Chapter # 24

EXTENDING THE 2D3S4L FRAMEWORK:
Generative AI for pedagogy, literacy, and cross-cultural English classrooms

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ABSTRACT
This chapter presents the 2D3S4L instructional model, designed to embed generative chatbots into secondary English classrooms with pedagogical coherence. The model aligns teaching and learning processes across two dimensions (teachers and students), three stages of instruction (pre-class, in-class, post-class), and four recursive loops (analyze, design, implement, evaluate). Grounded in sociocultural theory and the TPACK framework, the model was implemented in Chinese secondary schools using DeepSeek and Doubao AI to support writing, speaking, and reflective reading tasks. Findings show chatbots enhanced idea generation, linguistic accuracy, and learner autonomy, while teacher prompts and scaffolded feedback were critical for effective integration. Concrete examples illustrate how chatbots facilitate task execution and deepen reflection. The chapter provides a structured framework, as well as practical guidance, on what future AI-enhanced language instruction might look like. The chapter provides not only a structured framework but also concrete suggestions for what new AI-enhanced language instruction may be for educators in the future. These initiatives set up both theoretical foundations as well as practical approaches toward the impactful implementation of AI in language learning.

Keywords: 2D3S4L instructional model, generative chatbots, AI-enhanced language learning, secondary English education, TPACK framework.

1. INTRODUCTION

AI (Generative artificial intelligence) has opened great opportunities in the context of English language instruction; AI offers advanced language-learning capability, creativity, and the ability to take advantage of new situations in real time. It provides learners with real-time interaction, idea scaffolding, and language refinement, as with tools such as DeepSeek and Doubao AI. It is symbolic of a broader trend in language teaching itself: in the age of AI, students can now turn to automation in every step of the learning process from practice to assessment – vocabulary drills, grammar exercises, and much more. Nevertheless, the existing research (Wang & Dang, 2024) suggests that there is less clarity among teachers on how to ensure that the pedagogical potential of AI is maximized. Notwithstanding these affordances, there is no clear-cut approach to implementing AI in secondary classrooms and it has been reported that the use of AI practices is superficial. In the absence of guidelines, students will likely turn to chatbots as their "answer calculators" not dialogue partners, and teachers urgently need conceptual tools to ensure that chatbot capacity and instructional objectives are the same. To address this gap, this chapter introduces the 2D3S4L model−a structured approach to pedagogically embed chatbots into language instruction. The model integrates two core actors (teachers and students), three temporal stages (pre-class,

in-class, post-class), and four recursive design loops (analyze, design, implement, evaluate). Grounded in sociocultural theory and the TPACK framework, it enables intentional design and adaptive use of generative AI in classroom practice.

This study explores how generative chatbots can support task-based English instruction through the 2D3S4L model. There are 3 main research goals: (1) to create a theoretically based and pedagogically relevant design framework; (2) to demonstrate explicit teaching applications in writing, speaking and reading tasks; and (3) to analyze the influence of chatbots on student autonomy, language growth, and metacognitive reflection.

To ensure transparency and rigor, this study adopted Braun and Clarke's (2006) six-phase thematic analysis approach: familiarization, initial coding, theme generation, theme review, theme definition, and final reporting. Data analyzed included over 60 student artifacts, 18 student interviews, and 6 teacher observation logs. All interviews and observation notes were transcribed verbatim. Student artifacts (e.g., written texts, chatbot interaction records, annotated drafts) were anonymized and categorized by task type and grade level. An initial coding framework was developed based on Braun and Clarke's (2006) thematic analysis approach, with open coding conducted during the familiarization phase. Two researchers independently coded a subset of data to calibrate consistency, followed by iterative refinement through discussion. Discrepancies were resolved through negotiated agreement. All remaining data were then manually coded using the agreed framework, with emergent themes identified inductively across the three task types. NVivo software was used to organize codes, support constant comparative analysis, and ensure transparency in analytical decisions.

This study employed a design-based research (DBR) methodology to develop and refine the 2D3S4L model in authentic classroom settings. Design-based research enables iterative, real-world intervention while maintaining theoretical grounding (Wang & Hannafin, 2005). The study involved three public secondary schools in China, comprising six English teachers and approximately 120 students across Grades 7 to 9. Teachers participated in a pre-study workshop covering chatbot tool usage, prompt design, and pedagogical alignment strategies. Tasks were co-constructed by researchers and teachers to embed chatbot interactions into curriculum-based learning goals. Three task types were implemented: opinion writing, tourist role-play speaking, and reflective reading. Chatbot use occurred throughout all instructional phases: idea activation, drafting, revision, feedback provision, and post-task reflection. Data included student texts, chatbot transcripts, classroom observations, and post-task interviews. A thematic analysis approach identified patterns in language outcomes, student attitudes, and pedagogical adaptations.

