on its drives. Some safety issues of their operation were also addressed; therefore, the related infrastructure was at stake. Therefore, the Faculty of Electrical Engineering's capacities were also involved in the centre's activities. The center had 11 other partners across the Czech Republic, of which 4 were research organisations, 3 were end manufacturers, and 4 were component manufacturers. Around a hundred application results were achieved. Most were applied in practice since they were created in cooperation between research organisations and businesses. The transfer of new knowledge from research and development to teaching occurred naturally through the human capacities working simultaneously in research centers and departments. A bonus not only for students but also for professionals was publishing a series of books devoted to various technical aspects of the construction of rail vehicles.

3.3. Model C

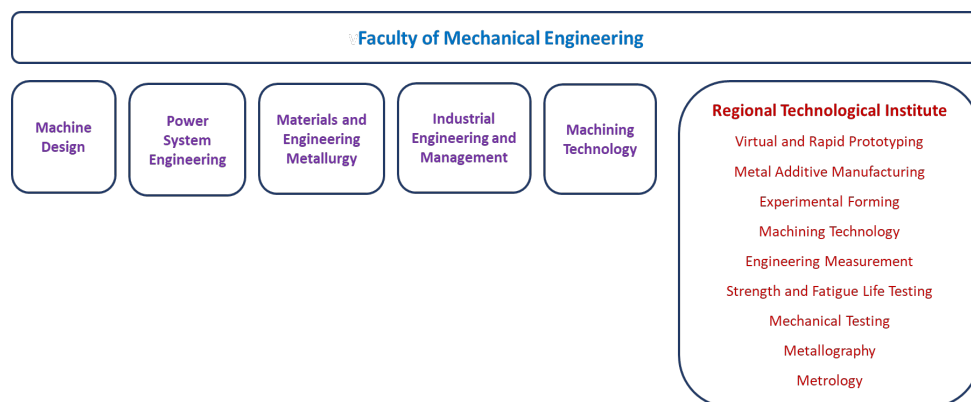
With the support of the European Regional Development Fund, a separate unit called the Regional Technology Institute (RTI) was built at the Faculty of Mechanical Engineering between 2011 and 2015. Around 60 new jobs were created, half under age 35, focused exclusively on research and development. A modern infrastructure for R&D was acquired. The capacities of the two aforementioned research centers were transferred to RTI. RTI was put into full operation in the middle of 2015, and its institutional support was terminated on 30 June 2019, which, until then, represented roughly half of the financial resources required for the operation of RTI. Since then, institutional support for RTI has been in the minority, and RTI workers obtain most funds (up to 80%) from grant agencies in the form of subsidies for accepted R&D project proposals and, of course, also as sales for solving research contracts for businesses. Most subsidised projects are solved in cooperation with the industrial sphere, and other domestic research organisations often participate. International projects are also handled.

The benefit of RTI for faculty development is indisputable. Most of the results are translated into practice thanks to the developed cooperation with the business sphere. Some results of own research have received public recognition. The number of employees of the faculty, which can now clearly be described as a research faculty, has almost doubled.

The faculty has modern equipment, so students can go on excursions in their home environment (one of the demonstrative teaching methods). It is possible for students to carry out their calculations and experiments here as part of their qualification work (practical teaching method). The best doctoral students work in teams solving complex multidisciplinary R&D projects, which can be considered a participatory learning method (Honzikova, 2015).

The structure of the RTI laboratories was not conceived in such a way as to have the greatest possible impact on the quality of teaching, but above all in such a way as to enable a complete cycle of development and testing of some engineering products. This can be demonstrated in the example of additive technologies, where to develop a new component successfully, it is not enough to have a suitable printer but the developers need to have software for its design and optimisation, postprocessing (heat treatment and surface treatment) and various testing. In the organisational structure of the faculty, RTI stands next to (at the same level as) the departments, see Fig. 4.

Figure 4.
Model C for the faculty.



To date, the administrative and research team of the RTI has completed 3 characteristic five-year periods:

I - phase of building, period 2010-2014 (project design, construction of a new hall, acquisition and commissioning of new equipment with full financial support, start-up grant for gradual recruitment of research staff and step-by-step expansion of research and development activities);

II - sustainability phase, period 2015-2019 (mandatory full occupancy of newly created jobs and operation of purchased infrastructure, primarily for the implementation of research and development, were partially financially supported);

III - follow-up, independent operation, period 2020-2024 (research and development within the open market).

*Table 1.
Results of the RTI research center.*

Main categories of results achieved in the evaluated periods of RTI operation	Period I 2010 - 2014	Period II 2015 - 2019	Period III 2020 - 2024
Publications	127	511	195
<i>of which registered in WoS or Scopus</i>	not registered	93	95
Applied results	88	295	235
<i>of which patented</i>	21	39	47
Contractual research	584	3 815	3 701
<i>thousands of EUR</i>			

In all of the above phases, the measures of success of this relatively independent research center were the research results achieved. The results can be divided into two main categories: publications and application results. Cooperation with industrial companies is best measured by income from contract research or services such as accredited tests and expertise. Table 1 shows the structure of the results.

High-quality, application-oriented research and development primarily benefit cooperating industrial enterprises. The table illustrates the consolidation of industry partnerships and an improvement in the quality of both principal categories of outcomes. Additional evidence of increased excellence in research and development includes a higher share of publications indexed in recognised scientific databases and a growing number of original, patentable results.

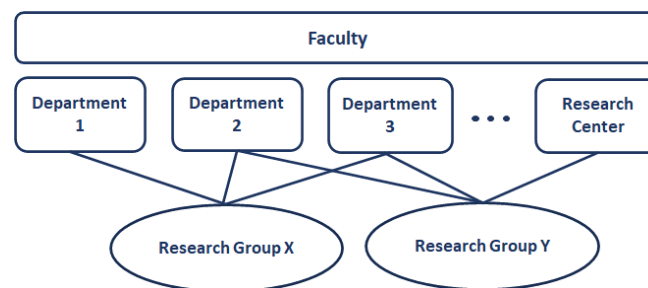
Humboldt's theory that research and teaching are inseparably intertwined within the university environment has been confirmed in practice. At the same time, however, it has become evident that the quality of teaching is not directly correlated with the quality of research and development. Similar conclusions have been reached by several international studies.

Within the existing organisational structure, the faculty has indeed increased its research output; nevertheless, this has not automatically translated into enhanced quality of education, as researchers have participated only marginally in the teaching process. Over time, the transfer of new knowledge from the RTI research center to individual departments has proven insufficient, and the departments have also begun to fall behind in terms of equipment. This challenge must be addressed.

A possible way forward lies in targeted cooperation between the heads of RTI laboratories and departmental chairs, the systematic involvement of leading researchers in the teaching process, and the joint implementation of R&D projects. An alternative would be to redefine the role of the RTI research center and manage it according to the concept of a combined research–educational unit.

Research and teaching activities are therefore currently being transformed into a model approximating the above-described Model B (see Figure 5). Academics and researchers are expected to collaborate in discipline-oriented research groups, the establishment of which is now under consideration by the faculty leadership.

Figure 5.
Plan for the reorganisation of research activities.



Researchers will gradually assume a more substantial role in teaching. At the same time, it is recognised that university instruction has its own particular demands. Success requires not only the deep subject expertise that new lecturers have acquired during their work at the RTI research center, but also thorough preparation, communication and managerial skills, and the ability to motivate and improvise. University lecturers should, therefore, place greater emphasis on the quality and effectiveness of their teaching.

An important aspect of university teachers' professionalism is, above all, their genuine interest in students and respect for their individuality. The decisive criterion in designing instruction should be the student, which constitutes one of the most demanding areas of a university teacher's pedagogical work. When university teachers succeed in creating appropriate conditions, students can contribute innovative ideas and propose solutions for both teaching and research.

4. CONCLUSION

The analysis of the development of organizational models of research and development at technical faculties confirms that the way they are structured fundamentally affects not only the effectiveness of scientific work, but also the quality of knowledge transfer into the educational process. Experience from the transformation at the Faculty of Mechanical Engineering of the University of West Bohemia shows that increasing research output alone does not automatically guarantee improved teaching. The Humboldt principle of linking research and teaching is fulfilled in practice only if mechanisms for systematic cooperation between research teams and teachers are created.

From the perspective of strategic management, the following factors appear to be key:

Institutional integration: Autonomous research institutions (Model C) bring a high degree of professional specialization and excellence, but without targeted measures, they risk

being isolated from the pedagogical process. It is therefore recommended to introduce hybrid models that connect research capacities with teaching through joint projects, shared laboratories and the participation of researchers in the creation of study plans.

Personnel policy: Successful knowledge transfer requires not only professional erudition, but also pedagogical competences of researchers. Systematic inclusion of didactic training, mentoring and support for the development of communication skills is essential for researchers to become quality university teachers.

Technological and infrastructural background: Modern research infrastructures, such as RTI, represent significant potential for demonstrative and participatory teaching methods. However, it is necessary to ensure their accessibility for students of all levels of study, not only for doctoral students.

International and interdisciplinary dimension: Trends in the field of higher education (UNESCO, EUA, OECD) clearly point towards linking research with global challenges, in particular sustainability and digitalization. It is therefore recommended to expand cooperation with international partners and to include the principles of open innovation and co-creation of knowledge in the educational process.

In the long term, it is essential that technical faculties adopt the concept of a “learning institution”, where research, teaching and the third role of universities (social responsibility, technology transfer) form a synergistic whole. Only in this way can we ensure that graduates will have not only deep professional knowledge, but also the ability to adapt, think critically and collaborate interdisciplinary – competencies that are key to solving the complex problems of contemporary society.

REFERENCES

- Abo-Khalil, A. G. (2024). Integrating sustainability into higher education: Challenges and opportunities for universities worldwide. *Heliyon*, 10, e29946. <https://doi.org/10.1016/j.heliyon.2024.e29946>
- AlAfnan, M. A. (2025). Enhancing educational outcomes using AlAfnan taxonomy: Integrating cognitive, affective, and psychomotor domains. *International Journal of Evaluation and Research in Education*, 14(3), 2419-2437. <https://doi.org/10.11591/ijere.v14i3.33147>
- Barrie, S. C. (2007). A conceptual framework for the teaching and learning of generic graduate attributes. *Studies in Higher Education*, 32(4), 439-458. <https://doi.org/10.1080/03075070701476100>
- Beutel, D. (2010). The nature of pedagogic teacher-student interactions: A phenomenographic study. *The Australian Educational Researcher*, 37(2), 77-91. <https://doi.org/10.1007/BF03216923>
- Borrell-Damián, L. (2009). *Collaborative doctoral education: University-industry partnerships for enhancing knowledge exchange. DOC-CAREERS project*. Brussels: European University Association.
- Borrell-Damián, L., Morais, R., & Smith, J. H. (2015). *Collaborative doctoral education in Europe: Research partnerships and employability for researchers. Report on DOC-CAREERS II project*. Brussels: European University Association. <https://doi.org/10.1080/03075079312331382498>
- Bligh, D. (1993). Learning to teach in higher education. *Studies in Higher Education*, 18(1), 105-111.
- Breznitz, S. M., & Feldman, M. P. (2012). The engaged university. *Journal of Technology Transfer*, 37(2), 139-157. <https://doi.org/10.1007/s10961-010-9183-6>
- Honzikova, J. (2015). *Work education with didactics* (in Czech). Praha: UJAK.
- Chan, C. K. Y. (2023). A comprehensive AI policy education framework for university teaching and learning. *International Journal of Educational Technology in Higher Education*, 20(38). <https://doi.org/10.1186/s41239-023-00408-3>

- Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed Methods Research: A Research Paradigm Whose Time Has Come. *Educational Researcher*, 33(7), 14-26. <https://doi.org/10.3102/0013189X033007014>
- McKeachie, W. J., Pintrich, P. R. & Lin, Y-G. (1985). Teaching Learning Strategies. *Educational Psychologist*, 20(3), 153-160. https://doi.org/10.1207/s15326985ep2003_5
- Perkmann, M. & Walsh, K. (2007). University–industry relationships and open innovation: Towards a research agenda. *International Journal of Management Reviews*, 9, 259-280. <https://doi.org/10.1111/j.1468-2370.2007.00225.x>
- Ramsden, P., & Ramsden, P. (2003). *Learning to Teach in Higher Education* (2nd ed.). Routledge. <https://doi.org/10.4324/9780203507711>
- Schoenfeld, A. H. (1999). Models of the teaching process. *The Journal of Mathematical Behavior*, 18(3), 243-261. [https://doi.org/10.1016/S0732-3123\(99\)00031-0](https://doi.org/10.1016/S0732-3123(99)00031-0)
- OECD. (2019). *University–Industry Collaboration: New Evidence and Policy Options*. OECD Publishing. <https://doi.org/10.1787/e9c1e648-en>.
- UNESCO, Global Independent Expert Group on the Universities and the 2030 Agenda, Parr, A., Binagwaho, A., Stirling, A., Davies, A., Mbow, C., Hessen, D. O., Bonciani Nader, H., Salmi, J., Brown Burkins, M., Ramakrishna, S., Serrano, S., Schmelkes, S., Tong, S., & McCowan, T. (2022). *Knowledge-driven actions: Transforming higher education for global sustainability* (pp. 1-101). Paris, France: UNESCO. <https://doi.org/10.54675/YBTV1653> Available at <https://unesdoc.unesco.org/ark:/48223/pf0000380519>
- UNESCO. (2023). *Transforming knowledge for just and sustainable futures: UNITWIN/UNESCO Chairs Programme* (pp. 1-79). Paris, France: UNESCO. Available at <https://unesdoc.unesco.org/ark:/48223/pf0000387435>

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Chapter # 26

THE ROLE OF THE LOCAL SCHOOL IN THE RURAL COMMUNITY:

A perspective of school multifunctionality

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ABSTRACT

Latvia is facing major demographic changes that threaten the existence of local schools in rural communities. National education policy has led to closing small rural schools; this process, however, affects not only children and teachers but also the whole community: it increases social inequality, makes it difficult to provide qualitative education as close as possible to where children live, and promotes further depopulation of rural areas. Transforming schools into multifunctional community centres can increase the quality of life of local communities. As a result of the case study of Garoza elementary school in Jelgava County (Latvia) conducted in 2025, the authors support the idea of more opened schools experimenting with different forms of learning in collaboration with the community as suitable scenario for small rural schools in Latvia. The research aimed to explore the opportunities for rural school multifunctionality in local communities, taking into account their needs as well as to develop recommendations to promote sustainable development of local schools. The results show that the multifunctionality of rural schools can provide solutions for their sustainable development and strengthening local community through adapting schools to the different needs of local communities and acknowledging significant advantages of the rural environment and small schools.

Keywords: rural schools, multifunctionality, community, education policy, sustainability.

1. INTRODUCTION

Latvia is facing major demographic changes that threaten the existence of local schools in rural communities. In Latvia, historically schools have been the centre of local communities; however, in many cases this experience had to be re-introduced (Tūna, 2015, p. 499). Tūna suggest that rural schools are significant local actors for life-long learning and rising social cohesion. Laizane (2012) in her doctoral thesis have emphasized ecological approach towards rural school analysis. To maintain a small school with a small number of children and ensure high quality teaching is complicated. Therefore, according to the priorities set by the Ministry of Education and Science, all municipalities in Latvia but especially in rural areas are implementing the school network reform by closing small local schools.

After the administrative territorial reform in Latvia, since 2021, 38 schools were closed in total and 142 schools were reorganized or merged with the other school (Ministry of Education and Science, 2024). The process often is full of emotions and protests; however, some municipalities seek a compromise. The process of school network optimization affects not only children and teachers but also the whole community: it increases social inequality, makes it difficult to provide qualitative education as close as possible to where children live, and promotes further depopulation of rural areas or in other words - “slow death” of local

community (e.g., Koroleva et al., 2017; Svendsen, 2009). In Latvia and other countries (e.g., Sweden), those who argue for closing the schools, in addition to the financial arguments, claim that small schools provided a low quality of education, isolation, small groups, and social vulnerability (Cedering & Wihlborg, 2020, p. 615).

The research of the Organization for Economic Co-operation and Development (thereafter OECD) envisages that local schools can be developed according to different scenarios. In this study the authors believe that scenario “Schools as learning hubs” where “diversity and experimentation are the norm”; “opening the “school walls” connects schools to their communities”, and “favouring ever-changing forms of learning, civic engagement and social innovation” indeed is a key (OECD, 2020, p. 49). Small schools often turn into the only one significant local hub maintaining crucial functions of community life. Based on the case study in Garoza parish, the paper aims to explore the opportunities for rural school multifunctionality in local communities, taking into account their needs as well as to develop recommendations to promote sustainable development of local schools. The authors examine the main challenges and opportunities of adapting rural schools to the different cultural, social and economic needs of local communities.

2. LITERATURE REVIEW

Interest in small rural school research is acknowledged in many countries and regions. Fargas-Malet and Bagley (2021) refer to the number of studies in European countries focusing on the potential these schools have “for the building of community engagement and social cohesion for sustainable change” (p. 823). In Lithuania, Misiūnienė (2019) has studied possibilities for activities of a full-day school in a multifunctional centre in case when schooling opportunities in local rural community are limited. These examples show how traditional interpretation of what is school and teaching process and what school can offer to wider public is changing. Based on their case study in a small Swedish municipality of Ydre, Cedering and Wihlborg (2020, p. 606) claim that after the local school closures local families referred to reduced life quality and loss of social networks when they had to travel longer distances to other schools. Meanwhile, the local municipal council considered the school closures to be beneficial to the community. The study emphasized also the level of integration of a school in community’s daily life, and the authors call for local policies “that can improve life quality and make everyday life more sustainable for people in rural areas” (Cedering & Wihlborg, 2020, p. 615). More recent study (Limbert, 2025) shows similar results: instead of consolidation outcomes, sustaining local schools foster stronger community ties, engagement, identity, and local economy as well as helps to reduce CO2 emissions. Limbert (2025, p. 60) also claims that maintaining existing schools can be more economical in the long term compared to consolidation costs and busing students to larger institutions.

Although this paper does not focus on rural community school management models, regarding the school and learning process governance, it is important to emphasize the role of the school founder (the state, municipal or other agency) as well as the one of the school administrators that may use a number of practices and strategies to foster family-school-community partnerships. As Cummins and Patel (2025) reveal, among the number of these strategies, some are as follows: encouraging parent leadership and advocacy, leadership presence in the community, and establishing the school as a social and cultural broker. In Latvia, schools are traditionally funded and maintained by the municipalities. The state provides grants for teaching staff remuneration. Parents are represented in school boards and thus involved in the decision-making processes.

