Chapter #4

FORENSIC SCIENCES AS EDUCATIONAL SUPPORT FOR THE PROMOTION OF TEACHING AND LEARNING OF SECONDARY STUDENTS

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ABSTRACT
The search for improvements in education systems has grown sharply, from incentives in the educational area to changes in the legislation, highlighting a more contextualized teaching, especially in the field of science. However, the dissemination of knowledge transcends the need and becomes a daily challenge in the life of educators, who need to reinvent themselves, reform themselves, and especially develop activities that make the understanding of content more relevant and meaningful. Although it is an arduous task for many students, this learning is indispensable to adequate scientific education. Thus, this research aimed to synthesize studies that have been developed on the use of forensic sciences as a pedagogical approach in the improvement of secondary education. The methodology is based on applied scientific research of a qualitative-exploratory nature. The results show experiences of the school context lived in the United States, Brazil, Singapore, and Portugal, where it is observed that students feel more motivated and involved in educational activities when integrated into the forensic context. The implementation of this theme to the school curriculum has the potential to attract attention and arouse interest in the sciences, contributing to the reduction of retention rates and school dropout and increasing the demand for scientific and technological careers.

Keywords: interdisciplinarity, scientific methodology, criminal investigation, school dropout, CSI effect.

1. INTRODUCTION

According to D'Ambrosio (1996), education should develop strategically in individuals, promoting stimuli that contribute to individual and collective relationships in a given culture, promoting the achievement of goals, and the satisfaction of survival needs and transcendence. This shows that education must be part of the individual's constitution so that they can understand, debate, and make decisions based on the understanding of scientific progress, in order to relate it to the factors present in their life.

In recent years there has been an increasing search for improvements in education systems, from incentives for research in the educational area to changes in the legislation itself (Lima, 2015), highlighting a more contextualized teaching to reflect in benefits to the teaching and learning of students, especially in science education. Science education is considered essential from the early years of schooling, as it prepares students for a more adapted social life and a qualified professional life. It promotes stimulation and develops a natural curiosity about things, and this contact contributes to the development of intellectual capacities.

In Brazil, a high number of students entering universities, especially in courses in the areas of exact and natural sciences and engineering, present difficulties due to learning failures throughout their compulsory education, especially when they come from public schools, where there is a very strong absence of teachers with training in the area and little structure of didactic support for the development of teaching. Silva, Viera, and Ferreira (2017) address points that directly affect address aspects that directly affect teaching and learning process, including the school structure, the absence of science laboratories, and adequate teacher training.

Especially nowadays, the dissemination of knowledge in science transcends necessity and becomes a daily challenge in the lives of educators. Transferring theoretical knowledge to everyday practice, whether in the personal or professional environment, remains a major challenge for science, especially when it comes to teaching (Cadola et al., 2020). The educator needs to reinvent himself, reform himself, and especially, develop work and research based on issues or problems of their daily life because this will make all this mobilization for teaching and learning become something meaningful for such.

Understanding the school subjects that derive from exact and natural sciences, which are integrated into the natural sciences, mathematics, and their technologies, according to the areas of knowledge of secondary education according to law Nº 9.394, article 35, Dez 20 of the National Education Guidelines and Framework Law (LDB), is not an easy task for many students, due to the fact that several contents are difficult to assimilate, especially when taught in the traditional way considered by many students as boring, dull and not very profitable. This demotivation has increasingly contributed to school retention and dropout rates.

While learning the syllabus contents of exact and natural sciences is characterized as a difficult task for many students, it is indispensable to adequate scientific education. Connecting science to social phenomena and applying technology to everyday life makes science more relevant and meaningful to students (Pais, 2009). The distance between the curricular content and the experience of integrating it to the phenomena present in the students' daily lives certainly accounts for their lack of interest and even dropout. Meaningful learning presupposes the existence of a referent that allows students to identify and identify with the proposed questions (Souza, 2016).

The articles arranged by LDB (Law Nº 9.394/1996) and National Council of Education (CNE, 1998) point to orienting learning towards a greater contextualization, effective interdisciplinarity, and a broader human formation, not only technical, already recommending a greater relationship between theory and practice in the learning process itself.

In 2018, according to Organisation for Economic Co-operation and Development (OCDE, 2020), the proportion of young adults without complete secondary education in Brazil were still large compared to other developed countries. On average, in the countries that make up the OCDE, 47% of 18- to 24-year-olds have dropped out of the education system, which is closely linked to leaving secondary school for higher education. In Brazil, Colombia, Israel, and New Zealand, more than 65% of these young adults are no longer studying. Therefore, pedagogical alternatives are needed to contribute to the interest in science teaching, thus, the implementation of interdisciplinarity presents itself as a possibility to overcome the fragmentation of sciences and the knowledge produced by them.

