

ARTICLE



Enhancing pre-service EFL teachers' TPACK through chatbot-integrated lesson planning projects

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Abstract

The growing interest in AI chatbots for language learning has highlighted their potential value in educational technology, particularly in teacher training for professional development (PD). This exploratory study extended this discussion by exploring how chatbot-integrated lesson planning modules supported pre-service teachers' Technological Pedagogical Content Knowledge (TPACK). Two types of qualitative data, including teaching artifacts (e.g., lesson plans and chatbot tasks) and self-reports (e.g., interviews and reflection papers), were collected from twenty-one pre-service English as a Foreign Language (EFL) teachers who participated in five TPACK training modules over sixteen weeks: (a) TPACK comprehension, (b) chatbot-design training, (c) lesson planning, (d) micro-teaching, and (e) TPACK reflection. Data analysis involved two TPACK assessment methods: (a) TPACK levels demonstrated in lesson plans and the associations of chatbot-integrated lesson plans with TPACK levels; (b) thematic analysis of self-reports for the perceived affordances of the TPACK training. The findings indicate that chatbot-integrated lesson plans demonstrated the participants' TPACK resulting from the training activities. They reported that the training modules had afforded their TPACK in diverse aspects of using chatbots in lesson development despite some constraints. This study provided insights into how to utilize chatbot-integrated lesson study for pre-service language teachers' TPACK.

Keywords: TPACK, AI chatbot, teacher education, pre-service teachers, lesson planning

Language(s) Learned in This Study: English

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Introduction

Chatbots, virtual agents designed to simulate communication between human users, have attracted growing interest in computer-assisted language learning (CALL) (e.g., Hew et al., 2023; Jeon et al., 2023). CALL scholars have recently conducted numerous studies on speech-recognition chatbots powered by artificial intelligence (AI) and natural language processing (NLP) technologies to examine their potential as conversational agents that scaffolds second language (L2) learners' communication skills (Celik, 2023; Hew et al., 2023; Jeon et al., 2023). Research indicates that when AI chatbots are appropriately designed for L2 learning, they can offer a range of pedagogical affordances for language learning, serving as conversational partners, feedback providers, resource suppliers, and needs analyzers (Ji et al., 2023).

Despite the benefits that chatbots provide for language education, additional research is necessary on their benefits in facilitating teachers' professional development (PD) (Moorhouse et al., 2023). While the pedagogical affordances of customized AI chatbots for L2 learning have been widely known (Hew et al., 2023; Lee et al., 2024), how to train teachers on chatbot design for language teaching has been underexplored except for a few studies (e.g., Kim & Lee, 2022; Kim et al., 2022). As the use of customized speech-recognition chatbots has recently gained ground in research, the demand for teacher training with this technology has increased to enhance its application in language learning (Hew et al., 2023; Lee & Jeon,

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2024). Pre-service language teachers, who lack classroom teaching experience, require specialized training courses for the pedagogical use of such advanced tools (Jeon et al., 2023; Nami, 2022).

Over the past decade, there has been extensive research on methods to promote pre-service CALL teachers' PD with technology (Moorhouse et al., 2023). Previous studies have identified various ways to enhance pre-service teachers' TPACK, such as a reflective teaching approach (Ma et al., 2024; Nami, 2022), lesson planning (Crosthwaite et al., 2023; Nami et al., 2016), design-based training (Bustamante, 2020; Jeon et al., 2022), and modeling by educators (Tai, 2015). Within the CALL field, however, while the majority of research has focused on evaluating the efficacy of teacher preparation programs for TPACK, relatively few studies have examined the cultivation of TPACK as a result of integrating specific technologies into classroom practice (Crosthwaite et al., 2023; Tai, 2015; Tseng et al., 2022).