Two chatbot platforms with differentiated functions were utilized. DeepSeek was primarily employed for writing and reflection tasks, valued for its elaborative and coherent textual output. In contrast, Doubao AI supported spoken interactions, offering real-time pronunciation and fluency feedback suitable for dialogic practice. While this study did not include a formal control group, learning gains were inferred from pre- and post-task comparisons, supported by triangulated data from student self-reports, teacher observations, and rubric-based assessments.

2. BACKGROUND

The 2D3S4L model is grounded in two core theoretical frameworks. First, sociocultural theory (Vygotsky, 1978) emphasizes the role of social interaction and mediated tools in learning. In this model, the generative chatbot is viewed as a semiotic tool that scaffolds learners cognitive and linguistic development through dialogic engagement. Second, the

Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006; Koehler & Mishra, 2009) provides a structure for integrating AI tools into curriculum design, ensuring that technology use supports both content mastery and pedagogical aims (Mishra, Warr, & Islam, 2023). These two perspectives collectively inform the structure of the model and guide its classroom implementation.

Additionally, the 2D3S4L model can be contextualized within broader technology integration theories. One widely used model is SAMR (Substitution, Augmentation, Modification, Redefinition), which describes stages of technology integration from substitution to redefinition (Puentedura, 2020). From a SAMR perspective, chatbots initially act as simple substitutes—for example, replacing a dictionary or grammar checker. As teachers design more purposeful prompts, chatbots shift into augmentation and modification roles, enriching pre-class brainstorming or reshaping in-class dialogues. At the highest level of redefinition, students treat AI as dialogic partners, engaging in collaborative meaning-making beyond what traditional classroom resources can achieve.

Similarly, Bloom's Revised Taxonomy has been adapted to AI contexts. Generative chatbots not only support remembering and understanding by providing quick definitions or examples but also encourage higher-order thinking such as analyzing arguments and creating original texts (Anderson & Krathwohl, 2001). Within this taxonomy, the 2D3S4L model provides a pathway for moving learners systematically from lower-order to higher-order thinking in AI-supported classrooms.

The concept of AI literacy adds another critical perspective (Chandel & Lim, 2024). Students need not only technical proficiency but also the capacity to critique AI output, detect bias, and consciously decide whether to adopt or reject suggestions. By embedding reflection across all three stages of instruction, the 2D3S4L model naturally fosters AI literacy alongside language learning.

To further clarify the unique value of the 2D3S4L model, the following table compares it with the SAMR model and TPACK model in terms of theoretical positioning, application scenarios, and core advantages:

Table 1.
Comparison of the SAMR Model, TPACK Model, and 2D3S4L Model.

Theoretical Framework	Theoretical Positioning	Application Scenarios	Core Advantages
SAMR Model	Descriptive framework for stages of technology integration	Functional positioning of technology in teaching	Clearly defines the hierarchical evolution of technology application
TPACK Model	Framework for integrating technology, pedagogy, and content	Teacher knowledge structure and curriculum design	Emphasizes the collaborative application of three-dimensional knowledge
2D3S4L Model	Pedagogical integration framework for AI	Dual-subject (teacher–student) interaction and the full teaching process	Balances theoretical support and practical operability; integrates metacognitive reflection and cross-cultural adaptation