In this relentless search for improvements in education, Forensic Science emerges as a student-centered scientific methodology, where its content naturally lends itself to constructivist inquiry-based learning because students are constantly fostered to ask

questions, evaluate evidence, and use critical thinking and reasoning to promote explanations to issues under analysis. It contemplates a range of sciences to answer questions of legal significance, thus it plays a crucial role in solving crimes (Hemanth, Tharmavaram, & Pandey, 2020). Besides its broad, diverse, and integrative context, it allows various fields of knowledge and science to be interconnected, such as Mathematics, Physics and Chemistry, Medicine, Engineering, thus making it an interdisciplinary science.

As a scientific discipline, it has its roots within the natural sciences. It is an area that has gained dimensions over the years by arousing curiosity and fascination for its contribution to justice. The media has expanded forensic science around the world through news and publicity. TV shows, such as investigative sitcoms, have played a large part in this expansion that has given rise to the "CSI effect" (Siegel, 2009). The investigative process often follows steps similar to a conventional laboratory exercise. This methodology can result in creating unrealistic expectations in students about how science is done.

In view of the above, this theme becomes extremely relevant to be worked in the classroom, because from fictional, expert case studies, it allows students to develop critical thinking and reasoning, in addition to creativity and independence in the development of activities, seeking to integrate various disciplines, thus expanding the range of observations and phenomena of everyday social life. The use of this tool to promote scientific literacy is a strategy for reducing school retention and dropout rates and the pursuit of scientific and technological careers.

This work aimed to attest through synthesis, studies that have been developed around the implementation of forensic sciences as a pedagogical practice in the promotion of teaching and learning in secondary school. Due to its interdisciplinary character, this approach allows contextualizing several contents, thus providing the integration of several sciences to solve a specific problem. The fact that forensic sciences are associated with mystery captivates even the most reluctant students, thus allowing an approach to the scientific method, helping them to think like real scientists.

2. METHODOLOGY

This study was based on applied scientific research, whose purpose is to generate solutions to human problems. Trujillo Ferrari (1982) emphasizes that "notwithstanding the practical purpose of the research, it can theoretically contribute to new facts regarding the planning of new research or even to the theoretical understanding of certain knowledge sectors" (p. 171).

Regarding the nature of this research, it fits into a qualitative approach located within the exploratory paradigm from a systematic review of the literature. The qualitative design was appropriate for this study, as it provides consistent information about the context and provides an understanding of the factors to be observed (Mcleod, 2017).

The study explored from recent studies, pedagogical practices benefits around forensic sciences adopted in the educational context of secondary education in schools of the United States, Brazil, Singapore, and Portugal. The qualitative evaluation of the results obtained in these surveys was based in the analysis of questionnaires and exercises proposed to students before and after carry out actions.

3. RESULTS AND DISCUSSION

Several kinds of research focusing on educational methodologies for secondary education have been discussed around the world, and, concerning the Brazilian educational system, it is the level of education that provokes the greatest debates, either by the persistent problems of retention and school dropout; by the lack of attractiveness of its curriculum; by the quality of education offered or yet, by the discussion about its identity (Souza, 2016). The school may be responsible for the success or failure of students during their academic life, as they are very quickly led to disinterest in studies, especially in the years comprising elementary and secondary education. Seeking methodological alternatives that promote student engagement and motivation becomes increasingly indispensable, especially for teaching exact and natural sciences.

At the international level, Saccaro, França, and Jacinto (2019) found that dropout in higher education is the result of several reasons, among which is the deficient quality of schooling in primary and secondary education. The subjects of Differential and Integral Calculus, for example, inserted in courses of exact and natural sciences and Engineering, present high retention rates, which commonly derive from the gaps in previous knowledge in physics and mathematics acquired during their previous education (Bigotte de Almeida, Queiruga-Dios, & Cáceres, 2021).

Students in Science, Technology, Engineering and Mathematics (STEM) are more likely to drop out than students in other areas of knowledge, instead of motivating the technical-scientific area, they end up being discouraged, contributing to the reduction, increasingly, of skilled professionals in technological areas (Costa, 2020).