As Smit, Hyry-Belhammer and Raggl (2015) state, there are two strands of discussion linked with teaching and learning in rural schools: one discourse focuses on limited opportunities of students to attain high educational success in rural schools, disadvantages and inequality compared to urban schools, and the other discourse emphasises rural schools as a place for experimentation and pedagogical innovation. Regarding the first discourse, it is important to understand the local rural community context in order to analyse some learning and teaching processes as well as the outcomes (Hargreaves, Kvalsund, & Galton, 2009). For example, in schools, where the place-based education approach is introduced, a greater attachment to local community and its context is achieved, students become proactive investigators of the multiple environments they live (Yemini et al., 2025). This is a way how to ensure locally driven, community based, or ecologically focused education. Based on empirical evidence, Svendsen (2009) points out that “multifunctional centres should ideally contain public services (e.g., school, kindergarten, library, health care), private enterprises [...], and “facilities for local voluntary associations [...]” (Svendsen, 2009, p.3). Transforming *schools into multifunctional community* centres can help preserve schools and strengthen the quality of life of local communities. Research conducted in Latvia by Supule (2019) indicates that “rural schools and municipalities positively evaluate the approach of community schools with extended functions” (p. 171); however, extended functions and the community school model is not enough strong argument for keeping a school open as it rather is “a form of competition between municipalities” (p. 171). In Latvian municipalities, however, there is no strong support yet towards changing approach and transforming rural schools into community centres.

3. RESEARCH METHODOLOGY

The study was completed in two phases during April and May, 2025. Firstly, a literature review was conducted as a desk-research, and, secondly, the focus group with school management, teachers, and local government representatives (six participants in total) was organized to collect views from the local stakeholders on the possibilities for adapting schools to community needs and the necessary support mechanisms. Qualitative research approach was applied and particularly case study methodology (Yin, 2003) was selected to analyse multifunctionality of Garoza elementary school and its role in local community which is Salgale parish (Jelgava County, Latvia). The advantage of this methodology is that a case is investigated deeply as a united and integrated entity by using several data collection methods (Creswell, 2007).

The focus-group was conducted in the school, it was 1 hour and 30 minutes long and was recorded. The researchers followed the respective ethical guidelines: all invited discussion participants were informed about the aim of the discussion, informed consent was received, participation was completely voluntary with an opportunity to withdraw anytime, participants were asked permission to record the discussion. Before the discussion, participants were introduced with the main topics and questions. Focus-group took place in a friendly and cordial atmosphere; the participants were quite insightful and interested in the topic, and elaborated on each other's ideas. Later, the audio recording was transcribed with the tool *Transkriptor.com*. After revision, the focus-group data were coded and analysed according to the main discussion topics. They are: 1) the role and interaction of Garoza elementary school with local community of Salgale parish; 2) community needs and multifunctionality of a local school; 3) sustainable development and future perspectives of local rural school.

4. RESEARCH RESULTS

The first school in Garoza parish was founded in 1886, so it has a long and rich history. In 2026, it will celebrate its 140th anniversary. The school survived, despite the consequences of the First World War, when it turned into ruins. Location of the parish and the school is shown in the Figure 1.

*Figure 1.
Location of Garoza elementary school and its coat of arms.*



In 1926, the school was renovated and during the Second World War it remained intact until today (Skolas vēsture, n.d.; Štelmahere et al., 2016). Contemporary exterior of the school and its main buildings are shown in the Figure 2.

*Figure 2.
Garoza elementary school, Spring 2025 (author of the photos: Liga Paula).*



The number of pupils has varied from approximately 70 to a little bit over 100 from year to year. Besides the elementary schooling program, the school has pre-school unit providing Montessori education what the school is very proud of. During some period after 2000, the school was renovated and its infrastructure was greatly improved according to contemporary requirements combining historical buildings with new amenities and infrastructure. During its rich history, the school has changed its name several times (Štelmahere et al., 2016); now it is Garoza elementary school.

In Salgale parish there are two villages: Emburga and Garoza. The territory of Garoza village is 156.9 km², its population is around 1500 inhabitants. The local school in Emburga was closed as the village is near to some neighbouring parish and Jelgava County municipality decided to optimize their costs. The Garoza elementary school now is also one the biggest employers in the village, it also serves as important community hub involving community people in joint activities. The school regularly participates in a number of projects. One of them is related to training seniors in computer skills and digital literacy. The school has experience and skilled personnel to work with children with some learning disabilities therefore it is popular among the parents also from the neighbouring parishes and Jelgava city as Garoza elementary school can ensure inclusive learning environment in smaller groups.

Regarding the role and interaction of Garoza elementary school with local community, the focus-group discussion revealed a number of links and activities. The school has strong networks with local community groups especially children's families and their parents. Even more, children with behavioural and learning disabilities from near Jelgava city are accepted in the school as it has inclusive learning policy. As school representative stated: *"Children from Jelgava and the surrounding area are transported to the school by Salgale parish school bus, because the school in Garoza provides an individual approach, works with children who did not do so well in big forms of a city school, implements inclusive education. What cannot be achieved in the city, small schools do it, you could say they do the work that city schools did not do."*

The school representatives named a number of local organizations and activities where school is involved. Amongst the other, cooperation with the local motorcycle trial club was mentioned. The club offers various creative activities for pupils and educators (e.g., career education). Through sport children learn the importance of sports, increase their purposefulness; in sport camps organized in the open-air they acquire certain survival activities in the forest, etc. Cooperation with local churches was also emphasized, e.g., pastor came to address children at Christmas service. Garoza elementary school has strong cooperation with the Music and Art School and with the local library. Also, local entrepreneurs were mentioned as cooperation partners: *"There is an excellent cooperation with an entrepreneur next to the school, who was engaged in berry farming and shares his experience with students about practical knowledge and skills useful for life."*

A number of activities and events take place at Garoza elementary school, in which the residents of Salgale parish also get involved: Easter celebration, National Day concerts and balls, disc golf, motorcycle rides, sports festivals, march on Lāčplēsis Day (November 11) to the Vareļi Monument and much more. The overview of the school's multifunctionality is presented in the Table 1.

Table 1.
Overview of Garoza elementary school's multifunctionality
in the context of local community.

Community school's function	Implementation level	
	Currently	Intentions for the future
Educating school children families (events, lectures)	community level	will be continued
Course organizing (computer training for seniors)	community level	will be expanded
Organizing local culture events (concerts, balls)	community level	will be continued
Organizing sport events and training	community level	will be expanded
Organizing children camps with specialization	limited opportunities	solutions must be developed
Specialist consultations (psychologist, speech therapist)	school level	will be expanded
Centre for interest-related education (after-school activities)	community level	will be expanded
Extended day program (two groups)	school level	will be continued
Offering preschool education (Montessori education)	community level	will be expanded
Availability of workshops (design and technologies)	school level	solutions must be developed
Tourism destination (heritage oak tree, museum)	community level	will be continued
Eco Garden (in strong cooperation with pupils' parents)	community level	will be continued
Cooperation with community library	community level	will be continued
Cooperation with a local music and art school (Salgale parish)	community level	will be continued
Inclusive education for children with special needs	community level	will be continued
Latvian plain air painting camps during summers	community level, national level	will be continued
Memorial procession 11 to local Vareļi monument on November	community level	will be continued
Offering boating to Ozolnieki village, camping sites in summers	idea to be implemented	will be continued

The school is very proud of its Eco Garden program which is part of the international project. Next to the school building, there is a garden (Figure 3.) where each form and group from the pre-school unit has their own plot and greenhouse where they grow different crops.

Figure 3.
Eco Garden in Garoza elementary school, Spring 2025 (author of the photos: Liga Paula).



The Role of the Local School in the Rural Community:
A perspective of school multifunctionality

The aim of the programme is indoor and outdoor classes that promote pupils' interest in a healthy and environmentally friendly lifestyle, encourage them to acquire knowledge about organic, environmentally friendly cultivation and use of crops in the household, as well as smart, sustainable collection, use and protection of wild plants that are friendly to the environment and people (Kraukle-Veisa, "n.d."). After crops are harvested, children together with their parents and teachers cook together, prepare preserves for the winter or use products for school lunch meals (Figure 4).

Figure 4.

Products of the school Eco Garden, Autumn 2025 (author of the photos: Rebeka Grinfelde).



The program has defined number of objectives (Kraukle-Veisa, n.d.) such as 1) learning to classify, compare, generalize, and apply the knowledge acquired in natural science, informatics, home economics, visual arts, and foreign language classes; 2) learn the basics of organic cultivation of crops, the principles of collecting, wisely using, researching, and protecting wild plants in the natural environment; 3) practically use IT technologies, Latvian and foreign languages; 4) get to know the climate and natural environment of their country in comparison with the natural environment of other countries, promote and seek solutions together with foreign students for a modern, healthy, environmentally friendly and sustainable lifestyle.

During discussion the participants shared slightly different opinions about multifunctionality of school and its future as a community center. Executive of local community was quite sceptical: *"A school must be visible in today's society and it is visible in Salgale parish, but this requires constant advertising, which takes away the strength and energy of the school to carry out its basic tasks what is teaching."* One of the teachers, however, responded: *"I agree that it is necessary to earn money and think about financing, but the school attracts families who earn money, pay taxes, which go to the municipality, so the school must be more open and multifunctional."*

Asked about the challenges that small rural schools face and respective decisions what local authorities should make in order to optimize school network in municipality territory according to the national education policy guidelines, the representative of municipality (decision-making authority) acknowledged that this is also parents' responsibility whether local school will exist and develop or not. He put it this way: *"Community residents must take responsibility for driving past the school, but of course they have the right to educate their children in Jelgava, where their work."*

When speaking about the future vision of the school, its principle mentioned: *“The school is very well located geographically, so it can attract interested parties outside the community. We want to create the first school in Latvia as an example of good practice. A school where the main focus, in parallel with studies, would be directed towards the acquisition of social skills by students in order to gain competence in completely independent self-education, to acquire survival skills.”* Therefore, her plan is to attract entrepreneurs who would be interested in helping to create an appropriate place and invest in the material and technical base, so that children could develop respective professional skills, as well as acquire various household skills. School staff plan to work towards creating a partnership between the municipality and entrepreneurs to develop a school what prepares children from the community and surrounding communities for their first work skills and to start an independent life. This is closely in line with the ideas presented in the OECD research and the scenario “Education outsourced” (OECD, 2020).

The results show that the multifunctionality of rural schools can be an important solution for their sustainable development and strengthening of the local community. By adapting schools to the different needs of the local community, while simultaneously using the advantages of the rural environment and small schools, it is possible to ensure their existence and promote regional development. To achieve this, strategic cooperation between school management, municipalities and the local community is necessary.

5. CONCLUSIONS

Due to the critical demographic indicators of Latvia, rural schools can exist by supplementing educational services with multifunctional and diverse activities that meet the needs of the local territorial community. Rural school can be considered strong if it has good educational quality and close ties with the local community, however, they cannot compete with city schools. The Garoza elementary school has proven its ability to work with students who are not accepted into a city school due to low achievement, however, showing progress and student development dynamics in smaller school.

Although Garoza elementary school already offers a wide range of valuable multifunctional activities for the local community, educators show great interest, encouraging new, creative ideas and readiness for various experiments, just to maintain the sustainability of the school. The school is currently focused on the goal of the Eco Garden program - to promote students' interest in a healthy and environmentally friendly lifestyle and the ability to use knowledge and skills to solve problems in changing real-life situations.

The executive of the local community is more sceptical of the school's efforts to become a multifunctional community center than the decision-making units of a County, indicating that teachers should deal with the educational service offer and not invest energy in ensuring other activities. Both the political decision-makers and the executive of the local community confirm that there would be no risks in future maintaining the school's infrastructure if the heating system were replaced with a more economical solution.

The local community and the school management agree that children must learn to survive in today's rapidly changing world and be ready to self-organize in diverse and unexpected situations in the future, therefore, they see an increasingly close cooperation with entrepreneurs from the local community who would be interested in material and spiritual investments in the Garoza elementary school as a challenge for school development.

REFERENCES

- Creswell, W. J. (2007). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches* (2nd ed.). Thousand Oaks, London, New Delhi: SAGE Publications.
- Cedering, M., & Wihlborg, E. (2020). Village schools as a hub in the community - A time-geographical analysis of the closing of two rural schools in southern Sweden. *Journal of Rural Studies*, 80 (2020), 606-617. <https://doi.org/10.1016/j.jrurstud.2020.09.007>
- Cummins, N., & Patel, S. (2025). Leadership and Family-School-Community Partnerships in the Model Schools for Inner Cities Initiative. *Improving Schools*, 27(2-3), 57-70. <https://doi.org/10.1177/13654802251397190>
- Ministry of Education and Science (2024, December 28). *Reorganizētās, slēgtās un dibinātās izglītības iestādes* [Reorganized, closed and founded educational institutions] Retrieved from <https://www.izm.gov.lv/lv/reorganizetas-slegtas-un-dibinatas-izglitibas-iestades>
- Fargas-Malet, M., & Bagley, C. (2021). Is small beautiful? A scoping review of 21st-century research on small rural schools in Europe. *European Educational Research Journal*, 21(5), 822-844. <https://doi.org/10.1177/14749041211022202>
- Hargreaves, L., Kvalsund, R., & Galton, M. (2009). Reviews of research on rural schools and their communities in British and Nordic countries: Analytical perspectives and cultural meaning. *International Journal of Educational Research*, 48(2), 80-88. <https://doi.org/10.1016/j.ijer.2009.02.001>
- Koroleva, I., Karklina, I., & Aleksandrovs, A. (2017). Rural Schools as Multifunctional Centres: Alternative for School Survival and Flourishing Communities. *Social Sciences Bulletin*, 1(24), 7-29. Retrieved from https://du.lv/wp-content/uploads/2022/11/SZF-vestnesis_2017_1_druka.pdf
- Kraukle-Veisa, V. (n.d.). Eco Garden. Retrieved from <https://www.garozaspamatskola.lv/pirmsskola/interesu-izglitiba/eco-garden/>
- Laizane, A. (2012). *Latvijas lauku skolu izglītības vides mainības un daudzveidības izvērtēšana*. [The Evaluation of Fluctuation and Diversity of the Education Environment of Rural Schools in Latvia] (Summary of Doctoral dissertation, Latvia University of Agriculture). Retrieved from https://lluflb.llu.lv/dissertation-summary/education/Anna_Laizaane_Kopsavilkums_LLU_TF_IMI_2012.pdf
- Limbirt, C. (2025). *Transforming Rural Schools: Adaptive Reuse for Sustained Community and Sustainability* (Master's thesis, Rochester Institute of Technology). Retrieved from <https://repository.rit.edu/theses/12135>
- Misiūnienē, G. (2019). *Operational Possibilities of Full-Day School Within a Rural Multifunctional Center*. In G.-B. von Carlsburg (Ed.), *Transkulturelle Perspektiven in der Bildung* (pp. 461-471). Berlin: Peter Lang..
- OECD. (2020). *Back to the Future of Education: Four OECD Scenarios for Schooling*, Educational Research and Innovation. Paris: OECD Publishing. Retrieved from <https://doi.org/10.1787/178ef527-en>.
- Skolas vēsture. [School History] (n.d.). Retrieved from <https://www.garozaspamatskola.lv/parskolu/skolas-vesture/>
- Smit, R., Hyry-Belhammer, K. E., & Raggl, A. (2015). Teaching and learning in small, rural schools in four European countries: Introduction and synthesis of mixed-/multi-age approaches. *International Journal of Educational Research*, 24, 97-103. <https://doi.org/10.1016/j.ijer.2015.04.007>
- Supule, I. (2019). Community School Model: Is It an Alternative for School Closures in Rural Territories? *Eastern European Countryside*, 25(1), 171-194.
- Svendsen, G. L. H. (2009). Multifunctional Centers in Rural Areas: Fabrics of Social And Human Capital. In C. M. E. Frisiras (Ed.), *Rural Education in the 21st Century* (pp. 1-31). USA: Nova Science Publishers, Inc.
- Štelmahere, D., Vāvere, I., Cīrle, M., & Helviga, S. (2016). *Mana skola gadu simteņos*. [My School through the Centuries], Rīga: Avots. Retrieved from <https://drive.google.com/file/d/14-3JzXMAHjyqZAs3tIEOUY-noTqGk32u/view>

- Tūna, A. (2015). *Development of the School as Multifunctional Community Resource in Latvia: Opportunities and Challenges*. *Society. Integration. Education*, 1, 496–504. <https://doi.org/10.17770/sie2014vol1.759>
- Yemini, M., Engel, L., & Ben Simon, A. (2025). Place-based education – a systemic review of literature. *Educational Review*, 77(2), 640–660. <https://doi.org/10.1080/00131911.2023.2177260>
- Yin, R. K. (2003). *Case Study Research: Design and Methods* (3rd ed.). Thousand Oaks, CA: SAGE Publications.

ADDITIONAL READING

- Beach, D., & Öhrn, E. (2023). The community function of schools in rural areas: normalising dominant cultural relations through the curriculum silencing local knowledge. *Pedagogy, Culture & Society*, 33(3), 943–960. <https://doi.org/10.1080/14681366.2023.2298466>
- Hardman, F., & Sandi, A. M. (2024). School Improvement in Rural Settings: A Review of International Research and Practice. In Y. Zhao, & J. Liu (Eds.), *Rural School Improvement in Developing Countries*. SpringerBriefs in Education. Springer, Singapore. https://doi.org/10.1007/978-981-97-4917-1_1
- Kovács, K. (2012). Rescuing a Small Village School in the Context of Rural Change in Hungary. *Journal of Rural Studies*, 28, 108–117. [10.1016/j.jrurstud.2012.01.020](https://doi.org/10.1016/j.jrurstud.2012.01.020).

KEY TERMS & DEFINITIONS

Multifunctional rural community school: a type of publicly funded school that serves as both an educational institution and a centre of community life.

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Chapter # 27

THE IMPACT OF THE EXTENDED CURRICULUM PROGRAMMES: THE NARRATIVES FROM CURRENT AND GRADUATE STUDENTS

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ABSTRACT

This study investigates the efficacy of Extended Curriculum Programmes (ECPs) in Science and Commerce at a South African University, aimed at addressing persistent educational inequality. The ECPs provide an alternative access pathway for students who do not meet standard admission requirements, offering four streams: commerce, physical sciences, mathematical sciences, and biological sciences, with the objective of completing a three-year degree within an extended timeframe (n+1). A cohort analysis of students enrolled between 2017 to 2020 indicates a modest improvement in graduation within the (n+1) period, increasing from 17% to 19.5%. Despite this positive trend, substantial challenges remain. Approximately 32% of students discontinued their studies at the end of the fourth year, while many of those who remained required more than the prescribed timeframe to graduate. To contextualise these outcomes, the study includes a qualitative component comprising interviews with twenty randomly selected students who commenced their studies in the foundational year. These interviews explore the students' lived experiences, identifying factors that facilitated or hindered their academic progress. The qualitative findings enrich the quantitative results by providing insight into both effective practices and persistent barriers within the ECPs structure. Student-generated recommendations offer practical guidance for strengthening programme design and enhancing student success.

Keywords: extended curriculum programmes (ECPs), academic progress, educational inequality, cohort analysis, students lived experiences.

1. INTRODUCTION AND BACKGROUND

The Study University offers four streams of Extended Curriculum Programmes (ECPs) on a dedicated Campus situated approximately 21 kilometres from its main Campus. The three of which are Bachelor of Science (BSc) Programmes and one a Bachelor of Commerce (BCom) Programme. The BSc Stream comprises a) BSc Extended Physical Sciences, b) BSc Extended Mathematical Sciences and c) BSc Extended Biological and Agricultural Sciences. The BSc extended curriculum programme, formerly known as the BSc Four-year programme, was implemented in 2008, whereas the BCom extended curriculum programme, formerly known as the BCom four-year programme, was implemented in 2012.