Given this context, the present study explored how prospective EFL teachers display their TPACK through AI chatbot design for their lesson plans. As Celik (2023) noted, recent teacher-training programs should address the use of AI-based technology such as AI chatbots in the era of generative AI, with a focus on their pedagogical affordances. Therefore, building on previous research on diverse teacher-training programs for TPACK (Crosthwaite et al., 2023; Tai, 2015), this exploratory study examines how the integration of chatbot-design projects into lesson study supports pre-service teachers' growth in TPACK. To fulfill this goal, we adopted a qualitative approach with two data sources: (a) an evaluation of the participants' TPACK demonstrated in lesson plans, as outlined in Crosthwaite et al. (2023) and Tseng (2018); (b) an analysis of the perceived affordances and constraints of chatbot-integrated lesson study for TPACK (Bustamante, 2020; Tai, 2015). In doing so, we aimed to capture the participants' detailed voices on how they actualized their TPACK in their lesson study, as well as how they perceived their TPACK growth through the training activities.

Literature Review

The Potential of Using Chatbots for Language Teaching

The use of chatbots for language learning has been a central topic in CALL over the last twenty years (Huang et al., 2022; Ji et al., 2023). Earlier studies were largely focused on text-based agents (Kim et al., 2022; Jeon et al., 2023); however, with the development of AI technologies, researchers in CALL shifted their attention to investigating the communicative capabilities of chatbots (Ji et al., 2023). Specifically, exploring chatbots for language learning has spanned a broad range of topics, including L2 learner perception (Lee & Jeon, 2024), pedagogical effectiveness (Hew et al., 2023), affective factors (Lee & Jeon, 2024), and learner behaviors (Yang et al., 2022). In recent years, the introduction of large language models and generative AI has prompted significant scholarly debate due to their capacity to engage in human-like authentic conversations (Jeon et al., 2023).

Research notes that educational chatbots offer technological, pedagogical, and social affordances that support L2 learning through goal-oriented activities (Huang et al., 2022). Hew et al. (2023) explored the use of AI chatbots to support goal-setting and social presence online using Dialogflow. They reported that goal-oriented chatbot activities enhanced students' engagement in language learning due to their perceived usefulness and ease of use. Lee and Jeon (2024) added that customized chatbots sustain goal-oriented conversations for language learning, thereby providing young learners with positive learning experiences. However, AI chatbots have been used mostly as conversational partners rather than goal-oriented learning tools for evaluation, feedback provision, needs analysis, and learning resources (Ji et al., 2023). This is attributed to the limitations of current speech-recognition chatbots before the release of generative AI chatbots (Jeon et al., 2023), including their technological, cognitive, and psychological constraints (Huang et al., 2022). Kim et al. (2022) argue that L2 learners may not be able to develop their communication skills through conversations with chatbots because customized chatbots do not support task-based language teaching (TBLT).

The proper design of AI chatbots in accordance with second language acquisition (SLA) theories and the communicative language teaching (CLT) principles is crucial to enhancing L2 students' learning experiences (Hew et al., 2023; Kim et al., 2022). It should be further based on CALL-based design principles, such as identifying L2 learners' individual needs, considering goal-oriented learning potentials in line with TBLT literature, and ensuring authenticity in real-life tasks (Kim et al., 2022). Yang et al. (2022) added that it is important to design chatbot tasks by considering individual differences, such as proficiency level, age, and cultural background. Kim and Lee (2022) elaborated that teachers should learn how to create customized chatbots tailored to students' characteristics and learning objectives, ultimately catering to pedagogical needs in chatbot-enhanced language learning.

However, despite the possible benefits of chatbots for language education and the necessity of training language teachers with goal-oriented chatbot design, research on training pre-service teachers through chatbot-design projects remains underexplored (Jeon et al., 2023; Kim & Lee, 2022). Research in this area holds significant potential to develop innovative pedagogical approaches, thereby empowering pre-service teachers with the necessary pedagogical skills amidst rapidly evolving educational environments (Jeon et al., 2023; Ji et al., 2023). Moorhouse et al. (2023) emphasized the urgent need to train pre-service language teachers with state-of-the-art technologies in addition to content and pedagogical knowledge. Kim and Lee (2022) highlighted that teacher candidates who lack actual teaching experience need design-based learning courses that encompass the pedagogical application of advanced technological tools.