The search for scientific methodologies that increase the interest and performance in these areas, make forensic sciences with high didactic potential to the learning and intellectual development of students in their construction of knowledge, indispensable to social and professional life. They allow advances in the concepts and processes explained in the classroom, thus, several studies have been developed to validate the insertion of this methodology in the school context, as a strategy to improve the teaching and learning process.

Based on the observation of studies that have been taken around the use of forensic sciences for science teaching to secondary school students, it was made a synthesis about some of these actions proposed in secondary schools, as shown in Table 1.

Table 1.
Actions in forensic science for education.

Author	Methodology used	Site	Main results
Raza (2012)	A six-week module involving practical forensic science activities. The evaluation about this action was based on a quantitative and qualitative analysis around mini evaluations applied to the students.	United States	The qualitative evaluation indicated: benefits of group work and discussion in problem solving process; higher-order thinking skills in evaluation and analysis in training; and connections between classroom learning and the real world. Quantitative analysis revealed an increasing level of higher-order thinking and enhanced use of cognitive skills.

Author	Methodology used	Site	Main results
Low and Yow (2014)	A ten-week module covering forensic science-based learning through workshops, laboratory practice, and sharing the experiences of professionals in the field. At the end, students were evaluated based on a series of questions prepared by teachers during their presentations.	Singapore	The qualitative analysis showed that the insertion of this module promoted the improvement of communication skills among students and provided a better interpretation of the concepts acquired in class.
Rocha, Garrido, and Garrido (2014)	An action involving six easy-to-use and low-cost forensic tests as a practical activity in science classes. For evaluation purposes, questionnaires were applied to assess the students' knowledge and interest in a practical program involving this theme to be included in the school curriculum.	Brazil	It was observed an absence of practical classes in the teaching of these sciences, and about 94% of these students have great interest in improving learning through the visualization of content in a more tangible way, especially if these classes are contextualized with topics related to forensic science. They also demonstrated that the use of topics related to forensic sciences would provide more motivation and would certainly result in great benefits to the teaching and learning process.
Souto et al. (2015)	They proposed the use of a forensic science educational kit, to be used by students under the supervision of their teachers. The kit allowed them to relate these activities to curricular subjects, such as Biology, Chemistry, Physics and Mathematics. The effectiveness of this action was evaluated through questionnaires applied to teachers.	Portugal	According to surveys, teachers considered that the activities presented could improve the subject they teach, since they promote interdisciplinarity and diversification of practical work. They also consider that these activities lead to encouragement, creativity and critical thinking, allowing students to develop new abilities to question and to connect the classroom to reality.

Author	Methodology used	Site	Main results
Munayer (2018)	The author investigated the use of a textbook consisting of suspenseful short stories about real facts about forensic science. The technique employed in the implementation of this scientific methodology allowed the use of curricular topics of the chemistry discipline to promote productive disciplinary engagement of students. The feedback for the action was based on the application of a questionnaire about the proposed activities.	Brazil	Students were engaged in discussions that permeated the application of scientific concepts in solving the problems involved. In students' records, it was found that the activities enabled the understanding of Chemistry content from the investigations, where they could review concepts already seen in the classroom and integrate them into the construction of new knowledge.
Santos and Amaral (2020)	In this study their applied a series of activities related to forensic chemistry to promote potentially meaningful learning of curriculum content in chemistry. The research approach was qualitative of action-research type and applied to secondary school students. The activities involved the resolution of a "crime". The action evaluation consists of the application of three questionnaires (Pre, Post test 1 and 2), and aimed to measure the effect of the intervention on long-term learning.	Brazil	The questions showed that the videos provoked dialogic discursive interactions between student/student and student/teacher. Based on the interpretation of the results from the completion of the exercise lists before and after the activity, we noticed an evolution around 42% and 30%, respectively, evaluated by the significant learning of the scientific content covered in class.

Author	Methodology used	Site	Main results
Lino, Sá, and Silva (2020)	They used a learning model involving interactions with forensic sciences, the practice was based on the simulation of a crime scene composed of several pieces of evidence distributed throughout the site, involving interdisciplinarity and contextualization in a playful way, addressing issues related to human identification. The effectiveness of the proposal was based on the application of questionnaires before and after the action, addressing students' knowledge about human identification, levels of interest in natural sciences, and levels of satisfaction with the classes.	Brazil	In the initial questionnaire, of the 37 students interviewed, 51% said they knew the concept of human identification; 81% of the students said they did not know the methods used for this analysis; and 95% of the students said they did not take practical classes often. After the activity, students illustrated the importance of practical classes in science teaching, since triggering themes such as criminalistics and forensic science promote an increase in the level of interest for learning in science subjects.