The ECPs were designed for students who are not academically prepared but who have the potential to succeed and obtain their degree (Megbowon, Palesa, Bongiwe, & Sipokazi, 2023; Mokganya & Zitha, 2024; Mouton & Rewitzky, 2025). Admitted students are those who have achieved a bachelor's degree endorsement, but they have not met the minimum requirement for enrolment in the mainstream modules. The programmes include an additional year of study for the commerce stream and an additional eighteen months for the

sciences stream, which aims to enhance students' basic knowledge and skills before they progress to more specialist studies in later years. Some students migrate to other faculties after their extended first year to do Engineering (BEng), Medicine and Dentistry (MBChB, BChD), Veterinary science (BVSc), Education (BEd) or Humanities (BA). Thus, the students admitted in the first cohort of this study, 2017, should complete their first degree in December 2020 (n+1) and their graduation take place in the subsequent year. From its inception, the programme was designed so that most of the teaching and learning activities take place in relatively small groups (50 students per group) to allow individual attention and provide sufficient time and opportunity to engage students in discussions. The lecturing staff are encouraged to use a variety of methods to deliver subject content in order to address possible gaps in content knowledge (Brits, Eloff, & Van Staden, 2025; Snyman & Kasirye, 2021). The programmes focus on understanding and developing critical thinking skills, as well as practical skills needed to continue with the more rigorous content of the subject areas dealt with later on in the programmes. The progress of the students is assessed continuously as they have to meet set levels of academic performance throughout the year.

The main idea behind the ECPs is to bridge the gap between school and higher education (Brits et al., 2025; Engelbrecht, Harding, & Potgieter, 2014; Koiko (in Hutchings & Garraway, 2010); Garraway (in Hutchings & Garraway, 2010); Mabila et al., 2006; Mouton, 2025; Pearce et al., 2015). Moreover, ECPs serve as the primary systemic social justice intervention designed to create the necessary curriculum space for talented but underprepared students (Mabila et al., 2006; Mouton, 2025). Therefore, ECPs offer foundational knowledge, academic skills, and a more gradual transition by allowing for a slower pace and dedicated developmental modules. In this paper, students who commenced their journey in the ECPs will be referred to as 'ECP students'.

Notwithstanding the noble purpose of ECPs in the South African context, there exist several challenges and complexities (Koiko (in Hutchings & Garraway 2010); Garraway (in Hutchings & Garraway 2010); Mabila et al., 2006; Mokganya & Zitha, 2024; Mouton, 2025; Snyman & Kasirye, 2021). There is a two-fold stigma associated with the programmes: the geographical location, outskirts of the city, and far from the main campus, as well as the perceived feeling by students as "grade 13" or less than their mainstream counterparts (Brits et al., 2025; Mokganya & Zitha, 2024; Ogude, Meyer, Mwambakana, & Mthethwa, 2019). Mabila et al., (2006) reported that evidence consistently shows that ECP students, once they complete their foundation phase, often outperform mainstream students in later years of study.

In the 2017 academic year, the University launched a strategic campaign termed FLY@UP, to constantly encourage students to complete their degrees in the minimum time indicated for the programme in which they were enrolled. FLY stands for 'the Finish Line is Yours. This motivational as well as inspirational message to students was designed to encourage them to take responsibility for their progression to graduation in the minimum period. This campaign encouraged students to keep up with their classes, choose their modules carefully, manage their time, work consistently and aim for good semester marks.

The narratives of both current and graduate ECPs students are crucial for understanding the true impact of these programs. By exploring their lived experiences, researchers can move beyond mere statistics on pass and retention rates to uncover the personal and academic journeys of these individuals. These stories shed light on how ECPs affect students' identities, their social integration, and their long-term academic and professional success. Listening to these voices provides a powerful, human-centred perspective on the effectiveness and future of extended curriculum programmes (Mouton & Rewitzky, 2025). In this paper, students who commenced their journey in the ECPs will be referred to as 'ECPs students'.

2. METODOLOGY

With over a decade of implementation, this research seeks to evaluate the impact of Extended Curriculum Programmes (ECPs) on their student population. Thus, the study aimed to: a) determine the degree to which ECPs have significantly influenced students' trajectories and achievements. b) explore the experiences of a twenty-randomly-selected group of current (ten) and graduate (ten) ECPs students, providing qualitative insights into the perceived effects of these programmes. c) analyse the movement of ECPs students across different qualifications and faculties to identify preferred pathways and destinations associated with graduation.

The main objective of this research is to provide a comprehensive analysis of the impact and experiences related to the ECPs. Specifically, it seeks to quantify the effect of ECPs on graduation trends, illuminate the lived experiences of participating students, and map the academic trajectories of these students through various qualifications and faculties leading to graduation. This understanding will contribute valuable insights into the future of ECPs at the University.

A mixed method was used in this research to assess the effectiveness of ECPs by looking at factors like time to graduation, first year progression, and overall completion rate. This quantitative part of the study will thus provide a clear, data-driven picture of the academic outcomes of the ECP students. The analysis of the narratives to the open-ended questions of the twenty randomly selected students will provide insight into ECPs students' lived experiences, their emotional and psychological journey, their academic and social integration, as well as their perceived value of the programmes.

Quantitative data were collected from institutional records databases, and the enrolment number per year and per specific stream, the graduation rate per year, degree, and faculty, the time to graduation, and the dropout rate will be the key variables. Cohort analysis was performed from our database platform systems.

Qualitative data were gathered through a purposive sampling strategy that included ten current ECPs students in order to understand their ongoing experiences and ten ECPs graduates to capture a longitudinal perspective on the programmes' impact.

3. PRESENTATION OF FINDINGS AND DISCUSSION

Through a collaboration with the Department of Enrolment and Student Administration (DESA), crucial data of the ECPs students who commenced their academic journey on the outskirt Campus since 2017 has been accessible. Of the cohort that started in 2017, approximately 17% completed their studies in time, in December 2020, and their graduation took place in the following year. There was a drop out of 11% at the end of year one. The analysis captured in Table 1 further revealed a 54.4% of a cumulative number of students who graduated and a further 35% of students dropping out at the end of the year (n+4), that is, the end of 2023. The results were similar for both 2018, 2019, and 2020, with a noticeable steady increase in the percentage of graduates at the end of the year (n+1) reaching 19.5% in 2024. In their study, van Broekhuizen, van der Berg, & Hofmeyr (2017) stated that: "only a small percentage of all matriculants complete any undergraduate qualification (whether a degree, a diploma or a certificate) within the first four to six years following matric". These authors reported that from the 2008-2010 cohorts of learners, only a small portion, between 5% and 6% of learners, completed their undergraduate studies within four years. Our results are fairly high, although the authors warned us not make further conclusions about university programme completion or dropout rates from the above percentage. Their study took into

consideration all candidates in the respective matric cohorts (van Broekhuizen et al., 2017). This study's results reveal similar findings, in general, with the majority of the students taking a longer time frame to graduate.

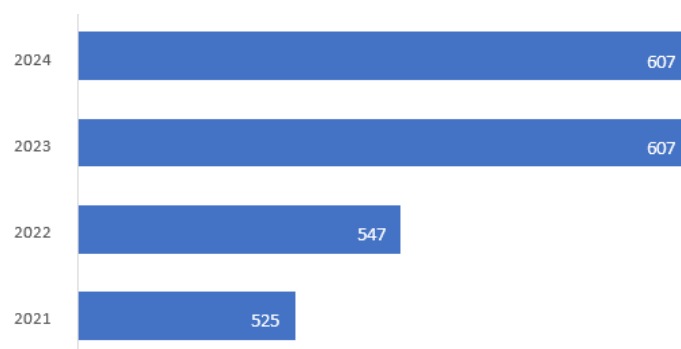
Table 1.
Cohort analysis of ECPs students who started their studies journey in 2017.

	Enrolment in 2017 (%)	Numbers end of 2020	Graduates end of 2020 (n+1)	Graduates end of 2023 (n+4)	% drop out end of year1	Cumulative % of drop out end of year (n+4)
BSc: Ext Biological and Agricultural Sciences	328(51)	173	59	184	15	105(32%)
BSc Ext Physical Sciences	116(18)	53	10	40	25	60(52%)
BSc Ext Mathematica l Sciences	84(13)	46	5	30	10	29(35%)
BCom Ext Programme	116(18)	52	37	77	18	30(26%)
Total	644(100%)	324(50.3%)	111 (17.2%)	333(54.4%)	68(11%)	224(35%)

By embracing the Extended Curriculum Programmes (ECPs), the University has opened doors to a significant number of aspiring students who might otherwise have been denied access to higher education (Brits et al., 2025, Kioko, in Hutchings & Garraway, 2010). A rising number of ECPs graduates are successfully completing their degrees and embarking on fulfilling careers (Mouton & Rewitzky, 2025). This is a testament to the transformative power of education and the dedication of our students, faculty, and staff. By providing a supportive teaching and learning environment and tailored academic support, students have been empowered to overcome challenges and achieve their dreams.

Of the cohort that started in 2017, only 17% completed their studies in December 2020, and their graduation took place in the following year. This percentage demonstrated a steady increase, reaching 19.5% in 2024. The bar graph presented in Figure 1, utilising data from University Graduation Ceremonies between 2021 and 2024, reveals a noteworthy pattern of consistent and substantial growth in the annual number of graduates. Although the data is cumulative, including students who take more than n+1 years to graduate, this upward trend is clearly evident. This achievement underscores the transformative impact of the ECPs and the dedication of our students and faculty. However, the cohort analysis also highlights significant challenges; approximately 32% of ECPs students are discontinuing their studies by the end of year four (n+1).

Figure 1.
Total number of ECPs Graduates during the 2021-2024 Graduation period.



The Study University offers a wide array of academic programs across various faculties, providing students with numerous pathways to success. A total of 2286 ECPs students who started at the Study University received their degrees from the 2021 to 2024 graduation ceremonies, as undergraduates or postgraduate students. Table 2 below showcases the movement of ECPs students across different faculties, with Natural and Agricultural Sciences and Economic and Management Sciences being in the lead with more than two-thirds of students (68%) graduating from various degrees within these two faculties.

Table 2.
Degrees awarded to ECPs students at 2021-2024 Graduation Ceremonies.

Faculties	2021	2022	2023	2024	Total number of graduates: 2286
Natural & Agricultural Sciences	220	204	220	208	37.3%
Economic and Management Sciences Engineering, Built,	107	156	219	219	30.7%
Environment and Information Technology	88	77	64	66	12.9%
Health Sciences	76	61	64	72	11.9%
Education	18	12	12	12	0.24%
Humanities	8	7	13	12	0.17%
Law	6	13	7	8	0.15%
Veterinary Science	1	15	8	9	0.14%
Theology and Religion	1	1			0.01%
GIBS Business School		1		1	0.01%

Students were asked to share their lived experiences, identifying factors that facilitated or hindered their academic progress and areas necessitating improvement.

In general, all the students appreciated the slower pace, smaller classes, and the opportunity for reflection and adjustment to university life. Student 1 stated: “It provided a crucial foundation that facilitated my later success in mainstream programmes. Students 2 and 3 initially felt some disappointment about being in the Extended Curriculum Programmes, but later they recognised its value in preparing them for their chosen fields. All students recalled the shift to online learning during the pandemic (COVID-19), leading to a feeling of isolation. The pandemic presented significant challenges with online assessments. They had to increase self-discipline.

All students emphasised the necessity of hard work, dedication, and perseverance to succeed in their studies. They acknowledged that the university journey can be challenging and requires consistent effort. They also valued the support systems available to them: family, lecturers (faculty members) and tutors, friends and peers played a crucial role in supporting them through difficult times, especially during the pandemic and when facing academic challenges.

Students 4 and 5 mentioned the importance of taking breaks, pursuing extracurricular activities, and making meaningful connections to enhance their overall university experience. Below are four synopses from two current and two graduate ECPs students.

Student A

Looking back, the extended programme was one of the most important stepping stones in my journey to becoming a medical student. It gave me the space to adjust academically and personally, while still challenging me to grow. The support from tutors was consistent and encouraging, and the class sizes created an environment where I could really engage with the material and build a solid understanding of each module. Even though we were all aiming for a spot in medicine, there was a real sense of community among us—we helped each other through the tough parts and celebrated the small wins together. The way the syllabus was structured and paced made it easier to retain information without feeling pressured to cram. In many ways, it was the perfect bridge between high school and university, and it helped me feel confident and prepared when I finally entered the MBChB programme. Now, in my final year, I can clearly see how much that foundation has shaped the student and future doctor I’ve become. I am forever grateful and genuinely hope

Student B

The day I was admitted into the Extended Programme, I chose to see it as an opportunity rather than a setback. From the very first day, I knew I had to work hard to get into my desired programme. I set clear goals, knowing exactly what I was working towards. One of the things I valued most about the campus was the smaller class sizes, which meant I could get more attention from lecturers and tutors. The support was invaluable, especially when I encountered academic challenges. However, my journey was not without its setbacks. In my first semester, I failed one of my core modules. This failure was a significant blow, forcing me to alter my study plans. I reassessed my study habits and sought additional support from the Academic Success Coaches. The late-night study sessions, consulting with the academic staff and the frequent visits to the Student Support Office eventually paid off. When I got the opportunity to write the special exam in January, I made sure not to waste it. This experience taught me the importance of resilience and the power of perseverance. Today, I am a BCom Statistics and Data Science student; a testament to the belief that, with dedication, you can achieve your dreams. Do not let anyone demotivate you about starting with an

that more students get to experience the programme

extended programme. At this University, the finish line is yours, and the staff at this Campus ensure that you reach it. The journey may be longer and more challenging, but the rewards are well worth the effort.

Embrace the process and stay focused. My advice to anyone facing similar challenges is to never let setbacks discourage you. Set your goals clearly, work towards them diligently, and remember to take care of yourself along the way. Do not neglect your social life; the friends you make can provide essential support and joy. And if you have a spiritual belief, lean on it for strength and guidance.

I can proudly say that I am an alumna of this Campus.

Student C

At first, I was upset because most of my peers were in the mainstream programme on Main Campus. But, looking back, I am grateful that I followed the extended programme.

I got an extra year to reflect on the career path I wanted to follow and the degree programme that would get me there. I also made lots of friends due to the smaller classes. Additionally, I was able to complete the same modules as the mainstream first-year programme at a manageable pace.

In my second year, I managed to qualify for the BSc Medical Sciences programme.

The transition to Main Campus was easy thanks to the study skills I learnt in the extended programme. By managing my

time, I was able to join the Student Culture Committee and the University Women's Chorale, which allowed me to have fun and experience more of university life. With hard work, determination and support from my family and friends, I was also able to join the Golden Key International Honours Society and graduate on time.

I am currently completing my honours degree in Pharmacology. I am looking forward to working in the University's Clinical Research Unit to gain integrated work experience.

Student D

I was unsure about what I wanted to study, and initially applied for both the BCom Business Management programme and the BCom Extended Programme. After being accepted into the Extended Programme, I was disappointed because it was not initially what I wanted. However, I was grateful for the opportunity and took it. Throughout my time on this Campus, I worked as hard as I could to get into a mainstream programme, and to figure out what I wanted to do.

This Campus allowed me to adjust to university life more easily, as the modules were broken down in a way that was easier to consume. This prepared me for the mainstream programme. I chose BCom Informatics (Information Systems), and that has led me to become a graduate. This degree programme was the best decision for me. Coming from my Campus, I understand how the extended programmes prepare us to handle the workload in the mainstream degree programme.

I am currently pursuing my honours degree in BIT Information Systems and I was blessed to get into an internship programme at a leading IT company.

My biggest challenge at university was adding on a year of study. The fear of being

For me, working online during the COVID-19 pandemic was the most difficult time I have experienced at university. Without the routine of attending classes and opportunities to destress with friends, I felt isolated from the university community. During this time, I relied heavily on my family to support me. It made me feel better knowing that they are always there for me. It was also helpful to reach out to my friends who were also struggling with school, and to talk to peers for help with academic work.

My advice to prospective students is to work very hard. University is very difficult, so put in lots of effort into everything you do.

However, working hard does not always give the intended results. When this happens, remember how far you have come and all the things you have achieved so far. Being at this University is a huge accomplishment! Remember that you are worthy, regardless of setbacks. Take a break, and start again.

During my studies, I prepared for my classes, and asked questions (even if they felt like dumb questions). It is also important to take a break when you need it. This can prevent burnout. Just forget about work for a bit – and then get back to it!

a failure and just another statistic really got to me. I did not have the perfect university story, but I overcame it through my faith and belief that everything will work out in the end if I just continue playing my part to the best of my ability.

Personally, I would have liked more access to a student faculty advisor on the campus, but the support from the lecturers and tutors was really great. I would not have been here had it not been for them.

The advice I can offer students starting at this Campus now is:

"Be curious!" Constantly consult your lecturers and tutors, and apply yourself to what you are doing. Most importantly, do not give up! Visualise yourself in that graduation outfit.

I wish to encourage the Campus to continue doing what it is doing to support the students that come through the extended programmes. Continue making this path an option for students, as it can be a vital point in any young person's life.

The following were the advice and suggestions made by the students: a) have different tutors for maths and physics tutorials who can offer alternative explanations to the lecturer, b) improve the facilities with faster computers and more diverse seating areas in the library, c) do not discontinue the programmes due to their positive impact on students' journeys, d) expand the range of events, clubs, and sports on the study campus to foster a stronger sense of community, and e) implement a programme to help students navigate the increased workload and pace when transitioning to a different campus and faculty.

The current students were encouraged to be curious, seek help, persevere, enjoy the journey, and maintain a clear sense of purpose.

4. FUTURE RESEARCH DIRECTIONS

Tracer study of the full cohorts of students from inception till 2022, and student feedback or voice on their learning experience.

5. CONCLUSION AND RECOMMENDATIONS

The analysis clearly shows that ECPs do give access to students who could not have been admitted to science and commerce fields due to their matric results not meeting the minimum criteria for mainstream degrees (Mouton, 2025; Mouton & Rewitzky, 2025; Brits

et al., 2025). These 2286 students would not have graduated if they had not started their studies at the Study Campus. Moreover, in the paper by Ogude et al. (2019), previous and successful students attest that during their time at this Campus, they received the necessary support from the lecturing staff, the student advisors and the tutors, which enabled them to successfully complete their degrees.

More than a decade after its inception, the study University's ECPs continue to give students access to higher education and to lay a solid foundation by equipping them with the knowledge and skills necessary for success in mainstream higher education. Although the number of successful students is below 20%, this success could not have been possible if access had been denied to them. The Council on Higher Education (2024) argues that the discussion on educational inequality and institutional interventions in South Africa highlights a shift from viewing students' underpreparedness as an individual deficiency to recognising it as a systemic articulation gap that requires institutional transformation. ECPs put into practice the shift of policy emphasis from "access to success" (Lubben et al., 2010). International Journal of Educational Development Factors influencing access students' persistence in an et al., 2010; Mabila et al., 2006; Slabbert & Friedrich-Nel, 2015), which is the main drive of the university in the South African context.