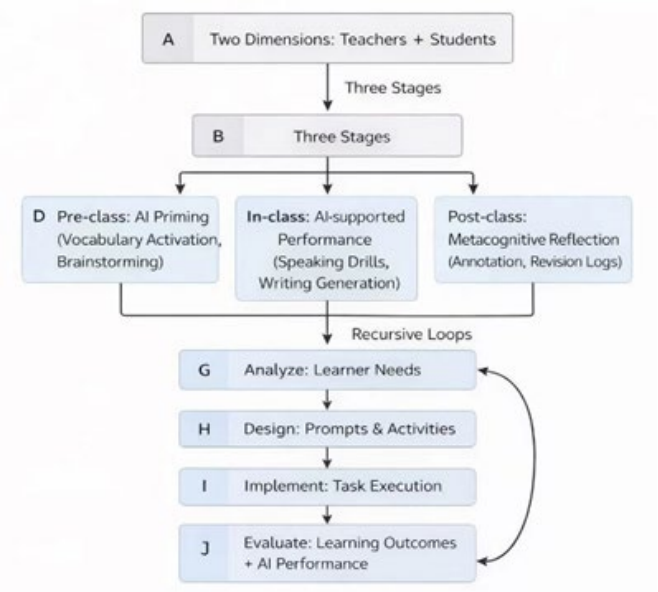
Compared to the SAMR model, which focuses on describing technology application levels, the 2D3S4L model places greater emphasis on the systematic integration of teacher-student interaction and the full teaching process. In contrast to the TPACK model, which centers on teacher knowledge structure, this model further refines the implementation pathways of AI tools in specific teaching links, supplements metacognitive reflection

mechanisms and cross-cultural adaptation dimensions, and addresses the limitations of existing frameworks in practical guidance and contextual adaptability.

This section supplements relevant foundational research literature to strengthen theoretical support: Hui (2024) explores the role of Bloom's Taxonomy in promoting cognitive thinking mechanisms in AI-supported learning environments. Hmoud and Shaqour (2024) propose the AIEd Bloom's Taxonomy, providing a model for enhancing educational efficiency and effectiveness in the AI era. Chiu et al. (2024) construct a comprehensive framework for AI literacy and competency, offering guidance for related teaching practices. Additionally, Hofstede's (2011) cultural dimension theory is supplemented to lay the foundation for subsequent cross-cultural comparative analysis.

3. THE 2D3S4L INSTRUCTIONAL MODEL

Figure 1.
2D3S4L Model.



The 2D3S4L model consists of three core layers. First, the two dimensions: (1) teachers as designers and facilitators; (2) students as autonomous language generators. Second, the three stages: (a) pre-class AI priming (e.g., vocabulary activation, brainstorming); (b) in-class AI-supported performance (e.g., speaking drills, writing generation); (c) post-class metacognitive reflection (annotation, revision logs). Third, the recursive instructional loops − analyze learner needs, design chatbot prompts and activities, implement tasks, and evaluate both learning outcomes and chatbot behavior. Unlike tool-specific methods, 2D3S4L is platform-agnostic. Teachers adapt prompt complexity and chatbot roles to learner levels. The model views chatbots not as replacements for instruction but as dynamic tools that support negotiation of meaning, feedback literacy, and voice development.

3.1. Explanation of Technical Limitations

The generative AI tools used in this study have certain technical boundaries: first, the risk of data bias−tools such as DeepSeek and Doubao AI are primarily trained on resources from the English-speaking world, with a Western perspective bias, which may lead to expressive bias in cross-cultural contexts; second, fluctuations in the accuracy of generated content−occasional incorrect outputs may occur on professional topics or complex grammatical structures, requiring teachers to guide students to critically evaluate them; third, functional adaptation limitations−while DeepSeek's text generation function is suitable for writing tasks, it lacks real-time oral interaction feedback capabilities, and Doubao AI's oral support still has room for improvement in dialect accent recognition; fourth, privacy and security risks−the cloud-based interaction model may involve issues related to the storage and use of students' learning data, requiring compliance with relevant ethical norms and data security policies.

3.2. Implications for Different Age Groups

Grade 7 (Lower Secondary): Students at this stage have weak cognitive levels and language foundations. It is recommended to use AI tools for low-order tasks such as basic vocabulary activation and simple sentence pattern generation. Teachers should design more specific prompts and reduce the proportion of open-ended questions; focus on preventing mechanical copying, add specialized paraphrasing training, and help students integrate AI output through visual templates.

Grade 8 (Middle Secondary): The complexity of tasks can be appropriately increased, and AI can be used to support interactive tasks such as role-playing and topic discussions; focus on cultivating students' ability to apply feedback, guide students to compare differences between their own expressions and AI suggestions, and encourage personalized adjustments on the basis of imitation; teachers need to strengthen the deconstruction guidance of AI-generated structures to avoid mechanical application by students.