The results obtained by Raza (2012) indicate that the forensic science curriculum offers students ample opportunities to learn and practice skills associated with scientific literacy. Students had the opportunity to acquire specific knowledge and domains in biology, chemistry, and physics, as well as to experiment the path into which knowledge of these areas is integrated, based on the context of its application to forensic science problems. The results indicate that students perceive that scientific knowledge is evolution and subject to change due to new trends and discoveries. In this way, learning provides a source of support and insight that help students deal with the challenges presented by the curriculum's problem-solving process. In addition, students are given the opportunity to reflect and receive feedback by teachers and other students, which helps to value social negotiation and group learning.

The study developed by Low and Yow (2014) show that students indicated that they enjoyed this type of activity because it allowed them to learn beyond the limits of the curricula offered in school, enabling them to acquire useful skills and competencies. In addition to developing a greater interest and motivation demonstrated during the development of the activities, it inspired many to explore the field of forensic science as a future career option, triggered especially, from work experiences shared by professionals in the forensic field.

According to Rocha, Garrido, and Garrido (2014) most of the students interviewed had already watched movies and television series related to forensic science activity, thus, this observation opens an important opportunity to bring students to the knowledge of the natural sciences in their curriculum, since they had indicated that these contents did not attract their interest when taught by traditional methods.

In your study, Souto et al. (2015) shows that teachers' feedback confirms the benefits provided by the implementation of these activities in the educational context and considers it to have great potential to attract the attention and arouse the interest of students in the science areas, thus improving the understanding of the theoretical concepts of the contents integrated into the school curriculum. They also add that this educational tool can contribute to minimize the disinterest and dropout of students at critical ages, as well as contribute to the motivation of the educational agents themselves. From the qualitative analysis by Munayer (2018), it was possible to notice the interest, motivation, performance, and engagement of students in the classroom during the implementation of this practice so that they could experience in a new way the understanding of scientific concepts and ideas worked in the school context.

In your results Santos and Amaral (2020) showed that forensic chemistry as a contextualizing theme in the teaching of chemistry, promoted a greater involvement, interest and motivation to the students, thus allowing a better understanding of the contents. Evaluating the before, during and after the development of the activities, it is possible to perceive the promotion of potentially significant learning from the use of this methodology.

In the work developed by Lino, Sá, and Silva (2020), the data indicate that the natural sciences still face a low acceptance among students, however, the simulations of forensic practices inserted into the classroom didactics contributed to the scientific stimulation of students from the interconnection between theory and practice, promoting curiosity and helping to keep them motivated within the teaching and learning process.

Forensic science is a subject that creates an conducive atmosphere to increasing student interest in science learning. The students are required to use scientific information as well as be involved in the investigation process in order to solve problems in a real-world environment. Forensic science becomes a strong ally in science teaching, since the inclusion of topics based on forensic scientific investigation shows an active involvement of students in the teaching and learning process, improving their critical thinking skills, developing scientific literacy, and improving interpersonal relationships through collaborative work. The interdisciplinarity and contextualization of content with forensic themes, besides benefiting learning, stimulate interest in technological areas.

5. CONCLUSION

Forensic science is an authentic subject that can be used to connect the classroom to a real working environment. Due to its nature, which is based on the mystery of the investigative process, it allows subjects such as Physics, Mathematics, Chemistry, and Biology to be approached in a contextualized way, promoting scientific learning. As observed by the studies outlined in this research, the use of forensics in the school setting has reflected in advances in the concepts and processes explained in the classroom, from the connections made with the real world, enabling other advantages such as the improvement of interpersonal relationships, based on the engagement arising from collaborative work, as well as in higher-order thinking skills in knowledge formation. Moreover, teachers evaluate the implementation of these activities in educational contexts with great potential to not only awaken the interest of students in areas of science, but also contribute to the motivation of educational agents themselves. The actions proposed by the insertion of forensic sciences in education reflect benefits on a horizon that goes beyond the high school barrier; these results can be observed in a more qualified schooling experience of the student who reaches higher education, being this decisive for their success in the course. The developed pedagogical activities that rely on non-conventional techniques,

complementary to traditional ways of teaching, provide meaningful learning, allowing students to identify and identify themselves with the proposed issues, acquiring the ability to understand and intervene, in an autonomous and not alienated vision of reality. The inquiry-based learning of sciences, effectively contributes to the development of scientific literacy, developing from a constructivist approach, a greater integration between science-technology-society-environment, contributing, consequently, to the reduction of retention and dropout rates and the search for technological careers.

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