Providing a supportive teaching and learning environment, along with tailored academic support, individuals are empowered to overcome challenges and achieve their dreams. However, approximately 80% of ECPs students take longer than n+1 timeframe to successfully complete their studies, and about 32% of students drop out of the programmes by their fourth year (n+1) of studies. The study also revealed that the majority of students migrate to other Faculties and in 112 various qualifications at the university. Based on the graduation trends and students' narratives, the management of the University reviewed the ECPs offerings and has introduced, in 2025, 11 new programmes; ten in the Faculty of Natural and Agricultural Sciences and one in the Faculty of Economic and Management Sciences. To resolve the stigmatisation and sense of belonging (Brits et al., 2025; Ogude et al., 2019), the ECPs have relocated to the main Campus.

REFERENCES

- Brits, G. P., Eloff, I., & Van Staden, S. (2025). Using Extended Curriculum Programmes to Improve Student Success at Universities. *International Journal of Higher Education*, 11(2), 58-83. <https://doi.org/10.6017/ijahe.v11i2.17771>
- Council on Higher Education. (2024). *Understanding Epistemic Access and Success of Students from Historically Disadvantaged Backgrounds in South African Universities* (Higher Education Monitor No. 16). Council on Higher Education. Pretoria: South Africa.
- Engelbrecht, J., Harding, A., & Potgieter, M. (2014). Evaluating the Success of a Science Academic Development Programme at a Research-intensive University. *African Journal of Research Mathematics, Science and Technology Education*, 18(3), 287-298.
- Garraway, J. (2010). Field Knowledge and learning on Foundation Programmes. In C. Hutchings, & J. Garraway (Eds.), *Beyond the University Gates: Provision of Extended Curriculum Programmes in South Africa. Rhodes University Foundation Seminar Proceedings* (pp. 31-39).
- Hutchings, C. & Garraway, J. (Eds.). (2010). *Beyond the University Gates: Provision of Extended Curriculum Programmes in South Africa. Proceedings of January 2009 Rhodes University Foundation Seminar*. June 2010. ISBN: 978-0-620-46968-5
- Koiko, J. I. (2010). Foundation Provision in South African Higher Education: A Social Justice Perspective. In C. Hutchings, & J. Garraway (Eds.), *Beyond the University Gates: Provision of Extended Curriculum Programmes in South Africa. Rhodes University Foundation Seminar Proceedings* (pp. 40-49).

- Lubben, F., Davidowitz, B., Buffler, A., Allie, S., & Scott, I. (2010). International Journal of Educational Development Factors influencing access students' persistence in an undergraduate science programme: A South African case study. *International Journal of Educational Development (on-line)*, 30, 351-358. <http://dx.doi.org/10.1016/j.ijedudev.2009.11.009>
- Mabila, T. E., Malatje, S. E., Addo-Bediako, A., Kazeni, M. M., & Mathabatha, S. S. (2006). The Role of Foundation Programmes in Science Education: The UNIFY Programme at the University of Limpopo, South Africa. *International Journal of Educational Development*, 26(3), 295-304.
- Megbowon, F., Palesa, M., Bongiwe, K., & Sipokazi M. (2023). Challenges of First-Year Extended Curriculum Programme Students at a University in South Africa. *International Journal of Learning Teaching and Educational Research*, 22(4), 178-194.
- Mokganya, G., & Zitha, I. (2024). Exploring the impact of the Extended Curriculum Programme (ECP) as a crucial motivating landing space: a Study on Student Transition in Higher Education. *International Journal of Research In Business And Social Science*. 13(10), 154-164.
- Mouton, M. (2025). Finding Purpose in Opportunity: Evaluating the Extended Curriculum Programme Through Former Students' Perspectives. *Cogent Education*. 12(1), Retrieved September 03, 2025, from <https://doi.org/10.1080/2331186X.2025.2497146>
- Mouton, M., & Rewitzky, I. M. (2025). Opportunity and Outcome: A Quantitative Evaluation of The STEM Extended Curriculum Programme at a Research-Intensive University. *South African Journal of Higher Education*. 39(2), 157-171.
- Ogude, N. A., Meyer, I. J., Mwambakana, J., & Mthethwa, N. E. (2019). Can Extended Curriculum Programmes Be Improved Through Engagement With Students Using Appreciative Inquiry? *South African Journal of Higher Education*, 33(4), 219-236.
- Pearce, H., Campbell, A., Craig, T. S., leRoux, P., Nathoo, K., & Vicatos, E. (2015). The Articulation Between the Mainstream and Extended Degree Programmes in Engineering at The University of Cape Town: Reflections and Possibilities. *South African Journal of Higher Education*, 29(1), 150-162.
- Slabbert, R., & Friedrich-Nel, H. (2015). Extended Curriculum Programme Evolution: a Road Map to Academic Success? *South African Journal of Higher Education*, 29(1), 45-59.
- Snyman, L., & Kasirye, M. (2021). The Impact of Science Foundation Programmes on the Success Rate of First-Year Students in a Blended Teaching and Learning Environment. *South African Journal of Higher Education*. 35(5), 277-295.
- Van Broekhuizen, H., van der Berg, S., & Hofmeyr, H. (2017). Higher Education Access and Outcomes for the 2008 National Matric Cohort. *SSRN Electronic Journal (online)*. Retrieved from <https://www.ssrn.com/abstract=2973723>.

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Short biographical sketch: Dr. J. N. Mwambakana-Mutombo is an accomplished academic with a diverse background in mathematics and public health. She holds a DTech in Mathematical Technology from Tshwane University of Technology (TUT) and an MPH (Master of Public Health) from Sefako Makgatho Health Sciences University (SMU). She taught both undergraduate and postgraduate students and has supervised to completion six master's and two PhDs candidates. Dr. Mwambakana has held various academic leadership roles, such as the coordinator for mathematics module evaluations at the African Virtual University (AVU) and an external chair for a program review at Durban University of Technology (DUT). She is currently the Head of the Foundation Programmes. She has reviewed academic papers, served as an external examiner for multiple universities and published articles in peer-reviewed journals and conference proceedings. For over 10 years, she has served as the Head of Residences at the University of Pretoria.

Chapter # 28

TRI-THEORY APPROACH FOR MITIGATING THE IMPACTS OF POLY-VIOLENCE EXPOSURE ON LEARNERS IN SOUTH AFRICAN SCHOOLS

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ABSTRACT

The incessant episodes of learners' exposure to poly-violence and their attendant traumatic consequences in South African schools present a complex challenge that significantly impacts learners' well-being and academic outcomes. The lack of trauma-informed approaches in school safety management creates a cycle of disadvantage that can have long-lasting effects on learners and broader societal outcomes. This situation highlights a gap in the existing school safety framework. Hence, this study aims to propose a trauma-informed blueprint that empowers school leaders to mitigate the impact of poly-violence exposure trauma on learners' academic outcomes and general well-being. The study adopted a conceptual analysis research design to synthesise three theories and relevant literature. This study underscores the multifaceted negative impact of poly-violence exposure on learners' emotional, psychological, and academic well-being. The deficiencies in current school safety interventions are also highlighted. The study proposes an integrative trauma-informed school system (ITISS) to mitigate the impact of trauma associated with learners' exposure to poly-violence. Implementing the ITISS is anticipated to enhance learners' emotional and social competence and improve their well-being and learning outcomes. The study calls for a school safety policy reform that institutionalises trauma-responsive professional development and budgets for educational practitioners to be effective.

Keywords: learning outcomes, poly-violence, school leadership, trauma-informed school, human capital, trauma.

1. INTRODUCTION

Violence against children is a global public health concern because it affects the physical, mental, and social well-being of young people (Howell et al., 2023). The World Health Organization (WHO) (2022) defines violence against children as any form of physical, sexual, or emotional violence, including neglect of children. The organisation estimates that up to 1 billion children aged 2–17 years have experienced such violence or neglect in the past year. Child exposure to violence manifests as physical, sexual, and emotional abuse in homes, communities, and educational institutions. Studies indicate that children's exposure to violence increases the risk of adverse outcomes across multiple domains. Addressing the multifaceted traumatic consequences of poly-violence is imperative for enhancing learners' holistic well-being and academic achievement.

Given the associated implications of this menace, the United Nations (UN) prioritises the prevention and eradication of violence against children in its 2030 agenda in section 16.2. of its sustainable development goals (SDGs) (United Nations, 2015). Similarly, WHO also introduced a pro-child safety framework tagged INSPIRE: Prevention Strategies to End Violence Against Children (WHO, 2016). INSPIRE is an acronym for implementing and enforcing laws, norms, and values; safe environments; parent and caregiver support; income and economic strengthening; response and support services; and education and life skills. Unfortunately, the success rate of the framework varies by country (UNICEF, 2018). The variations characterising INSPIRE implementation in these countries are linked to inadequate funding, insufficient coordination, and a lack of comprehensive data collection and effective evaluation mechanisms.

The situation is no different in South Africa, where the high rate of violence against children is a major public health concern. Romero, Hall, and Cluver (2018) examined whether teacher support for learners who are victims of multiple forms of violence can mitigate school delays. The results indicated that while higher academic support from teachers was linked to reduced school delay, emotional support did not moderate the relationship between poly-violence exposure and school delay. Similarly, Romero et al. (2021) explored the effects of violence on the educational outcomes of adolescents living in socio-economically disadvantaged communities in South Africa. The findings revealed that approximately 93.8% of adolescents had experienced poly-violence within the past month. It was also found that more frequent exposure to poly-violence was associated with an increased risk of school delay.

Despite these advances in studies on the prevalence and impact of violence on children and adolescents, they predominantly focus on documenting the prevalence of violence rather than developing actionable blueprints for the school system. This study contributes to the existing body of knowledge and practice by proposing a novel tri-theoretical framework that synergises three theories. Unlike fragmented approaches, the proposed blueprint uniquely bridges individual trauma recovery, empathetic leadership practices, and strategic capacity-building to create healing-centered ecosystems in schools. The study offers a holistic blueprint that addresses poly-violence trauma at relational, institutional and systemic levels. It is anticipated that if well-actioned, the model could advance a culturally responsive model that disrupts cycles of intergenerational violence. In addition, the blueprint fills a gap in school safety frameworks by prioritising actionable, scalable strategies over descriptive analyses, thereby offering a transformative pathway for trauma-affected school systems globally.

Research Questions:

1. What is the impact of poly-violence trauma on learners' academic achievement in South African schools?
2. What gaps exist in South Africa's school violence prevention frameworks?
3. In what ways do the principles of ARCT, Trauma-Informed Leadership (TiL), and Human Capital Theory (HCT) interact to explain how trauma exposure impacts learners?
4. How can a theory-informed blueprint be developed to mitigate the negative effects of post-poly violence trauma on learners' well-being and outcomes?

2. METHODOLOGY

This study employed Leenaars's Thematic Conceptual Analysis (TCA), a qualitative framework rooted in psychological autopsy methods and psychodynamic theory (Leenaars, 1988, 2004), to synthesise insights from literature and theories. TCA was selected for its capacity to identify and interpret latent psychological themes in trauma-affected learners' experiences while integrating multidisciplinary theories (e.g., attachment, cognitive, and psychosocial frameworks). TCA's emphasis on psychological validity and multidisciplinary triangulation (Leenaars, 2004) guided the synthesis of themes, ensuring alignment with South Africa's socio-educational context. Unlike traditional content analysis, TCA prioritises depth over breadth, emphasising recurring psychological constructs such as unbearable psychological pain, interpersonal trauma, turmoil, and cognitive distortions (Leenaars, 2004).

While the literature selection process does not follow systematic review protocols like PRISMA, its strength lies in synthesising interdisciplinary insights to address the study's unique tri-theoretical focus. Our searches spanned 2000–2024 to prioritise contemporary trauma-informed interventions but included foundational works (e.g., Becker's, 1964, HCT). (It should be noted that this work is drawn from a larger work) We queried Web of Science, Scopus and ERIC databases using Boolean operators and terms like as "poly-violence trauma," "trauma-informed leadership in schools," "attachment theory and education," "human capital," "trauma management," "child exposure to violence and academic performance," and "student achievement". After screening, relevant articles that met the inclusion criteria and peer-reviewed studies in English explicitly linking trauma to learning outcomes, psychological well-being, or systemic interventions were included. We excluded studies focusing solely on violence prevalence without educational implications and those not written in English.

Leenaars's Thematic Conceptual Analysis (TCA) was employed to synthesise our findings into themes that align with the study's focus on trauma's impact on learners' attachment, self-regulation, and competency (ARCT). The process involved iterative phases: (1) repeated readings of literature to identify patterns (e.g., trauma's role in academic disengagement), (2) grouping findings into conceptual categories (e.g., institutional safety gaps), and (3) interpreting themes through the tri-theoretical lens of ARCT, TiLT, and HCT. This approach ensured analytical rigor while accommodating the complexities of poly-violence trauma in South African schools.

3. FINDINGS

Consistent with the research question, this section presents the findings of this study.

3.1. Theme One: An Overview of the Prevalence and Impact of Poly-Violence Against Children in South Africa

This theme responds to research question one: What is the impact of poly-violence trauma on learners' academic achievement in South African schools? Empirical studies underscore the alarming prevalence and multifaceted nature of this issue, emphasising its intersection with socioeconomic, familial, and systemic factors.

3.1.1. Epidemiological Patterns of Violence

Nationwide surveys have revealed disturbing trends in violence against children (VAC). Meinck et al. (2016), in a study of 3,515 adolescents across two provinces, found that 56.3% reported lifetime physical abuse, 35.54% emotional abuse, and 9% sexual abuse. Poly-victimisation is prevalent, with 35.4% of children experiencing at least five forms of victimisation before the age of 17 (Leoschut & Kafaar, 2017).

3.1.2. Structural and Contextual Drivers

The aetiology of VAC is rooted in interconnected systemic factors. Community and political violence are significant predictors of adverse psychological outcomes, with poly-victimisation strongly correlating with anxiety, depression, and perceived stress (Sui et al., 2018). The COVID-19 lockdown exacerbated risks, intensifying domestic violence through heightened family conflict in affluent households and food insecurity in low-income settings. All of these culminate in the intergenerational transmission of violence, which perpetuates cycles of abuse; children exposed to parental violence are more likely to perpetrate dating violence in adulthood.

3.1.3. Psychosocial and Health Consequences on Learners' Well-Being

VAC's repercussions extend far beyond immediate harm. Victims of multiple violent exposures exhibit a 3.5-fold higher risk of depression and elevated suicidal ideation (Meinck et al., 2016). Poly-victimisation compounds vulnerabilities, increasing the risks of school dropout, unemployment, and HIV exposure (Leoschut & Kafaar, 2017). Early childhood exposure to violence disrupts neurodevelopmental trajectories, impairing emotional regulation and cognitive function. These outcomes underscore the detrimental nature of VAC, where overlapping epidemics of violence, mental health disorders, and socioeconomic inequities mutually reinforce harm to children.

3.1.4. Consequences of Poly-Violence Trauma on Learning Outcomes

Studies have shown that exposure to multiple forms of violence negatively impacts students' learning outcomes in South Africa. Studies have indicated that exposure is associated with poor mental health, behavioural problems, and reduced academic performance among students. A study of Cape Town adolescents found that exposure to violence was strongly associated with high levels of depressive, anxiety, and PTSD symptoms, as well as an increased risk of self-harm, even after adjusting for social support (Stansfeld et al., 2017). Another study found that experiencing physical fighting, weapon-related threats, and bullying at school were all associated with higher levels of safety concerns and depression, which in turn led to lower academic performance. However, the study reported that these effects were significantly greater for female students than for males (Kim et al., 2020).

3.2. Theme Two: Deficiencies of School Safety Framework and Interventions in South Africa

This theme examines the deficiencies in South African school safety interventions in response to the second research question: What gaps exist in South Africa's school violence prevention frameworks? It focuses on the National School Safety Framework (NSSF) and the Care and Support for Teaching and Learning (CSTL) program. The NSSF, introduced in 2015, aims to address school violence through human rights and collaboration with stakeholders. However, its implementation has been inconsistent owing to varying school capacities, stakeholder commitments, and contextual factors. Systemic weaknesses include

inadequate resources, insufficient monitoring, and limited implementation (Kutywayo et al., 2024). The framework's uniform approach fails to address evolving challenges, such as cyberbullying, and some students still feel unsafe during school commutes. Another intervention is the CSTL program, initiated in 2008, which aims to support vulnerable learners holistically. While it positively impacted some schools, its effectiveness is limited by insufficient funding, high staff turnover, coordination challenges, and uneven implementation (Department of Basic Education, 2017). Recent evaluations reveal that over 50% of schools lack adequate CSTL training for educators, many school-based support teams are inactive or poorly resourced, and only 12% of schools hosted mental health awareness events in the past year. Despite its holistic intent, CSTL's efficacy is undermined by fragile support structures, limited psychological services, and training gaps, necessitating urgent policy and systemic reforms.

3.3. Theme Three: Understanding and Mitigating Trauma's Impact on Learners: A Tri-theoretical Perspective

This theme addresses research question three: In what ways do the principles of ARCT, trauma-informed leadership, and human capital theory interact to explain how trauma exposure affects learners? These theories were synthesised to elucidate how trauma exposure impedes learners' well-being and academic performance.

3.3.1. ARCT's Tripartite Framework for Trauma Recovery

ARCT posits that trauma disrupts attachment, self-regulation, and competency, which are interdependent domains critical to resilience (Blaustein & Kinniburgh, 2019). Attachment underscores relational security as foundational to emotional stability. Trauma fractures trust, destabilising learners' sense of safety. However, educators trained in trauma-informed practices can rebuild secure attachments through consistency and empathy, fostering emotional regulation and engagement. Self-regulation addresses trauma-induced neurodevelopmental impairments, particularly in emotional modulation and impulse control. Structured routines and mindfulness practices help recalibrate stress responses and restore cognitive focus. Competency focuses on skill-building to counteract the erosion of agency caused by trauma. Collectively, ARCT provides actionable pathways for transforming classrooms into environments that foster resilience.

3.3.2. Trauma-Informed Leadership Theory (TiLT) as an Organizational Paradigm

TiLT, informed by Felitti and Anda's (2010) ACE study, shifts institutional focus from pathologizing behaviour ("What's wrong?") to contextualising trauma ("What happened?"). Its tenets—safety, collaboration, empowerment, and cultural responsiveness—reorient school climates toward healing. Safety prioritises predictable routines and transparent communication to mitigate hypervigilance. Collaborative empowerment engages stakeholders in co-designing interventions and redistributing the power eroded by trauma. For example, training teachers on trauma's neurobiological impacts reduces re-traumatisation risks, while student involvement fosters inclusive policies. *Cultural responsiveness* acknowledges the intersecting traumas linked to marginalisation, necessitating culturally attuned support. TiLT reframes behavioural challenges as survival strategies, replacing punitive discipline with empathetic enquiry. A student's outburst, reinterpreted as unmet safety needs, illustrates how TiLT-driven leadership fosters trust and academic risk-taking (Papa & Robinson, 2023). TiLT thus positions schools as ecosystems of healing, where trauma-aware practices unlock the potential of students and staff.