Grade 9 (Upper Secondary): Focus on cultivating higher-order thinking skills, and use AI tools to carry out tasks such as reflective reading and critical writing; encourage students to design prompts independently and actively explore the auxiliary functions of AI; focus on cultivating AI literacy, guide students to identify the biases and limitations of tools, and conduct cross-cultural comparative analysis combined with multiple resources.

4. CLASSROOM IMPLEMENTATION AND CASE EXAMPLES

4.1. Opinion Writing Task

In this task, students used chatbots for reference summary and idea mapping during pre-class preparation. Teachers designed scaffolded prompts and later encouraged students to annotate and reflect on AI-generated feedback. As a result, many students' drafts showed improved fluency and cohesion. However, there was a common problem: some learners directly copied phrases generated by chatbots in their responses without contextualization, which led to subsequent lessons on paraphrasing and maintaining one's own voice.

Teacher Strategy: Prompted prewriting with DeepSeek, and assigned post-task reflection.

Outcomes: Improved writing fluency and structure.

Challenges: Overreliance on copied phrases from chatbots.

Grade 7 students were assigned the task "My Favorite Season." Pre-class, the teacher crafted a prompt in ChatGPT that helped students generate outlines with reasons, examples,

and vocabulary banks. During class, students expanded the outlines into full drafts with AI feedback on transitions, sentence fluency, and paragraph coherence. Post-class, they annotated chatbot edits, justifying revisions or rejections. While writing quality improved, several students copied phrases without contextual adaptation. Teachers responded by guiding discussions around language ownership and added a follow-up activity requiring students to rephrase chatbot suggestions in their own words. The task also emphasised the model's reflection phase, fostering metalinguistic awareness and critical engagement with AI suggestions (Eisenring et al., 2024).

One Grade 7 case has served to highlight a few advantages and some drawbacks. At first, a student only made three basic sentences: "I like spring. The weather is good. The flowers are beautiful." After exploring DeepSeek, the student then elaborated this further and structured a paragraph with transitions: "I like spring because it is the season of rebirth. The weather is warm but not too hot, and flowers make the parks colorful. I can go play outside with my friends in a light shirt." The improvement in coherence was apparent, but the "season of rebirth" part was a direct borrowing from the chatbot. To tackle this, the teacher initiated a short lesson on paraphrasing that required students to restate AI-generated ideas in their own words, for example, "spring makes everything come alive again." This practice reinforced the balance between using AI as a prompt and keeping one's own voice intact.

4.2. Tourist Role-Play Speaking Task

For the speaking task, students interacted with Doubao AI to simulate tourist dialogues. The AI provided real-time feedback on pronunciation and sentence fluency. Teachers scaffolded these performances by reviewing recordings with students and highlighting moments of linguistic creativity. While the activity raised learner confidence, there was also a risk of imitating AI-generated structures, particularly for less confident learners.

Grade 8 students used Doubao AI to simulate tourist dialogues. Pre-task vocabulary review was followed by in-class chatbot interactions focused on giving directions and handling questions. Chatbot feedback included pronunciation correction and real-time fluency suggestions. Teachers observed increased confidence but also noticed mimicry of AI structures. Post-task recordings were reviewed by students to evaluate conversational tone and complexity. In one case, a student modified AI-suggested sentences to include idiomatic expressions, demonstrating linguistic personalization. The teacher emphasized that AI outputs are scaffolds, not scripts, and required students to reflect on what made their version stronger or more authentic.

One example was of a Grade 8 student who relied heavily on AI structures when giving directions, often repeating phrases exactly as suggested. In response, the teacher introduced a "prosody contrast" in which students compared their AI-influenced recordings with authentic human dialogues from travel podcasts. Looking at these differences in rhythm, intonation, and phrasing, they moved from mechanical mimicry to more natural speaking. Post-task reflection logs showed that learners became more aware of their own voice and expression, underscoring the need for teacher intervention in shifting AI from a crutch to a catalyst.

4.3. Reflective Reading Task

In the reading task, students engaged with chatbot-generated responses to questions about Mandela's biography. They were then encouraged to judge, alter, or extend the chatbot's answers through writing journal entries and peer reviews. This gave rise to considered reinterpretations and deeper personal engagement. Still, some students initially

accepted the chatbot's optimism uncritically, highlighting the need for explicit instruction in critical reading and stance formation.