3.3.3. Human Capital Theory (HCT) for Capacity Building

Human Capital Theory (HCT) posits that staff training is a crucial investment for enhancing an organisation's capacity (Becker, 1964). This translates to developing educators' trauma-informed competencies in the educational context, which can significantly improve learners' well-being and academic outcomes (Brunzell, Stokes, & Waters, 2016). HCT emphasises the importance of context-specific training, suggesting that targeted approaches yield substantial returns in terms of productivity and innovation. For instance, when teachers are equipped to identify trauma symptoms, they can foster an empathetic environment that empowers students to regain their agency. This underscores the critical role of school leaders as human capital architects who must prioritise professional development tailored to address the complexities of trauma. Such focused training ensures that staff are well prepared to address the unique needs of learners affected by traumatic experiences.

3.4. Theme Four: Integrative Trauma-Informed School System (ITIIS)

The study proposes ITIIS as a blueprint to answer research question four: How can a theory-informed blueprint be developed to mitigate the adverse effects of poly-violence trauma on learners' well-being and outcomes? Grounded in ARCT, TiLT, and HCT principles, ITIIS reimagines schools as healing ecosystems that prioritise empathy, equity, and evidence-based practices. Specifically, ITIIS addresses the systemic impact of trauma on learners by synthesising three theoretical pillars: attachment, self-regulatory, and competency theory (ARCT), trauma-informed leadership theory (TiLT), and human capital theory (HCT).

The Rationale for Theories Synthesis

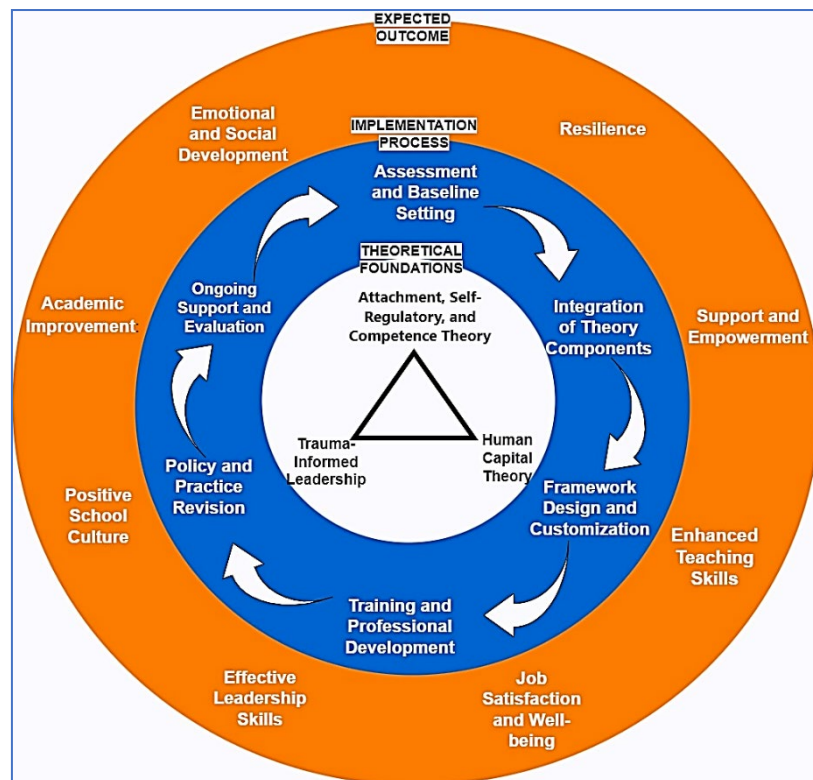
We considered the synthesis and implementation of the three theories mentioned earlier as more effective than when each is implemented in a silo, based on the following reasons. ARCT, as a standalone theory, primarily focuses on individual therapeutic processes and classroom-level interactions, with limited attention to system-wide leadership and policy constraints. TiLT, in turn, as a singular framework, though, offers a robust organisational lens for understanding the impact of trauma on leadership; it does not fully specify how leaders can operationalise trauma-responsive practice in resource-constrained schools without a deliberate focus on staff development and capacity building. Finally, HCT emphasises investments in human capital but is relatively silent on the specific relational and organisational conditions needed to ensure that such investments translate into trauma-responsive practice in schools. In light of the deficiencies of these theories, we propose an integrative trauma-informed school system (ITIIS) as a comprehensive and more explicit approach. The model was proposed as a blueprint designed to address the relational, organisational, and capacity-building blind spots that emerge when the three approaches are applied separately.

ARCT provides a foundation for rebuilding secure attachments, emotional regulation, and competency in trauma-affected learners. For instance, consistent teacher-student relationships restore trust, enabling withdrawn students to re-engage academically. The application of TiLT principles will reorient school leadership from punitive to empathetic practices, replacing "What is wrong with you?" with "What happened to you?" to foster healing climates (Papa & Robinson, 2023). The blueprint holds that effective implementation of HCT principles through strategic investments in staff training will ensure that educators recognise trauma's neurobiological impacts and adopt responsive pedagogies (Brunzell et al., 2016). Together, these theories position schools as resilient ecosystems.

3.4.1. Implementation Process

We propose that the ITISS implementation process, as shown in Figure 1. The implementation process comprises (1) assessment and baseline setting; (2) trauma-informed capacity-building and professional development; (3) policy and practice realignment; and (4) continuous monitoring and refinement (Chafouleas et al., 2016; Whitford et al., 2018). At each stage of implementation, the principles of the theories operationalised and interact; for example, assessment includes mapping poly-violence exposure, learner outcomes, and existing supports to determine institutional readiness, consistent with recommendations for trauma-informed school system implementation (Overstreet & Chafouleas, 2016). In the capacity-building phase, ARCT structures educator training around attachment, self-regulation, and competency; TiLT guides leaders in creating safe, collaborative climates; and HCT underpins systematic investment in trauma-specific professional development and support for staff (Blaustein & Kinniburgh, 2019; Brunzell et al., 2016; Papa & Robinson, 2023). Next, efforts should be made to institutionalise policy and practice revision to replace punitive measures with restorative approaches. Finally, there is a need for ongoing support and evaluation to ensure sustained integration of theory components. By synthesising these theories, the ITISS represents a comprehensive blueprint that addresses trauma at the individual, institutional, and systemic levels. This approach will enable schools to create resilient ecosystems that support learners affected by trauma, ultimately improving their well-being and learning outcomes.

Figure 1.
Integrative Trauma-Informed School System (ITISS).



Source: Developed by the authors (2025)

We believe that the effective implementation of ARCT will contribute to ITISS by focusing on individual recovery. ARCT principles offer strategies for teachers to rebuild secure attachments, enhance the emotional regulation of affected learners, and foster competencies in trauma-affected learners. They address the interpersonal aspects of trauma recovery, helping students regain trust and re-engage academically through consistent teacher-student relationships. The TiLT principle should be leveraged to reconfigure the institutional climate by reorienting school leadership from punitive to empathetic practices. It helps them shift the focus on managing learners who are trauma victims from "What is wrong with you?" to "What happened to you?" (Papa & Robinson, 2023). This approach fosters a healing environment and supportive atmosphere for trauma-affected learners. To sustain the impact of previous theories, an effective application of HCT principles will engender strategic investments in staff capacities toward school-based trauma-informed practices. This will equip them to recognise trauma's neurobiological impacts and adopt responsive pedagogies (Brunzell et al., 2016) that support trauma-affected learners effectively.

3.4.2. Anticipated Outcomes

The ITISS is anticipated to yield multifaceted benefits if effectively implemented. Key outcomes may include improved student well-being and resilience, enhanced trauma-informed teaching pedagogy, increased job satisfaction and well-being among teachers, increased academic engagement, reduced disciplinary issues through restorative practices, and enhanced school culture and climate, as well as the emotional and social development of affected learners. The framework is expected to boost educators' competency in trauma-responsive pedagogies that disrupt intergenerational trauma cycles (Brunzell et al., 2016). Systemic changes may involve policy reforms and trauma-informed training at the institutional level. The ITISS aims to ensure improved outcomes for all students, particularly those affected by trauma, and to improve accessibility to mental health resources. However, empirical validation of these anticipated outcomes across diverse contexts, especially regarding the long-term impacts on academic performance and mental health, is necessary for future research.

Notably, while empirical validation is germane to authenticate the operationalisation of ITISS, the key strengths of the framework are foregrounded in the synthesis of the empirical evidence of the prevalence of poly-violence against children in South Africa; the tri-theoretical conceptualisation at various levels (including individuals, relational, organisational and systemic) and finally, the proposed framework builds on the existing school safety framework in the country.

4. IMPLICATIONS FOR POLICY AND PRACTICE

Effective ITISS adoption requires coordinated policy action. Governments should institutionalise trauma-informed training in teacher certification programmes and allocate budgets for interdisciplinary coalitions (e.g., educators, social workers, and NGOs) (Leoschut & Kafaar, 2017). Labour reforms, such as workload limits and trauma certification stipends, should be considered to protect educators from burnout (Motta, 2020). School partnerships with local clinics and anti-violence organisations will enhance resource accessibility, particularly for survivors of gender-based violence.

5. CONCLUSION

The study explored the impact of trauma on the well-being and learning outcomes of learners who were previously exposed to poly-violence in South Africa. The findings revealed: the existence of pervasive and multifaceted effects of poly-violence on learners' mental health and learning outcomes; limitations of the current school safety measures, the complementary, yet incomplete nature of ARCT, TiLT and HCT when deployed separately. The ITISS proposed a holistic blueprint for how schools can mitigate the impact of trauma on learners. The framework has the potential to integrate relational healing, empathetic leadership, and strategic staff development. It also serves as a precursor for an inclusive school environment where traumatised learners are empowered to regain emotional competence, resulting in enhanced well-being and improved learning outcomes. This study is not insulated from limitations, like every other study. The limitation of this study lies in its conceptual nature and reliance on secondary data. Hence, we propose that future research empirically validate the ITISS's efficacy across diverse contexts, particularly its long-term impact on academic performance and mental health. Longitudinal studies tracking poly-victimised learners could refine trauma-responsive strategies, ensuring equitable outcomes for all students.

REFERENCES

- Becker, G. S. (1964). *Human capita*. New York: National Bureau of Economic Research.
- Brunzell, T., Stokes, H., & Waters, L. (2016). Trauma-Informed Positive Education: Using Positive Psychology to Strengthen Vulnerable Students. *Contemporary School Psychology*, 20(1), 63-83. <https://doi.org/10.1007/s40688-015-0070-x>
- Blaustein, M., & Kinniburgh, K. M. (2019). *Treating traumatic stress in children and adolescents: How to foster resilience through attachment, self-regulation, and competency* (2nd ed.). New York: The Guilford Press.
- Department of Basic Education (2017). *Care and support for teaching and learning program: Midline evaluation report*. Pretoria: Department of Basic Education.
- Felitti, V. J., & Anda, R. F. (2010). The relationship of adverse childhood experiences to adult health, well-being, social function, and healthcare. In R. Lanius, E. Vermetten, & C. Pain (Eds.), *The impact of early life trauma on health and disease: The hidden epidemic* (pp. 77-87). Cambridge: Cambridge University Press.
- Howell, K. H., Napier, T. R., Thomsen, K. N., Martinez-Torteya, C., & Källström, Å. (2023). Global perspectives on family violence: Prevalence and effects on children across cultural contexts. In S. L. Moeschberger & L. E. Miller-Graff (Eds.), *Psychological perspectives on understanding and addressing violence against children: Towards building cultures of peace* (pp. 132-153). Oxford: Oxford University Press.
- Kim, Y. K., Sanders, J. E., Makubuya, T., & Yu, M. (2020). Risk factors of academic performance: Experiences of school violence, school safety concerns, and depression by gender. *Child & Youth Care Forum*, 49(5), 725-742. <https://doi.org/10.1007/s10566-020-09552-7>
- Kutywayo, A., Mabetha, K., Naidoo, N. P., Mahuma, T., Njobe, P., Hlongwane, R., & Mullick, S. (2024). Learner experiences of safety at public high schools in three South African townships: Baseline findings from the National School Safety Framework learner surveys. *Gates open research*, 6, 6. <https://doi.org/10.12688/gatesopenres.13328.2>
- Leenaars, A. A. (1988). *Suicide notes: predictive clues and patterns*. Human Sciences Press.
- Leenaars, A. A. (2004). *Psychotherapy with suicidal people: A person-centred approach*. John Wiley & Sons.

- Leoschut, L., & Kafaar, Z. (2017). The frequency and predictors of poly-victimisation of South African children and the role of schools in its prevention. *Psychology, Health & Medicine*, 22(sup1), 81-93. <https://doi.org/10.1080/13548506.2016.1273533>
- Meinck, F., Cluver, L. D., Boyes, M. E., & Loening-Voysey, H. (2016). Physical, emotional and sexual adolescent abuse victimisation in South Africa: prevalence, incidence, perpetrators and locations. *Journal of Epidemiology and Community Health*, 70(9), 910-916.
- Motta, R. W. (2020). *Alternative therapies for PTSD: The science of mind-body treatments*. Washington, D.C.: American Psychological Association.
- Overstreet, S., & Chafouleas, S. M. (2016). Trauma-informed schools: Introduction to the special issue. *School Mental Health*, 8(1), 1-6. <https://doi.org/10.1007/s12310-016-9184-1>
- Papa, A. and Robinson, K. (2023). 'Leadership and Trauma-Informed Care: Working to Support Staff and Teams. *Journal of Emergency Nursing*, 49(2), 172-174. <https://doi.org/10.1016/j.jen.2022.11.001>
- Romero, R., H., Hall, J., & Cluver, L. (2018). Exposure to violence, teacher support, and school delay amongst adolescents in South Africa. *British Journal of Educational Psychology*, 89(1), 1-21. <https://doi.org/10.1111/bjep.12212>
- Romero, R. H, Hall, J., Cluver, L., Meinck, F., & Hinde, E. (2021). How Does Exposure to Violence Affect School Delay and Academic Motivation for Adolescents Living in Socioeconomically Disadvantaged Communities in South Africa? *Journal of Interpersonal Violence*, 36(7-8), NP3661-NP3694. <https://doi.org/10.1177/0886260518779597>
- Stansfeld, S. A., Rothon, C., Das-Munshi, J., Mathews, C., Adams, A., Clark, C., & Lund, C. (2017). Exposure to violence and mental health of adolescents: South African Health and Well-being Study. *BJPsych Open*, 3(5), 257-264. <https://doi.org/10.1192/bjpo.bp.117.004861>
- Sui, X., Massar, K., Kessels, L. T. E., Reddy, P. S., Ruiter, R. A. C., & Sanders-Phillips, K. (2018). Violence Exposure in South African Adolescents: Differential and Cumulative Effects on Psychological Functioning. *Journal of Interpersonal Violence*, 36(9-10), 088626051878836. <https://doi.org/10.1177/0886260518788363>
- United Nations (2015). *Transforming our world: The 2030 Agenda for Sustainable Development*. Available at: <https://sdgs.un.org/2030agenda> (Accessed: 19 January 2024).
- United Nations Children's Fund (UNICEF). (2018). *INSPIRE indicator guidance and results framework – Ending violence against children: How to define and measure change*. UNICEF, New York. Retrieved from [unicef.org/media/66896/file/INSPIRE-IndicatorGuidance-ResultsFramework.pdf](https://www.unicef.org/media/66896/file/INSPIRE-IndicatorGuidance-ResultsFramework.pdf)
- World Health Organization (WHO) (2016). *INSPIRE: Seven strategies for ending violence against children*. Available at: <https://iris.who.int/bitstream/handle/10665/207717/9789241565356-eng.pdf?sequence=1&isAllowed=y> (Accessed: 19 January 2025).
- World Health Organization (WHO). (2022, November 29). *Violence against children*. Who.int; World Health Organization: WHO. Retrieved from: <https://www.who.int/news-room/fact-sheets/detail/violence-against-children>

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O. Sasere & M. Matashu

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Chapter # 29

ENHANCING SOCIAL INCLUSION: THE ROLE OF COGNITIVE AND EMOTIONAL REGULATION IN ADOLESCENTS WITH SPECIFIC NEEDS

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ABSTRACT

This study examines the role of cognitive and emotional regulation in promoting social inclusion among adolescents with specific needs. Drawing on theoretical frameworks and current practices, it explores how regulatory processes support adaptive functioning and inclusive participation in school settings. A mixed-methods design combined quantitative data from the short version of the Cognitive Emotion Regulation Questionnaire (CERQ) and the Emotion Regulation Questionnaire (ERQ) with qualitative data from semi-structured interviews. The sample comprised 158 high school students with identified specific needs. Quantitative results showed a significant age effect on cognitive reappraisal, with older adolescents using this strategy more frequently, while no significant gender differences were observed. Qualitative findings revealed ongoing barriers to inclusion, including limited peer support and insufficient institutional measures. The study highlights the developmental importance of emotional and cognitive regulation and underscores the need for targeted interventions. Enhancing regulatory skills and integrating social-emotional learning into inclusive educational practices may strengthen adolescents' resilience and foster supportive, socially inclusive school environments.

Keywords: adolescents, cognitive regulation, emotional regulation, specific needs, social inclusion.

1. INTRODUCTION

In recent decades, education for children and adolescents with special needs has undergone a fundamental transformation, as segregated and integrative models are progressively replaced by inclusive education frameworks. These emphasize every learner's equal right to high-quality education within mainstream educational settings (Ainscow, 2020; Messiou et al., 2022). Inclusive education is currently conceptualized not as a static placement of students with special needs, but as a dynamic, systemic process aimed at increasing participation, equity, and belonging for all learners, regardless of individual abilities, developmental characteristics, or social background (Florian, 2021; Slee, 2020). This paradigm shift is strongly supported by international and European policy frameworks, including the United Nations Convention on the Rights of Persons with Disabilities (United Nations, 2006) and the European Strategy for the Rights of Persons with Disabilities 2021–2030 (European Commission, 2021), which explicitly highlight inclusive education as a prerequisite for social participation, well-being, and lifelong learning. Adolescence represents a critical developmental period marked by profound biological, psychological, and social changes that significantly shape identity formation, emotional functioning, and social integration (Steinberg, 2017; Sawyer et al., 2018). Recent research underscores that the ability to regulate emotions and cognition plays a central role in adolescents' adaptive

functioning, academic engagement, and mental health (McRae & Gross, 2020; Weissman et al., 2021). These regulatory capacities are particularly crucial for adolescents with special needs, who are disproportionately exposed to stressors such as stigmatization, social exclusion, academic failure, and reduced access to supportive resources (Lakkala et al., 2020; Lindsay et al., 2022).

Insufficient support for the development of emotional and cognitive regulation skills has been consistently associated with increased vulnerability to internalizing and externalizing difficulties, lower academic achievement, and impaired peer relationships (Compas et al., 2017; Riediger & Klipker, 2021). In contrast, recent evidence suggests that systematic support for regulatory processes enhances psychological resilience, social inclusion, and overall school adjustment, particularly within inclusive educational environments (Masten & Barnes, 2018; Panayiotou et al., 2023). Adolescents employ a wide range of regulation strategies that vary according to developmental stage, gender, and contextual demands, including school climate and teacher support (Davis et al., 2019; Zimmermann & Iwanski, 2021). Among the most extensively studied strategies are cognitive reappraisal and expressive suppression, which have been shown to exert differential effects on emotional well-being, interpersonal functioning, and long-term adjustment during adolescence (Gross, 2015; McRae et al., 2020; Troy et al., 2023).

2. THEORETICAL FRAMEWORK

2.1. Cognitive Regulation

Cognitive regulation involves processes through which individuals modulate thoughts, attention, and interpretations to manage stress and optimize adaptive responses (Ochsner & Gross, 2008). In adolescence, it is closely linked to executive functions such as planning, self-reflection, working memory, and decision-making (Ahmed et al., 2015; Crone & Dahl, 2012). Effective use of cognitive regulation is associated with greater well-being, better interpersonal relationships, and higher academic achievement (Gross, 2015; McRae et al., 2012), whereas suppression of negative emotions relates to lower well-being and impaired social functioning (John & Gross, 2004). Preference and effectiveness of strategies change with age: younger adolescents rely more on impulsive or behavioral strategies, while older adolescents increasingly use cognitive reappraisal (Ahmed et al., 2015; Silvers et al., 2012). Social environment, support, and individual characteristics also shape their use (Compas et al., 2017). Adolescents with special needs, such as those with learning disabilities or ADHD, often face challenges in planning, anticipating consequences, and responding adaptively, affecting reappraisal abilities (Luman et al., 2010; Murray, 2018). Targeted interventions, however, can enhance cognitive regulation and promote adaptive behavior and social inclusion in this population (Klingbeil et al., 2017).

2.2. Emotional Regulation

Emotional regulation involves monitoring, evaluating, and modulating emotional states to support adaptive functioning and cope with challenges (Gross, 2015). It includes recognizing, understanding, and appropriately expressing emotions, with cognitive and behavioral mechanisms interacting to guide regulation (Thompson, 2011). In adolescence, emotional regulation is linked to self-reflection, social skills, and executive functions, contributing to adaptation, reduced psychological risk, and inclusive participation in school (Gross, 2015; McRae & Gross, 2020). For adolescents with special needs, regulation is particularly important due to increased stress, stigmatization, and limited social interaction (Murray, 2018).

Effective strategies such as cognitive reappraisal, problem-solving, and seeking social support enhance well-being, stress management, and interpersonal relationships (Gross, 2015; Zimmermann & Iwanski, 2014), while maladaptive strategies like suppression, avoidance, and rumination are linked to anxiety, depression, and impaired social functioning (John & Gross, 2004; Schäfer et al., 2017). The development of emotional regulation is influenced by age, gender, social environment, temperament, and cognitive abilities (Compas et al., 2017; Silvers et al., 2012). Adolescents with learning disabilities, ADHD, or autism often face difficulties in adaptive emotional management (Luman et al., 2010; Murray, 2018). Intervention programs targeting emotional regulation can improve coping, adaptive behavior, and social participation, supporting effective inclusion in educational settings (Klingbeil et al., 2017; McRae et al., 2012).

2.3. Adolescence and Special Educational Needs

In recent decades, education for children and adolescents with special educational needs (SEN) has shifted from segregated or integrative models toward inclusive education, emphasizing every child's right to quality learning in mainstream settings (Ainscow, 2020; Booth & Ainscow, 2016). Inclusive education ensures active participation for all students, regardless of abilities, needs, or socio-economic background (Florian & Black-Hawkins, 2011), and is reinforced by international frameworks such as the UN Convention on the Rights of Persons with Disabilities (United Nations, 2006) and the European Strategy for the Rights of Persons with Disabilities 2021–2030 (European Commission, 2021).

Adolescence involves profound biological, psychological, and social changes shaping identity and development (Steinberg, 2017). Effective regulation of emotions and cognition is crucial for coping, adaptation, and mental health, particularly for adolescents with SEN who often face elevated stress and social isolation (Gross, 2015; McRae & Gross, 2020; Murray, 2018). Cognitive regulation, linked to executive functions such as planning and decision-making, includes strategies like cognitive reappraisal, which promotes well-being and academic achievement, and emotional suppression, which is associated with negative outcomes (Ochsner & Gross, 2008; Ahmed et al., 2015; Crone & Dahl, 2012; Gross, 2015; McRae et al., 2012; John & Gross, 2004).

Emotional regulation involves monitoring, evaluating, and modulating emotions to support adaptation and social participation (Gross, 2015; Thompson, 2011). Adaptive strategies, including reappraisal, problem-solving, and seeking support, enhance well-being and relationships, while maladaptive strategies such as suppression and rumination increase anxiety and social difficulties (Gross, 2015; McRae & Gross, 2020; John & Gross, 2004; Schäfer et al., 2017). Strategy use is shaped by age, gender, environment, temperament, and cognitive abilities (Ahmed et al., 2015; Compas et al., 2017; Silvers et al., 2012), with adolescents with learning disabilities, ADHD, or autism often facing greater challenges (Luman et al., 2010; Murray, 2018). Targeted interventions can improve regulatory skills, adaptive behavior, and social inclusion (Klingbeil et al., 2017; McRae et al., 2012).

The present study examines emotional and cognitive regulation in adolescents with SEN, focusing on age- and gender-related differences in strategy use and adolescents' experiences of social inclusion, with the aim of informing pedagogical recommendations to enhance regulatory skills and inclusive education.

2.4. Social Inclusion and Support Mechanisms

Social inclusion ensures the full participation of all individuals in social and school life, regardless of their abilities or needs (Booth & Ainscow, 2016). In educational settings, it promotes student engagement, reduces barriers, and strengthens the sense of belonging,

which is particularly important for the psychological and social well-being of adolescents with special educational needs (Florian, 2019). Inclusive environments support the development of social competences, enhance self-esteem and learning motivation, and facilitate effective integration into society (Ainscow, 2020; Kollerová & Říčan, 2018). However, the implementation of inclusive education varies across European countries, with barriers including a shortage of qualified teachers, limited methodological resources, and insufficient collaboration among schools, families, and professionals (European Commission, 2021; National Institute for Education, 2022).

Effective social inclusion therefore requires the systematic integration of cognitive and emotional regulation support within educational processes. Research indicates that the comprehensive development of emotional, cognitive, and social competences in adolescents with special needs enhances adaptation, reduces the risk of social isolation, and improves academic outcomes (Murray, 2018; Schonert-Reichl & Lawlor, 2010; Zoogman et al., 2015). These findings highlight the necessity of inclusive strategies that combine pedagogical support with the cultivation of regulatory skills to strengthen students' social participation and overall well-being.

3. METHODOLOGY

3.1. Research Design

The present study employed a mixed-methods research design that integrated quantitative and qualitative approaches. The quantitative component examined the relationships among age, gender, and the use of cognitive and emotional regulation strategies in adolescents with special educational needs (SEN). The qualitative component provided an in-depth exploration of their experiences with social inclusion in the school environment. The combination of these approaches enabled a more comprehensive understanding of the phenomenon under investigation and enhanced both the validity and interpretability of the findings (Creswell & Plano Clark, 2018).

3.2. Sample Selection

The research sample consisted of 158 adolescents attending secondary schools with special educational needs. Participants were recruited using convenience sampling to ensure the inclusion of various types of SEN, including learning disabilities, attention deficit/hyperactivity disorder (ADHD), sensory impairments, and emotional-behavioral difficulties. The sample included 78 girls (49.4%) and 80 boys (50.6%). The participants' ages ranged from 15 to 19 years ($M = 16.8$, $SD = 1.2$).

Inclusion criteria required (a) a formal diagnosis of SEN and (b) willingness to participate in the study. Adolescents with severe psychiatric or physical conditions that could limit full participation were excluded.

3.3. Instruments

1. Cognitive Emotion Regulation Questionnaire – Short Version (CERQ-S). The CERQ-S assesses the frequency and type of cognitive and emotional regulation strategies used. It contains 20 items rated on a 5-point Likert scale (1 = never, 5 = always). Previous studies with adolescents with SEN have demonstrated good internal consistency ($\alpha = .82-.89$) (McRae et al., 2012; Schäfer et al., 2017).

2. Emotion Regulation Questionnaire (ERQ). The ERQ measures two primary emotion regulation strategies: cognitive reappraisal and suppression. It includes 10 items rated on a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree). The instrument is widely used

in adolescent populations and has demonstrated strong psychometric properties (Gross & John, 2003).

3. Semi-structured Interviews. Individual semi-structured interviews were conducted to obtain detailed information about participants' experiences with social inclusion in the school environment. The interviews focused on three key domains:

- perceived support from teachers and peers,
- opportunities for participation in school activities,
- barriers and challenges to engagement in the educational process. All interviews were audio-recorded and transcribed verbatim for subsequent qualitative analysis.

3.4. Data Collection

Data collection was conducted between January and March 2025. Participants were contacted through school administrations and school psychologists. Quantitative questionnaires were distributed in person, with researchers providing necessary instructions and assistance during completion. Semi-structured interviews were conducted in separate, quiet rooms and lasted approximately 30-45 minutes. The data and material are available on request from the author.

3.5. Ethical Considerations

The study was approved by the university's ethics committee. Prior to data collection, participants and their legal guardians were informed about the study's purpose, voluntary participation, and their right to withdraw consent at any time. All data were anonymized and processed in accordance with data protection regulations and APA ethical standards (American Psychological Association, 2017). The study was conducted within the project VEGA no. 1/0955/17/11 "Multimodality of the Development of Emotional Regulation in Adolescents with Typical and Atypical Development." The research protocol was reviewed and approved by the Ethics Committee of the Faculty of Education, Comenius University in Bratislava (date: November 2024). All procedures involving human participants were performed in accordance with the ethical standards of the institutional research committee.

3.6. Integration of Methodology and Empirical Findings

The combination of quantitative and qualitative methods allowed not only the identification of statistically significant relationships between age, gender, and cognitive and emotional regulation strategies, but also a deeper understanding of adolescents with special educational needs' individual experiences in the school context. Quantitative data provided a measurable overview of the use of regulatory strategies, whereas qualitative interviews elucidated factors that support or hinder social inclusion. This approach ensured data triangulation, increased the reliability of findings, and facilitated the formulation of practical recommendations for educational practice.

Quantitative data were analyzed using SPSS 28. Descriptive statistics, including means and standard deviations, were computed for all questionnaire items. Pearson correlation coefficients were used to examine the relationship between age and cognitive and emotional regulation strategies. Differences between genders in specific regulatory strategies were tested using independent-samples t-tests.

Transcripts from 30 semi-structured interviews were analyzed using thematic analysis (Braun & Clarke, 2006). The analysis proceeded in two phases: first, open coding of individual statements, followed by the grouping of codes into thematic categories. Three dominant themes were identified: (1) support from the school, (2) participation, and (3) barriers to social inclusion.

The integration of quantitative and qualitative approaches allowed for a holistic understanding of adolescents' regulatory mechanisms and the factors influencing their social inclusion in school environments.

4. RESULTS

4.1. Quantitative Results

Correlation analysis indicated a significant positive association between age and the use of cognitive reappraisal strategies ($r = .31, p < .01$), suggesting that older adolescents more frequently employ adaptive cognitive strategies to manage stress and emotionally challenging situations. Mean scores for cognitive reappraisal increased with age: adolescents aged 15-16 scored an average of 4.8 (SD = 0.9), 17-year-olds 5.2 (SD = 0.8), and those aged 18-19 5.7 (SD = 0.7). The range of scores (2-7) reflects considerable individual variability, indicating that some younger adolescents already demonstrate strong reappraisal skills. This developmental trend aligns with the maturation of executive functions, such as planning, selfmonitoring, and decision-making (Ahmed et al., 2015; Crone & Dahl, 2012).

Independent-samples t-tests showed no statistically significant gender differences in cognitive reappraisal ($t(156) = 0.87, p = .38$, Cohen's $d = 0.14$) or emotional suppression ($t(156) = 1.05, p = .29$, Cohen's $d = 0.17$), indicating minimal gender effect in this sample. Nevertheless, small effect sizes suggest subtle influences of social and relational contexts, such as peer acceptance, on the deployment of these strategies.

Descriptive statistics revealed that cognitive reappraisal was more frequently used ($M = 5.3, SD = 0.9$, range 3-7) than emotional suppression ($M = 3.1, SD = 1.2$, range 1-6), consistent with prior findings in adolescent populations (Gross & John, 2003; McRae et al., 2012). Subgroup analysis indicated that participants with learning disabilities scored slightly lower on reappraisal ($M = 4.7, SD = 0.8$) compared with those with ADHD or sensory impairments ($M = 5.4, SD = 0.7$), suggesting that cognitive limitations may constrain the application of adaptive strategies, even in the presence of general trends toward reappraisal.

4.2. Qualitative Results

Thematic analysis of thirty semi-structured interviews revealed three primary themes, each containing subthemes and illustrative examples highlighting how adolescents applied cognitive and emotional regulation strategies in real school situations.

1. Support from the School

Adolescents emphasized the importance of teacher support, which was often perceived as inadequate. For instance, a student with ADHD explained, "When I don't understand the instructions, I get stressed, and sometimes I just shut down. Teachers don't notice it." Subthemes included insufficient individual adaptation ("I need more time for tasks, but teachers give everyone the same deadlines"), inconsistent methodological guidance ("Sometimes instructions change from one teacher to another, and it confuses me"), and limited access to school psychologists ("I can only see the psychologist once a month, which is not enough when I feel anxious"). These narratives illustrate that insufficient structural and relational support can hinder adolescents' ability to employ reappraisal or other adaptive strategies effectively.

2. Participation in School Activities

Many adolescents reported feeling marginalized in group projects or extracurricular activities. A student with a learning disability noted, "In group work, I usually get the easiest task and rarely get a chance to share my ideas. It makes me feel invisible." Conversely, inclusive activities or small project groups facilitated effective cognitive and emotional

regulation: “During a small science project, I could discuss my ideas with the team, which helped me stay calm and focused even when the task was hard.” These examples indicate that structured opportunities for participation enhance both the practice and perceived efficacy of adaptive regulation strategies.

3. Barriers to Social Inclusion

Key barriers included peer stigmatization, lack of adapted educational content, physical accessibility limitations, and insufficient teacher engagement. A student described, “Some classmates tease me for needing extra help, and it makes me anxious before class.” Another student with ADHD shared, “I need tasks broken down step by step, but usually it’s just given to everyone, and I get frustrated.” Physical barriers, such as crowded classrooms or inaccessible equipment, also limited engagement. These accounts show how environmental and social obstacles can interfere with the practical application of emotional and cognitive regulation strategies, even among adolescents who possess these skills.

Within these themes, adolescents described specific strategies used in situational contexts. For example, students used cognitive reappraisal during stressful exams by reframing difficulties as learning opportunities (“I tell myself it’s just one test, not the end of the world”), while emotional suppression was often applied during social challenges with peers (“I hide my frustration when others ignore me so I don’t cause a scene”). The narratives indicate that adaptive strategies are most effective when supported by inclusive practices and individualized guidance, whereas maladaptive strategies often emerge when school support is lacking.

4.3. Integration of Quantitative and Qualitative Findings

Triangulating quantitative and qualitative data provided a comprehensive view of emotional and cognitive regulation. Age-related increases in reappraisal were reflected in adolescents’ accounts, with older students using reframing strategies more consistently. Although no significant gender differences were found quantitatively, qualitative evidence indicated that peer acceptance and teacher support influenced the use of adaptive strategies. Variability in reappraisal scores was contextualized by environmental factors: lower scores were linked to inadequate support or high social stress, while higher scores corresponded to structured inclusive activities, supportive teacher relationships, and collaborative experiences that facilitated effective emotion and cognition regulation.

4.4. Implications for Inclusive Educational Practice

The integrated results indicate that adolescents with special educational needs exhibit developmental improvements in adaptive regulation strategies with age, yet the school environment plays a crucial role in enabling or constraining these skills. Individualized support, structured participation in inclusive activities, and accessible psychological resources were consistently identified as key factors that strengthen the practical application of cognitive reappraisal and other adaptive strategies. The findings underscore the importance of educational policies and classroom practices that actively support emotional and cognitive regulation, thereby fostering both academic success and social inclusion.

5. DISCUSSION

The aim of this study was to examine the relationship between age, gender, and cognitive and emotional regulation strategies in adolescents with special educational needs (SEN) and to explore their experiences of social inclusion in the school environment. Quantitative results indicated that age is a significant predictor of the use of cognitive

reappraisal strategies. Older adolescents more frequently applied adaptive cognitive strategies to cope with stress and emotionally challenging situations, which aligns with previous research emphasizing the progressive development of executive functions and selfreflective capacities during adolescence (Ahmed et al., 2015; Silvers et al., 2012). This trend supports the theoretical assumption that the development of cognitive regulation contributes to effective adaptation to developmental tasks and reduces the risk of psychological difficulties (Gross, 2015; McRae & Gross, 2020).

In contrast, no statistically significant differences were observed between boys and girls, suggesting that gender may not be a key determinant in the use of cognitive and emotional regulation strategies within this population. This finding is consistent with literature indicating that individual characteristics, type of SEN, and contextual factors may exert a stronger influence than gender alone (Compas et al., 2017; Davis et al., 2019).

Qualitative analysis identified three primary themes: school support, participation, and barriers to social inclusion. Participants perceived teacher support as important but often insufficient, highlighting a lack of individualized approaches, unclear methodological procedures, and limited access to school psychologist services. Most adolescents felt marginalized in extracurricular activities and group projects, although some reported positive experiences with small project groups and inclusive school-organized activities. Barriers to social inclusion included peer stigmatization, insufficiently adapted educational content, physical constraints, and low teacher motivation to support individual needs. These findings reflect the multidimensional nature of social inclusion and underscore the importance of integrating support for cognitive and emotional regulation into educational practice (Booth & Ainscow, 2016; Florian, 2019). The lack of individualized and methodological support aligns with previous European studies that highlight variability in the implementation of inclusive education and the critical role of collaboration among schools, families, and professionals (European Commission, 2021; Štátny pedagogický ústav, 2022).

The integration of quantitative and qualitative findings provides a comprehensive perspective on adolescents' regulatory mechanisms and factors influencing social inclusion. While quantitative data confirmed the development of adaptive regulation strategies with age and their relative independence from gender, qualitative results clarified the contextual application of these strategies and revealed practical barriers in the school environment. Overall, the results support theoretical claims that effective support of emotion and cognition regulation is critical for the well-being, adaptation, and social participation of adolescents with SEN (Gross, 2015; Florian, 2019; Murray, 2018).

From a practical perspective, the study suggests that intervention programs should purposefully develop cognitive and emotional regulation strategies while simultaneously addressing systemic barriers in the school environment to enhance effective social inclusion. Teacher support, adapted educational content, and facilitation of participation are key factors for integrating adolescents with SEN into regular school life.