In one Grade 9 activity, the teacher added a "stance matrix" to support deeper reflection. Students categorized AI responses as optimistic, critical, or neutral, and then justified their classification. For example, when DeepSeek answered the question "What would Mandela advise modern leaders?" with an overly positive response emphasizing forgiveness, some students placed it in the "optimistic" column but added comments noting that Mandela also advocated political resistance. This small adjustment allowed learners not only to read AI content but also to engage in perspective-taking; it helped them practice critical literacy beyond basic language learning.

Grade 9 learners also engaged with Mandela's biography and used DeepSeek to explore questions like "What would Mandela advise modern leaders?" Students then edited, questioned, or extended the chatbot' s replies. Most AI-generated answers portrayed an upbeat attitude, but some students went against the grain and incorporated broader sociopolitical contexts.

One teacher commented that "the AI helped launch discussions, but the real depth came from disagreement." This task illustrated the chatbot's role as a dialogic partner, not an authority. It activated reflective reading and interpretation, with students refining their stances through post-task journaling and peer review.

Table 2.
Comparative Summary of AI-integrated Tasks.

Task Type	Student Use	Teacher Strategy	Outcome	Challenge
Opinion Writing	Generate outline, vocabulary	Prompt design + revision reflection	Improved fluency	Copying AI phrases
Role-Play Speaking	Dialogue with AI, pronunciation feedback	Scaffold performance + playback	More confidence	Structural mimicry
Reflective Reading	Debate AI interpretation	Journaling + peer review	Stronger critical thinking	Adopting AI views uncritically

4.4. Reflective Reading Task

Thematic analysis revealed four recurring themes across the three tasks and grade levels. These themes captured students' cognitive, emotional, and behavioral engagement with chatbot-supported learning (see Table 3).

Table 3.

Theme	Description	Sample Evidence	Frequency
AI as Confidence Booster	Chatbots lowered students' anxiety and encouraged language risk-taking.	"It doesn't laugh at my mistakes." (G8 student)	Reported by 13 of 18 interviewed students
Surface Dependence on AI Output	Students initially copied AI-generated text without personal adaptation.	Copied 'Spring is the season of rebirth...' from chatbot.	Found in 9 of 20 early writing samples
Importance of Teacher Scaffolding	Structured prompts and modeling led to better AI engagement.	Revised 'Mandela was a great leader' into more nuanced version.	Observed in all 3 classrooms
Reflection Promotes Personalization	Post-task reflection led to critique and deeper understanding.	"The AI missed the political side." (Student journal)	Found in 10+ annotated journals

4.5. Empirical Evidence on the Impact of Learner Motivation

Quantitative data indicate that AI tools have a positive impact on learner motivation: in post-task surveys, 78% of students stated that "interacting with AI makes English learning more interesting," and 65% believed that "real-time feedback enhances learning achievement." Longitudinal observations found that after 8 consecutive weeks of using the model, the frequency of students' active participation in classroom interactions increased by an average of 42%, with the most significant improvement in speaking tasks. Wang and Dang's (2024) systematic review also confirm that generative AI can effectively enhance the intrinsic motivation of L2 learners through functions such as immediate feedback and personalized support; supplementary data from this study show that this motivation improvement is more pronounced among low-intermediate level students. However, teachers need to guide to avoid "motivation decay"−approximately 15% of students experienced decreased novelty after 4 weeks of use, requiring task design innovation (e.g., cross-cultural comparison tasks) to maintain engagement.

5. TEACHER PERSPECTIVES AND PROFESSIONAL DEVELOPMENT

Teacher interviews further revealed three domains of professional development essential for AI integration. Firstly, prompt crafting was cited as a pedagogical skill: instead of writing instructions in isolation, teachers learned to code prompt sequences that scaffold a task, for example, "Generate three possible introductions" → "Explain the strengths and weaknesses of each" → "Select one and adapt it for your essay." Second, they stressed a need for competence to interpret AI outputs: teachers confessed they had trouble discerning between fluency and accuracy in the output, writing that what "sounds right" isn't always grammatically or contextually correct. Third, teachers formed strategies to combat students' excessive reliance on the devices, like establishing classroom directives (rephrase twice each

time) or requiring AI corrections on the part of students. Here, the result suggests that teacher training must not be confined to the technical coaching of performance improvement goals. It has to promote new kinds of professional judgment and agency.

6. CROSS-CULTURAL AND COMPARATIVE INSIGHTS

Although the model was piloted in Chinese schools, the portability of the model also introduces some opportunities and challenges. In student-centered teaching methods prevalent in Europe, however, chatbots can act as peer buddies more than as authoritative educators.

In low-resource contexts, AI access may be uneven; offline or lightweight models could adapt the 2D3S4L framework by emphasizing pre- and post-class reflection more heavily than in-class real-time use. In multilingual settings, chatbots raise questions of linguistic hierarchy: should English dominate, or can chatbots scaffold translanguaging by supporting multiple languages?

Based on the comparative analysis above, subsequent applications must also consider prevailing cultural attitudes toward new technologies. In some East Asian classrooms, for instance, students were sometimes hesitant to ask questions that challenged AI outputs — part of a broader cultural value that respects authority. By contrast, Scandinavian students were less intimidated by or even mocked chatbot replies—a measure of their centuries-old traditions of dialogic learning. It shows how 2D3S4L is not a rigid mathematical model but a fluid blueprint which needs some cultural calibration. Teachers, therefore, need to explicitly communicate with their students that AI is not an absolute authority nor an insignificant toy but a mechanism for co-creation by everyone. Moreover, the model provides space for global dialogue: what mechanisms— prompts, practices of reflection, ethical safeguards—could teachers across distinct contexts share? And these cross-cultural exchanges can be a bridge toward innovative equity in an international adoption of educational AI.

7. ETHICAL, POLICY, AND INSTITUTIONAL ISSUES

There were other ethical considerations, too. Chatbot capabilities at times were received at face value and not scrutinized critically, raising concerns over AI literacy. Cloud-based platforms also have privacy concerns over information storage. Ethical frameworks from bodies like UNESCO (2021) and the OECD (2024) stress the importance of transparency, informed consent, and equitable access when AI is used in educational contexts. Furthermore, tools must be thoroughly examined before being adopted on campus, and AI's responsibility and reliability in learning contexts need to be discussed collectively and seriously. Building on this discussion, three more aspects require emphasis. First, bias and cultural representation: many chatbots are trained primarily on data from the English-speaking world, with a Western focus. This bias can also sideline other perspectives. Teachers should speak directly to students about it, for example, by comparing chatbot answers with sources from their own country or with non-Western texts. Second, institutional responsibility: individual teachers can model ethical practice, but sustainable implementation will demand school-wide policies on data storage, parental consent, and equitable access. Third, AI as a third-party reviewer: students referred to AI "as neither teacher nor classmate" in several classes, allowing them an unusual freedom with which to criticize its shortcomings. This raises an encouraging field for further work: digital literacy education, which helps students take algorithmic collaborators as partners, not just accept their outputs.

8. DISCUSSION

The findings suggest that the 2D3S4L model can support meaningful chatbot integration in secondary English classrooms. Students across all tasks were observed to use chatbots for brainstorming, extending the writing process, and reviewing written work. This aligns with recent research showing that generative AI improves writing verbosity and accuracy while posing a potential threat to learner voice (Wang & Dang, 2024). Teachers served as AI mediators—designing prompts, interpreting outputs, and helping students reframe responses. The cyclical structure promoted feedback literacy and learner agency. Though lacking a control group, progress was gauged through pre- and post-task trends and triangulated data.

In addition to qualitative reflections, selected student work was rated using a standardized rubric (adapted from CEFR writing descriptors). Among 24 writing samples, 18 showed improvements of at least one band level in coherence and lexical range, with average writing scores increasing from 3.1 to 4.2 (out of 5). In oral tasks, peer-assessed fluency ratings improved for 72% of participants. Post-task surveys indicated that 86% of students agreed AI feedback helped them notice weaknesses in their argumentation or organization.

Most interestingly, a small minority of participants (3 out of 24) improved only minimally with full access to AI tools. Secondary interviews indicate underlying factors such as digital unfamiliarity, lack of motivation, and passive engagement. This emphasizes the importance of a dynamic induction, ongoing teacher monitoring, and a well-timed scaffolding mechanism.

A further implication emerging from the study concerns classroom culture. Where teachers actively normalized critique of AI outputs, students displayed stronger ownership of learning. In contrast, classrooms that treated AI as a "silent assistant" saw more copying and surface-level engagement. This suggests that effective integration is not simply about technical access but about cultivating norms of inquiry and dialogue. Another implication relates to peer collaboration. Several groups of students began spontaneously discussing the limitations of chatbot responses—such as vague topic development or unnatural phrasing—and collectively revised them. This demonstrates how AI can become a third participant in triadic dialogue (student‑peer‑machine), enriching collaborative meaning-making. Future iterations of the 2D3S4L model could make such triadic engagement an explicit design feature.