6. CONCLUSION

This study provided a comprehensive examination of cognitive and emotional regulation in adolescents with SEN and the factors influencing their social inclusion in the school environment. Quantitative results confirmed that age is a significant determinant of adaptive cognitive strategy use, while gender did not show a statistically significant effect. Qualitative data emphasized that practical barriers, such as lack of individualized approaches, absence of methodological support, and peer stigmatization, continue to limit full participation of adolescents with SEN.

The findings have several theoretical and practical implications. Theoretically, they reinforce the importance of integrating cognitive and emotional regulation as a key predictor of psychological well-being, adaptation, and academic success in adolescents (Gross, 2015; McRae & Gross, 2020; Florian, 2019). Practically, they highlight the need for targeted support for adolescents with SEN within schools that combines the development of regulatory strategies with the removal of systemic barriers.

Based on the study findings, the following recommendations for educational practice can be formulated:

1. **Development of Regulation Strategies:** Implement programs aimed at enhancing cognitive reappraisal and emotional regulation to promote adaptive coping with stress and improve psychological well-being among adolescents with SEN.

2. **Individualized Support and Methodological Guidance:** Teachers should provide differentiated support tailored to the individual needs of students, including clear methodological procedures and accessible professional counseling from school psychologists or special education teachers.

3. **Facilitation of Participation:** Schools should create inclusive environments that ensure equitable participation in both classroom instruction and extracurricular activities, such as through project-based groups or school-organized inclusive events.

4. **Removal of Barriers and Stigmatization:** Systematic efforts are needed to eliminate physical, curricular, and social barriers, including measures to reduce peer stigmatization and enhance teacher motivation to support individual student needs.

5. **Collaboration with Stakeholders:** Effective inclusion requires coordinated collaboration among schools, families, and professionals in psychology and special education.

Overall, the study indicates that combining the development of cognitive and emotional regulation with practical measures to support social inclusion can substantially improve psychological well-being, academic achievement, and social integration of adolescents with SEN. These implications underscore the need for continuous monitoring and evaluation of inclusive practices and programs supporting emotion and cognition regulation in school settings.

REFERENCES

- Ahmed, S. P., Bittencourt-Hewitt, A., & Sebastian, C. L. (2015). Neurocognitive bases of emotion regulation development in adolescence. *Developmental Cognitive Neuroscience, 15*, 11-25. <https://doi.org/10.1016/j.dcn.2015.07.006>
- Ainscow, M. (2020). Promoting inclusion and equity in education: Lessons from international experiences. *Nordic Journal of Studies in Educational Policy, 6*(1), 7-16. <https://doi.org/10.1080/20020317.2020.1729587>
- American Psychological Association. (2017). *Ethical principles of psychologists and code of conduct*. Retrieved from <https://www.apa.org/ethics/code>
- Booth, T., & Ainscow, M. (2016). *The index for inclusion: A guide to school development led by inclusive values* (4th ed.). Centre for Studies on Inclusive Education.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101. <https://doi.org/10.1191/1478088706qp063oa>
- Compas, B. E., Jaser, S. S., Bettis, A. H., Watson, K. H., Gruhn, M. A., Dunbar, J. P., Williams, E., & Thigpen, J. C. (2017). Coping, emotion regulation, and psychopathology in childhood and adolescence: A meta-analysis and narrative review. *Psychological Bulletin, 143*(9), 939-991. <https://doi.org/10.1037/bul0000110>

- Crone, E. A., & Dahl, R. E. (2012). Understanding adolescence as a period of social-affective engagement and goal flexibility. *Nature Reviews Neuroscience*, 13(9), 636-650. <https://doi.org/10.1038/nrn3313>
- Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE.
- Davis, E. L., Levine, L. J., Lench, H. C., & Quas, J. A. (2019). Metacognitive emotion regulation: Children's awareness that changing thoughts can change feelings. *Emotion*, 19(2), 283-297. <https://doi.org/10.1037/emo0000449>
- European Commission. (2021). *Union of Equality: Strategy for the Rights of Persons with Disabilities 2021–2030*. Publications Office of the European Union.
- Florian, L. (2019). On the necessary co-existence of special and inclusive education. *International Journal of Inclusive Education*, 23(7-8), 691-704. <https://doi.org/10.1080/13603116.2019.1622801>
- Florian, L. (2021). Inclusive pedagogy: A transformative approach to individual differences. *European Journal of Special Needs Education*, 36(3), 345-360. <https://doi.org/10.1080/08856257.2021.1901362>
- Florian, L., & Black-Hawkins, K. (2011). Exploring inclusive pedagogy. *Cambridge Journal of Education*, 41(4), 453-465. <https://doi.org/10.1080/0305764X.2011.625005>
- Gross, J. J. (2015). Emotion regulation: Current status and future prospects. *Psychological Inquiry*, 26(1), 1-26. <https://doi.org/10.1080/1047840X.2014.940781>
- Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology*, 85(2), 348-362. <https://doi.org/10.1037/0022-3514.85.2.348>
- John, O. P., & Gross, J. J. (2004). Healthy and unhealthy emotion regulation. *Journal of Personality*, 72(6), 1301-1334. <https://doi.org/10.1111/j.1467-6494.2004.00298.x>
- Klingbeil, D. A., Renshaw, T. L., Willenbrink, J. B., Copek, R. A., Chan, K. T., Haddock, A., & Clifton, J. (2017). Mindfulness-based interventions with youth: A meta-analysis. *School Psychology Quarterly*, 32(3), 345-365. <https://doi.org/10.1037/spq0000181>
- Lakkala, S., Uusiautti, S., & Määttä, K. (2020). How to make the neighbourhood school a school for all? *International Journal of Inclusive Education*, 24(1), 46-60. <https://doi.org/10.1080/13603116.2018.1460333>
- Lindsay, S., Proulx, M., Scott, L., & Thomson, N. (2022). Disability stigma in education: A systematic review. *Educational Psychology Review*, 34, 1-29. <https://doi.org/10.1007/s10648-021-09608-2>
- Luman, M., Oosterlaan, J., & Sergeant, J. A. (2010). The impact of reinforcement contingencies on AD/HD. *Clinical Psychology Review*, 25(2), 183-213.
- McRae, K., & Gross, J. J. (2020). Emotion regulation. *Emotion*, 20(1), 1-9. <https://doi.org/10.1037/emo0000703>
- McRae, K., Jacobs, S. E., Ray, R. D., John, O. P., & Gross, J. J. (2012). Individual differences in reappraisal ability. *Journal of Research in Personality*, 46(1), 78-85. <https://doi.org/10.1016/j.jrp.2011.10.003>
- Messiou, K., Ainscow, M., & Norwich, B. (2022). Inclusive education: The role of collaboration. *International Journal of Inclusive Education*, 26(7), 660-673. <https://doi.org/10.1080/13603116.2020.1713732>
- Masten, A. S., & Barnes, A. J. (2018). Resilience in children: Developmental perspectives. *Children*, 5(7), 98. <https://doi.org/10.3390/children5070098>
- Murray, D. W. (2018). Emotion regulation and ADHD. *Journal of Attention Disorders*, 22(10), 931-940.
- Ochsner, K. N., & Gross, J. J. (2008). Cognitive emotion regulation. *Cognition & Emotion*, 22(2), 153-158. <https://doi.org/10.1080/02699930701812920>
- Panayiotou, M., Humphrey, N., & Wigelsworth, M. (2023). An empirical investigation of resilience and inclusion. *School Psychology Review*, 52(2), 148-165.
- Sawyer, S. M., Azzopardi, P. S., Wickremarathne, D., & Patton, G. C. (2018). The age of adolescence. *The Lancet Child & Adolescent Health*, 2(3), 223-228. [https://doi.org/10.1016/S2352-4642\(18\)30022-1](https://doi.org/10.1016/S2352-4642(18)30022-1)

- Schäfer, J. Ö., Naumann, E., Holmes, E. A., Tuschen-Caffier, B., & Samson, A. C. (2017). Emotion regulation strategies in depressive and anxiety disorders. *Journal of Affective Disorders*, 215, 75-85. <https://doi.org/10.1016/j.jad.2017.03.032>
- Silvers, J. A., McRae, K., Gabrieli, J. D. E., Gross, J. J., & Ochsner, K. N. (2012). Age-related differences in emotional reactivity. *Social Cognitive and Affective Neuroscience*, 7(1), 11-23. <https://doi.org/10.1093/scan/nsr093>
- Slee, R. (2020). *Inclusive education isn't dead, it just smells funny*. Routledge.
- Steinberg, L. (2017). *Adolescence* (11th ed.). McGraw-Hill Education.
- Thompson, R. A. (2011). Emotion and emotion regulation. *Educational Psychology Review*, 23(1), 1-25.
- Troy, A. S., Brunner, J., & Shallcross, A. J. (2023). Cognitive reappraisal and mental health. *Clinical Psychology Review*, 98, 102221. <https://doi.org/10.1016/j.cpr.2023.102221>
- United Nations. (2006). *Convention on the Rights of Persons with Disabilities*. Retrieved from <https://www.ohchr.org/en/instruments-mechanisms/instruments/convention-rights-persons-disabilities>
- Weissman, D. G., Nook, E. C., Dews, A. A., Miller, A. B., Lambert, H. K., Sasse, S. F., & McLaughlin, K. A. (2021). Emotion regulation development. *Developmental Cognitive Neuroscience*, 47, 100893. <https://doi.org/10.1016/j.dcn.2020.100893>
- Zimmermann, P., & Iwanski, A. (2014). Emotion regulation from early adolescence to emerging adulthood. *Journal of Adolescence*, 37(8), 1331-1345. <https://doi.org/10.1016/j.adolescence.2014.08.009>
- Zimmermann, P., & Iwanski, A. (2021). Developmental trajectories of emotion regulation. *Journal of Youth and Adolescence*, 50(1), 41-56. <https://doi.org/10.1007/s10964-020-01327-9>

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Chapter # 30

ETHICAL LEADERSHIP WOVEN WITH INTEGRITY: EMERGING PATHWAYS FOR SCHOOL PRINCIPALS

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ABSTRACT

Recent research in the academic literature expressed the urgency for emerging pathways to assist school principals to understand ethical leadership (EL) toward leading with integrity. Notably, leading with integrity is a continuing learning process, yet the rewards are inevitable. The aim of this chapter, therefore, was to showcase how EL is woven with integrity, proposing moral pathways that can be used by school principals to act ethically in the line of their duties. Through the lens of integrity theory, this conceptual chapter presents an analysis of selected texts in the *South African Standard for Principalship* (SASP) which outlines significant pathways for school principals in supporting educational ethics. Data mining techniques were used to search for and select texts that could provide insights into school principals' application of EL toward acting with integrity. The findings suggest that *relational transparency*, *inclusive moral vision* and *moral reasoning* can be dynamic moral pathways to fuel school principals with innovative pathways on how to apply EL woven with integrity. These proposed pathways should be regarded as a source of light for the enactment of integrity in the hope that principals will be able to safely navigate issues of ethical concern in schools.

Keywords: emerging pathways, ethical leadership, integrity, school principals.

1. INTRODUCTION AND BACKGROUND

In the South African education context, many schools are plagued by adverse conditions such as poverty, a shortage of resources, and violence. These conditions have dire consequences for teacher morale and morality in schools (Msila, 2012; Monama, 2022). Another contributing factor to the worrisome situation in the South African education context is the fact that many schools are classified as underperforming schools, relating to those schools with a matric (grade 12) pass rate of less than 65% and where bachelor and diploma passes are below 30% (Monama, 2022). Adverse conditions like these and concerns about underperforming schools create the idea that some schools can be associated as educational spaces where equity and justice are absent, and which are regarded as “places in which ethical thought and action are needed” (Msila, 2012, p. 174). Principals who do not pay attention to improving conditions in schools are described as destructive, immoral and unethical. Contrary, principals can change situations in schools through fostering a culture of integrity, transparency and accountability (Ronnie, 2020). In this regard, EL can provide the equilibrium and ethical tutoring so that principals can lead with integrity toward nurturing a transformed sense of a positive school environment (Ahmed, 2023). Despite this expectation, there is a prevailing scepticism about EL, ranging from a negative attitude and a lack of integrity (Brown & Treviño, 2006) to blaming policies to be too wide-ranging, too ambiguous, and too intricate (Ngoepe-Ntsoane & Webb, 2021), thus creating confusion regarding EL. The problem with policy implementation is that individuals in schools might

be uninterested, demotivated or inexperienced to understand the attractiveness of policy benefits and crystallization of policy goals in practice (Ngoepe-Ntsoane & Webb, 2021). We, therefore, contend that it has become more urgent than before that researchers explore emerging pathways to arm educational leaders with moral ammunition to act decently and lead with integrity. We further assert that an analysis of policy texts can provide new directions into school principals' application of EL woven with integrity. Our claim is supported by the perception that, although policymakers and researchers paid some attention to looking at EL from different lenses, there remains an emptiness about leading ethically in contemporary educational spaces (Hsieh & Tai, 2023). Also, Mlambo (2021) asserts that, although legislation and ethical codes exist, unethical behaviour has not ended due to a lack of training and the development of attitudes and virtues for guiding human conduct. Considering the uncertainties regarding the phenomenon, we felt that it was a matter of utmost importance that EL should get the necessary consideration through proposing moral pathways that can be used by principals to lead with integrity in schools. In this regard, we asked the question: *how can an analysis of the South African Standard for Principalship (SASP) contribute to an understanding of ethical leadership so that school principals can lead with integrity?* In responding to this question, we proposed moral pathways that can be used by school principals to lead with integrity and live honourable lives as moral agents in schools. To live honourably implies that principals need to strengthen their ability to recognize right from wrong, whilst taking responsibility for their decisions and actions in schools (*vide*: Beyers & Du Plessis, 2023).

2. AIM AND OBJECTIVES

The aim of this chapter is to explore how an analysis of the South African Standard for Principalship (SASP) can contribute to an understanding of ethical leadership so that school principals can lead with integrity. As such, the objectives were to:

- Obtain insight to ascertain how ethical leadership is woven into integrity; and to
- Propose moral pathways that can assist principals as to how to lead with integrity.

3. LITERATURE REVIEW

3.1. Ethical Leadership as an Art of Moral Behaviour

EL as an art of moral behaviour is not only about the application of policy regularities and general accountability rules. Our view is underscored by Hartley et al. (2019) who purports that EL can be regarded as capacities and skills to navigate uncertain and complex moral value-driven issues in ethically acceptable ways. In this regard, principals must be able to personify integrity (Zhu, Zhi & Fang, 2025) so that EL can be performed more lawfully and realistically, and therefore, be more relevant to the needs of individuals in schools. Significantly, EL asks from individuals to “*start at the back of the textile, work the needle and thread through the fabric, and return through the fabric to the backside of the tapestry*” (Lehman, 2023). This notion shows how EL is woven with integrity. Significantly, EL and integrity are entangled strings in the ethical framework of leadership (Ciulla, 2014). Integrity thus forms the nucleus of EL, implying the stable alliance between a leader's actions, values and words. Thus, when integrity is woven into leadership, it renders moral behaviour both credible and strong (Ciulla, 2014). This implies that EL cannot be regarded as superficial but rather requires a deep and patient investigation into the self and a careful crafting of principles toward creating a moral textile filled with pathways of integrity.

3.2. Ethical Leadership as an Art of Moral Behaviour

We hold the view that integrity is more than merely following the golden rule, rather, it requires the ‘stitching of ethical actions’ together towards fostering a culture of trust in schools. We considered the ‘stitching of moral actions’ as a combination of moral imagination and promise-keeping and proactive personality (Aghighi, 2020) – elements we regarded as representatives of floss for incessant moral crafting. Moral imagination, as the first ‘string’, involves the sewing of individuals’ specific ideals and morals with newfound ethical possibilities in particular situations (Rindova & Martins, 2023). In this regard, individuals anticipate and explore the ethical effects of decisions and actions (Gerrits et al., 2023). Representing the second ‘string’, promise-keeping is connected to truthfulness, suggesting that individuals evaluate their objectives and behaviour toward improving their conduct (*vide*: Mozumder, 2022). The third ‘string’, proactive personality, hinges on the belief that individuals frequently follow their instincts about what might be the right thing to do, yet they often change their frames of references about their ethical behaviour and “*if they see something that they don’t like, they keep changing*” (Aghighi, 2020, p. 16). These strings complement each other in the sense that ‘new ethical possibilities’ (moral imagination), ‘improving their conduct’(promise-keeping), and ‘frequently change’ (proactive personality), ask from ethical leaders to constantly assess and morally change their ways of acting with integrity.

3.3. Education Policy as a Moral Compass

Harman (1984) explains that education policy is a goal-oriented document that comprises of various courses of action. Fan and Popkewitz (2020) elaborate that education policy should be regarded as a code of conduct formulated to meet the needs of development in particular areas of education. As a “course of action” and “code of conduct”, education policy provides options for best practices to address issues of educational concern. These views (Fan & Popkewitz, 2020; Harman, 1984) align with the aim of this chapter which was to explore how an analysis of the South African Standard for Principalship (SASP) can contribute to an understanding of EL so that school principals can lead with integrity. The SASP explains the roles of school principals, focusing on their level of capabilities and expertise, and provide direction in terms of principals’ leadership and developmental needs (Republic of South Africa [RSA], 2015). For instance, one of the elements of the policy is indicated as principals’ responsibility to subscribe to educational ethics (RSA, 2015). In adherence to educational ethics, the SASP (RSA, 2015) oblige principals to “behave with integrity toward people of all cultures” (p. 10), “take responsibility and be accountable in all matters concerning the school” (p. 10), “lead diversity” (p. 20) and “make accurate judgments” (p. 20). The effect of these educational ethics on the work principals do is overtly stated in the SASP, indicating that “*ethical leadership in all its various facets, and more particularly in leading diversity, is of paramount importance for an effective principal*” (RSA, 2015, p. 3). This statement suggests that an application of EL must be an act of making reliable decisions in schools which can be associated with the making of choices that align with the enactment of integrity and building trust, whilst be cognizant about the consequences of decisions being made (Olasehinde, Onibon, Weya-Ajayi, & Adewale, 2025). As such, we delicately studied texts in the SASP (RSA, 2015) to find fundamental pathways that can assist principals in leading with integrity in schools. Before presenting an analysis of texts in the SASP (RSA, 2015), we first explain the theory that underpinned this study and then explain the research processes followed in this research study.

4. APPLICATION OF INTEGRITY THEORY

This chapter adopted Williams' (2002) explanation of integrity theory as individuals' ability to "*follow the internal route, and expresses the self in authentic way, in which we should follow our deepest impulses, listen to ourselves within, be true to ourselves and expresses ourselves sincerely, thus a true self is revealed*" (p. 184). This frame of thinking implies that individuals have the intellectual capacity to make informed choices that embrace accountability when they act upon the choices they make. Such accountability requires leaders to act in tandem with ethical moralities to circumvent any actions that might compromise their moral values (Zarghamifard & Danaeefard, 2020) so that they can guide, influence, and inspire others to uphold similar ethical standards. When aligned to the application of EL, an application of integrity theory (Williams, 2002) guided our thinking in terms of school principals' ability to present their true selves and avoid actions that may compromise their moral values, while they guide, influence, and inspire others ethically.

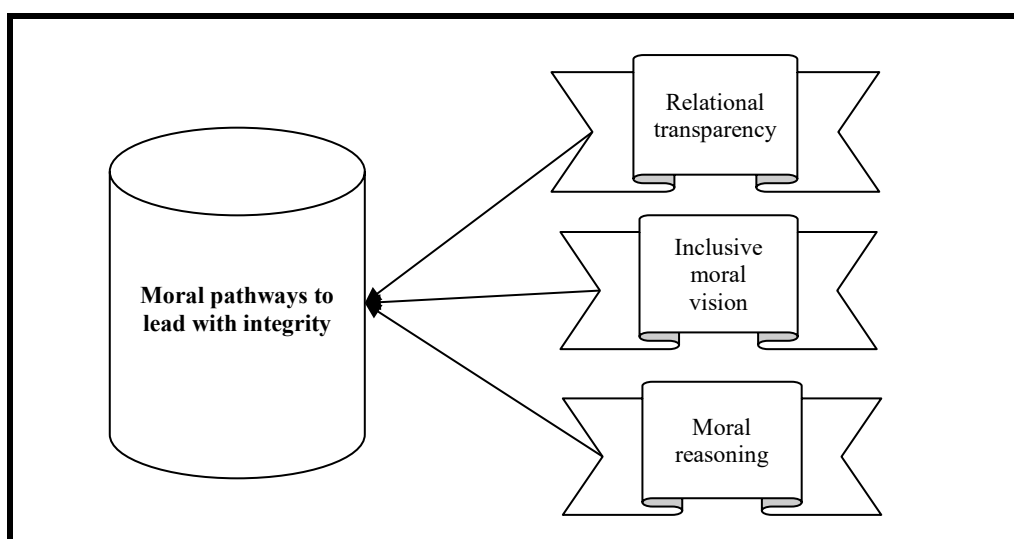
5. METHODOLOGY

This conceptual chapter employed a qualitative approach, analysing the content in documents, allowing researchers to understand how ideas and information are presented and what meanings can be derived about phenomena (Dalglish, Khalid, & McMahon, 2020). In this chapter, data is represented by selected texts in the SASP (RSA, 2015). We first scrutinized several South African education policy documents and found that the SASP (RSA, 2015) provides the strongest information that could be used to find information about how EL can be regarded as a delicate embroidery so that school principals can lead with integrity. We employed data mining, which is an exploratory method of knowledge finding, focusing on the detection and mining of significant patterns of information (Rasid et al., 2017). Firstly, we thoroughly combed through the large volume of texts in the SASP (RSA, 2015) and transferred relevant information to a WORD document (which we called our georgette – a relatively delicate silk). Secondly, we arranged the texts on the 'georgette' in layers ranging from mostly relevant to less relevant. Thirdly, we worked delicately to select those texts with the strongest connection to EL and integrity. Notably, we gently performed the text selection to avoid the georgette from twisting, implying that we were cautious not to leave out important information toward analysis. Next, we scrutinized the texts and were able to identify understandable, valid and useful patterns, which, after another round of scrutiny, assisted us to identify three moral ribbons that represent EL as a delicate embroidery of integrity: *relational transparency, inclusive moral vision and moral reasoning*.

6. RESULTS AND DISCUSSION

Derived from the SASP (RSA, 2015), we next discuss the three identified moral pathways (Figure 1):

Figure 1.
Moral pathways to lead with integrity.



Firstly, the SASP (RSA, 2015) is adamant that principals should act with “*fair-mindedness, patience, empathy, compassion, respect and humility in all dealings with others*” (p. 6). These ethical characteristics (RSA, 2015) make relational transparency probable and reliable. The enactment of relational transparency implies that EL allow others to voice their own true emotions, thoughts, opinions and ideas (Rego, Pina e Cunha, & Giustiniano, 2022). In so doing, principals may obtain a deeper sense of what it means to enact integrity in the line of their duty. In this regard, principals must build trust and always be honest with the individuals they work with. Principals must, therefore, be willing to acknowledge when they make mistakes – which is a sign of acting in conjunction with morals and values. When principals would prioritize transparency, they create a culture of ethical behaviour founded on loyalty, respect and trust (Biancone, 2024). In this regard, relational transparency becomes a valuably beacon of integrity for principals to enact ethical leadership. It is thus not strange that the SASP (RSA, 2015) reminds principals that they should refine their knowledge about integrity, whilst constantly revisit their understanding of what is morally right. Principals are supposed to be individuals with well-ordered souls, implying that they ought to know how to act transparently in terms of the knowledge they have about doing things in the right way and making decisions that are morally acceptable (Wright, 2020).

Secondly, the SASP (RSA, 2015) provide principals with the opportunity to foster an inclusive moral vision through shaping “*integrity and fairness in all dealings with people*” (p. 6). An inclusive moral vision requires an escape from ignorance and a search for a different truth regarding things, which considers the implications of knowledge and responsibility (Makwudo & Nkwakudo, 2025). Within such a vision, principals may be able

to strengthen answerability, consultation and critical reflection (McAuliffe & Greenslade, 2025). While answerability requires principals to rationalise and justify their decisions, consultation is about obtaining the guidance of others to endorse significant values in the interests of prudence and integrity. Also, critical reflection encourages individuals to evaluate their decision-making processes and engage in self-reflection toward improving future moral practices. When aligned to the SASP (RSA, 2015), integrity, as a moral inclusive vision represents principals' ability to take a brave stance to distance themselves from immoral behaviour toward searching for new opportunities and a greater understanding of how to act with integrity. Immoral behaviour occurs when principals abuse their authority to threaten or intimidate others through discriminatory practices, defiance of rules, favouritism or discrimination (*vide*: Arslan, Polat, Gürler, & Bulut, 2024). Significantly though, when principals would distance themselves from immoral behaviour, they safeguard professional integrity, whilst creating opportunities to re-affirm moral standards in schools.

Thirdly, principals must be able to employ moral reasoning in terms of the way they lead others and the decisions they make. In this regard, the SASP is adamant that principals should understand the “core values that underpin everything that happens at a school and that inform everything that the principal does in leading and managing the school” (RSA, 2015, p. 9). Such core values align with those enshrined in the South African Constitution (RSA, 1996), for instance, principals should protect the dignity of everyone at schools, ensure that all individuals are treated fairly and without discrimination and protect individuals from the abuse of power. Moral reasoning, therefore, implies that principals must be “alert of everything that happens in the school” (RSA, 2015, p. 9) so that everyone can be treated as worthy citizens of this country and the world. To strengthen the ability of moral reasoning, principals must employ moral judgment which hinges on notions of personal interests (PI), maintaining norms (MN), and postconventional (PC) thinking (*vide*: Rest et al., 1999). While PI reflects a dedication to what is morally acceptable, MN focuses on a devotion to lawful actions. PC requires individuals to assess several views and employ nuanced moral reasonings. When principals employ moral judgment, they may be stronger in condemning unethical behaviour, while honouring their moral commitments, even when it might not suit them (Isserow & Klein, 2017).

7. FUTURE RESEARCH DIRECTIONS

A valuable avenue for research would be to explore consolidative frames where integrity is theorized as equally an ethical orbit and behavioural model. Also, it might be interesting to investigate cross-cultural perceptions of integrity and how they shape ethical leadership depiction.

8. CONCLUSION

We first conducted a literature review and derived three valuable insights. Firstly, ethical leadership requires a deep and patient examination into the self and a careful crafting of principles toward creating a moral fabric filled with beacons of integrity. Secondly, integrity presupposes that moral imagination, promise-keeping and a proactive personality requires ethical leaders to continuously appraise morally transform their ways of doing things. Thirdly, education texts provide valuable options for the enactment of ethical leadership. After engaging with data mining of texts in the SASP, we found that an application of relational transparency can guide principals toward obtaining a deeper sense of what it means to enact integrity in the line of their duty. Also, principals should employ

an inclusive moral vision so that they can take a brave stance to distance themselves from immoral behaviour toward searching for new opportunities and a greater understanding of how to act with integrity. Furthermore, principals should employ moral reasoning so that they may be stronger in condemning immoral conduct, while honouring their moral commitments, even when it might not suit them. The noticeable impact of the SASP, as illustrated in this study, can be found in the focus on standards such as respect, integrity, accountability, human dignity and fairness. These standard may assist principals in understanding their ethical commitments beyond organizational effectiveness. Notably, the SASP can be useful in reducing vagueness in terms of decision-making and can thus guide principals to act in ways that are associated with professional and constitutional ethics.

REFERENCES

- Aghighi, A. (2020). The role of ethical leadership & proactive personality on organizational citizenship behaviors: Mediating role of positive & negative emotions. *International Journal of Ethics & Society (IJES)*, 2(2), 11-18.
- Ahmed, E. I. (2023). A systematic review of ethical leadership studies in educational research from 1990 to 2022. *Educational Management Administration & Leadership*, 2023, 1-20. <https://doi.org/10.1177/1741143223119325>
- Arslan, Y., Polat, S., Gürlü, M., & Bulut, I. (2024). Unethical behaviors of school principals according to teachers' views: Causes and recommendations for prevention. *International Journal of Psychology and Educational Studies*, 11(1), 50-65. <https://dx.doi.org/10.52380/ijpes.2024.11.1.1303>
- Beyers, R., & Du Plessis, A. (2023). Factors that influence public school principals' professional discretion: Perspectives of South African public-school principals. *Perspectives in Education*, 41(2), 33-48. <https://doi.org/10.38140/pie.v41i2.7067>
- Biancone, P. (2024, September 13). *The power of transparency and integrity in client relationships*. Retrieved from <https://www.linkedin.com/pulse/power-transparency-integrity-client-relationships-patrick-biancone-vxb9c>
- Brown, M. E., & Treviño, L. K. (2006). Ethical leadership: A review and future directions. *The Leadership Quarterly*, 17, 595-616. <https://psycnet.apa.org/doi/10.1016/j.leaqua.2006.10.004>
- Ciulla, J. B. (ed.). *Ethics, the heart of leadership*. Santa Barbara: Praeger. Retrieved from <https://scholarship.richmond.edu/cgi/viewcontent.cgi?article=1199&context=bookshelf>
- Dalglish, S. L., Khalid, H., & McMahon, S. A. (2020). Document analysis in health policy research: the READ approach. *Health Policy and Planning*, 35(10), 1424-1431. <https://doi.org/10.1093/heapol/czaa064>
- Fan, G., & Popkewitz, T. S. (2020). *Handbook of education policy: Value, governance, globalization and methodology* (Volume 1). Springer Open. Retrieved from https://link.springer.com/chapter/10.1007/978-981-13-8347-2_2
- Gerrits, E. M., Assen, L. S., Noordegraaf-Eelens, L., Bredenoord, A. L., & Van Mil, M. H. W. (2023). Moral imagination as an instrument for ethics education for biomedical researchers. *International Journal of Ethics Education*, 8, 275-289. <https://doi.org/10.1007/s40889-023-00171-z>
- Harman, G. (1984). Conceptual and theoretical issues. In J. R. Hough (Ed.), *Education policy: An international survey* (pp. 13-27). Australia, Sydney: Croom Helm Ltd.
- Hartley, J., Sancino, A., Bennister, M., & Resodihardjo, S. L. (2019). Leadership for public value: Political astuteness as a conceptual link. *Public Administration*, 97(2), 239-249. <https://doi.org/10.1111/padm.12597>
- Hsieh, C., & Tai, S., & Li, H. (2023). A bibliometric review of ethical leadership research: Shifting focuses and theoretical insights. *AERA Open*, 9(1), 1-13. <https://doi.org/10.1177/23328584231209266>

- Isserow, J., & Klein, C. (2017). Hypocrisy and moral authority. *Journal of Ethics and Social Philosophy*, 12(2), 191-222. <https://doi.org/10.26556/jesp.v12i2.224>
- Lehman, C. (2023, November 21). *Embroidery: meaning, types & examples*. Retrieved from <https://study.com/academy/lesson/what-does-embroidery-mean-in-textiles.html>
- Makwudo, K. K., & Nkwakudo, A. E. (2025). Escaping the cave: A platonic analysis of "Japa" as the philosopher's journey from darkness to light. *Trinitarian International Journal of Arts and Humanities*, 1(1), 45-61. Retrieved from <https://journals.ezenwaohaetorc.org/index.php/TIJAH/article/view/3126/3253>
- McAuliffe, D., & Greenslade, L. (2025). Turn it and turn it again: The updated inclusive model of ethical decision making. *Ethics and Social Welfare*, 19(2), 161-173. <https://doi.org/10.1080/17496535.2025.2483668>
- Mlambo, F. A. (2021). Exploring the ethical leadership practices of school management teams in selected secondary schools in Gauteng Province (MEd dissertation, University of South Africa). Retrieved from <https://uir.unisa.ac.za/handle/10500/28273>
- Monama, T. (2022, July 11). 80% of schools are dysfunctional, serve mostly black and coloured pupils, says report. *news24*. Retrieved from <https://www.news24.com/southafrica/news/80-of-schools-attended-by-black-coloured-pupils-dysfunctional-says-report-20220711>
- Mozumder, N. A. (2022). Can ethical political leadership restore public trust in political leaders? *Public Organization Review*, 22(3), 821-835. <https://doi.org/10.1007/s11115-021-00536-2>
- Msila, V. (2012). Fostering an effective school through moral leadership: A South African case study. *International Journal of Social Sciences and Education*, 2(1), 174-192. Retrieved from https://web.archive.org/web/20180409225043id_/http://www.ijssse.com/sites/default/files/issues/2012/volume%202%20issue%201%20Jan%202012/paper%2013/paper-13.pdf
- Ngoepe-Ntsoane, M. J., & Webb, W. N. (2021). Ethical leadership: Resolving the failure of public policies in corruption prevention. *Journal of Contemporary Management*, 17(2), 86-108. https://doi.org/10.35683/jcm20_3.134
- Olasehinde, S. A., Onibon, M. T. G., Weya-Ajayi, F. O., & Adewale, F. O. (2025). Ethical decision-making and its impact on reputational risk management and stakeholder expectations in competitive business environments. *Journal of Business Management, Innovation and Creativity*, 4(1), 182-194.
- Rasid, N., Nohuddin, P. N. E., Alias, H., Hamzah, I., & Nordin, A. I. (2017). Using data mining strategy in qualitative research. In H. B. Zaman, P. Robinson, A. F. Smeaton, T. K. Shih, S. Velasting, T. Terutoshi, A. Jaafar, & N. M. Ali (Eds.), *Advances in visual informatics* (pp. 100-111). Proceedings of the 5th International Visual Informatics Conference, IVIC 2017, Bangi, Malaysia, November 28–30, 2017. https://doi.org/10.1007/978-3-319-70010-6_10
- Rego, A., Pina e Cunha, M., & Giustiniano, L. (2022). Are relationally transparent leaders more receptive to the relational transparency of others? An authentic dialog perspective. *Journal of Business Ethics*, 180, 695-709. <https://doi.org/10.1007/s10551-021-04792-6>
- Republic of South Africa (RSA). (1996). *Constitution Policy of the South African, Act 108 of 1996*. Pretoria: Government Printer. Retrieved from <https://www.justice.gov.za/constitution/SAConstitution-web-eng.pdf>
- Republic of South Africa (RSA). (2015). *Policy on the South African Standard for Principals*. Pretoria: Government Printer. Retrieved from https://www.gov.za/sites/default/files/gcis_document/201603/39827gon323.pdf
- Rest, J. R., Narvaez, D., Bebeau, M. J., & Thoma, S. J. (1999). *Postconventional moral thinking: A neo-Kohlbergian approach*. Psychology Press.
- Rindova, V., & Martins, L. L. (2023). Moral imagination, the collective desirable, and strategic purpose. *Strategy Science*, 8(2), 170-181. <https://doi.org/10.1287/stsc.2023.0190>
- Ronnie, L. (2024). The challenge of toxic leadership in realising Sustainable Development Goals: A scoping review. *SA Journal of Human Resource Management/SA Tydskrif vir Menslikehulpbronestuur*, 22(0), a2754. <https://doi.org/10.4102/sajhrm.v22i0.2754>
- Williams, B. (2002). *Truth and truthfulness*. Princeton: Princeton University Press. <https://doi.org/10.1023/B:INQU.0000019140.71721.d1>

- Wright, W. (2020, August 28). *A critique and defense of Plato's "just state"* [Blog post]. Retrieved from <https://www.wrightswriting.com/post/a-critique-and-defense-of-plato-s-just-state>
- Zarghamifard, M., & Danaeefard, H. (2020). What drives leader integrity? *International Journal of Business Governance and Ethics*, 14(1), 1-33. <https://doi.org/10.1504/IJBGE.2020.104685>
- Zhu, J., Zhi, W., & Fang, Y. (2025). Ethical leadership, organizational learning, and corporate ESG performance: A moderated mediation model. *International Review of Economics and Finance*, 98(2025), 1-14. <https://doi.org/10.1016/j.iref.2025.103966>

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AUTHOR INDEX

Alonso-Rivera, A.	3
Amadoro, A.	119
Banek, N.	287
Bennett, C.	93
Bouwels, L.	106
Brian, M.	238
Charlot, J.-M.	81
Clavero, T.	106
De Klerk, E.	352
Di Gennaro, D.	119
Eftimova, S.	17
Enebe, N.	263
Fröjd, S.	274
Gambary, P.	67
García Pérez, L.	29
Gavira-Duron, N.	3
Genova, T.	17
Goodman, J.	81
Grinfelde, A.	309
Haggis-Burridge, M.	106
Hassreiter, S.	106
Haugen, T.	52
Helander, N.	274
Honzíková, J.	147, 215
Horverak, M.	52
Ingaramo, M.	179
Jaumot-Pascual, N.	129
Jiménez Preciado, A.	3
Kalengay, D.	170
Kashif, M.	29
Kepka, M.	295
Kerima, B.	170
Kirby, D.	41
Konidari, V.	225
Koutouzis, M.	225
Krotký, J.	147, 215
Langeland, G.	52

Lara-Meloy, T.	129
Levin-Güracar, E.	129
Lievens, J.	251
Lin, X.	179
Mallam-Hassam, A.	41
Matashu, M.	330
Mudadigwa, S.	352
Mutombo, A.	170
Mwambakana-Mutombo, J.	319
Myllärniemi, J.	274
Noël, L.	81
Palmer, J.	263
Paula, L.	309
Paulus, K.	170
Perera, A. T-M.	106
Polipowski, A.	81
Pratt, D.	189
Rafanan, K.	129
Reddy, P.	189
Ruchti, W.	93
Sari, E.	52
Sasere, O.	330
Sjödén, B.	251
Sondlo, A.	238
Stervinou, S.	81
Steuber, A.	287
Tomášková, T.	147, 215, 295
Vancu, E.	341
Vendramin, V.	161
Veneruso, U.	119
Xaba, N.	204, 238