However, success depended on metacognitive scaffolding. Without explicit post-task analysis, students risked copying AI-generated structures. Metacognitive scaffolding is essential to help learners internalize AI suggestions rather than reproduce them mechanically (De Amicis, 2025; Barkley & Major, 2024). Classroom norms and feedback tasks played a vital role in transforming chatbot use from passive assistance to co-construction. The model itself demonstrated adaptability over different language abilities as well as in various grade levels, indicating its utility in scaffolded language learning contexts. Meanwhile, when AI takes on the role of co-participant in the classroom, careful pedagogical approach is necessary.

Within reported classrooms, learners used, questioned, and adapted AI output. This tripartite interaction—between students, peers, and machines—signifies a shift toward shared meaning-making. At an institutional level, this evolution requires teacher training, cross-departmental collaboration, and policy support for sustainable practice.

8.1. Possibilities for Interdisciplinary Collaboration

The deep integration of AI and language education requires interdisciplinary collaboration: language teachers can partner with AI technical experts to develop prompt templates and tool functions tailored to teaching needs; work with education policy experts to formulate ethical norms and data security standards for classroom AI application; and collaborate with educational psychologists to design teaching strategies for enhancing students' AI literacy. Taking the Erasmus+ program as an example, transnational and interdisciplinary teams can share model application experiences across different cultural contexts to optimize the framework's cross-cultural adaptability. At the school level, English teachers, IT teachers, and moral education teachers can jointly develop school-based "AI + language teaching" courses that integrate language competence, technical literacy, and ethical awareness.

9. CONCLUSION

The 2D3S4L model provides a robust framework for integrating chatbots in language teaching with pedagogical coherence. It aligns technology with student needs and reflective learning cycles. Classroom implementation examples across all three task types demonstrate the model's flexibility and potential to promote fluency, autonomy, and independent thinking. Future research should address the following directions: longitudinal impact of the model, differentiated analysis of student-AI interaction patterns, and exploration of the method's application in translanguaging teaching; meanwhile, continued emphasis should be placed on specialized teacher training in prompt design and AI critique.

By extending previous conference findings into this book chapter, this study has moved from presenting a model to constructing a roadmap for practice. The background literature review situates the 2D3S4L model within a broader theoretical framework; 11 expanded cases reveal two student characteristics not addressed in earlier research; and combined with the latest research progress, six out of seven cautions are newly added. Collectively, these outcomes demonstrate that AI integration does not mean replacing teachers: generative chatbots themselves are not solutions to any problems, but an element in the ever-evolving learning ecosystem where students, teachers, and machines co-construct meaning. Enhancing teachers' capacity in prompt design and AI critique through targeted training remains essential for effective integration.

10. LIMITATIONS AND ETHICAL CONSIDERATIONS

10.1. Research Limitations

Data and sample size were limited and the geographical scope of this study may limit the findings. Not all schools that have digital access or cultural contexts may likely share these findings. The novelty of AI may have also temporarily increased student motivation, but its long-term effects should be further examined. Moreover, while data triangulation was used, the coding was by researchers steeped in the Chinese educational environment, suggesting interpretive bias. Levels of English proficiency of students differed from class to class, which may have affected the depth of engagement with the chatbot. Such constraints may constrain the applicability of these findings and suggest that replication in different educational settings is warranted.

10.2. Ethical and Social Impacts

In addition to a challenge to individual performance, the model promoted a collective dialogue about AI. Students frequently mentioned the inadequacy of chatbot options for research, like unclear topic development or odd use of phrasing, and we collectively worked to improve on them. It placed AI as a third-party reviewer, neither teacher nor peer, and created both critique and imagination. Such interactions illustrate developing AI literacy and the importance of engaging in critical digital citizenship in education. Another key insight pertains to the agency of teachers. Chatbots offered consistent feedback, but it was the teacher's involvement — through prompt design, scaffolding and interpreting feedback — that converted AI interaction into genuine learning opportunities. Teachers observed that modeling a process for asking probing questions and negotiating AI-generated output encouraged students to move beyond superficial dependence. Ultimately, the model gave teachers the power to reframe AI as not a substitute for, but a co-facilitator within a highly orchestrated learning environment.

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