The Potential of Using Chatbots for Language Teaching

Research has investigated TPACK to develop teachers' knowledge of integrating technology into their teaching practices (e.g., Crosthwaite et al., 2023; Koh, 2013, Tseng et al., 2022). Drawing on Shulman's (1987) pedagogical content knowledge (PCK), Koehler and Mishra (2005) proposed TPACK incorporating technological knowledge (TK) into PCK to reflect the rapid development of information and communication technology (ICT) in education. TPACK has been elaborated as an integrated framework to address teachers' comprehensive subject knowledge integrated with ICT—content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK)—to incorporate technology into teaching for teachers' PD (Crosthwaite et al., 2023; Nami, 2022). By addressing the interactions among CK, PK, and TK, as well as their overlapping components, such as PCK, technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge, the TPACK framework may serve as a guide for understanding the multi-faceted knowledge required for pre-service teachers to use technology in their teaching effectively (Koh, 2013).

Most studies in L2 education have focused on measuring teachers' TPACK in specific training programs while how to enhance their TPACK has been relatively less explored (Crosthwaite et al., 2023; Tseng et al., 2022). The latter has taken two different paths: (1) designing PD programs to help develop TPACK; (2) using specific tool contexts for TPACK growth. First, research notes that PD training includes structured training modules (Crosthwaite et al., 2023; Tai, 2015), collaboration (Jeon et al., 2023; Tai, 2015), lesson study (Crosthwaite et al., 2023; Nami et al., 2016), teacher support groups (Bustamante, 2020), and design-based learning (Boschman et al., 2015; Tondeur et al., 2016). In particular, collaborative lesson studies, which encompass lesson planning, teaching demonstrations, and self/peer reflection, can promote TPACK of pre-service language teachers who do not have technology-integrated teaching experience (Jeon et al., 2022; Nami et al., 2016). Many studies additionally highlighted that hands-on experiences alongside lesson study can enhance teacher candidates' confidence in customizing and utilizing technology in local teaching contexts (Crosthwaite et al., 2023; Ma et al., 2024).

The benefits of using particular technology tools in promoting language teachers' TPACK have been explored by some studies, as adopting technological affordances is significant to achieving pedagogical goals in practice (Crosthwaite et al., 2023; Ma et al., 2024; Tai, 2015; Tseng, 2018). Teacher-training courses aimed at TPACK development need to focus on educating teachers to identify and utilize pedagogical affordances of specific tools (Boschman et al., 2015; Ma et al., 2024). This knowledge enables teachers to align these tools with their teaching strategies, thus allowing them to select the most appropriate

technological tools to deliver the subject content (Jeon et al., 2022; Tai, 2015). For instance, Bustamante (2020) explored the TPACK growth of 18 Spanish instructors who integrated Web 2.0 technologies into their classrooms. The findings indicated that the tools fostered collaborative learning and peer assessment. Crosthwaite et al. (2023) who explored the impact of data-driven learning (DDL) integration with lesson planning on CALL teacher trainees' TPACK reported that diverse DDL-enhanced tasks developed by the trainees revealed different TPACK levels evident in their lesson plans. Ma et al. (2024) added that the learning-by-design approach to corpus-based language pedagogy could further aid in pre-service language teachers' TPACK development. This approach specifically allowed them to identify and employ the pedagogical affordances of corpus technology through collaborative lesson design.

As noted in the literature, however, more empirical research is necessary to understand how to enhance pre-service teachers' TPACK in specific technology contexts (Crosthwaite et al., 2023; Tseng, 2018). Notably, a few recent studies indicate that AI chatbots may offer educational affordances for pre-service teachers' PD in preparing corpus data, developing dialogue algorithms, and designing diverse chatbots for specific tasks (Celik, 2023; Jeon et al., 2023; Kim & Lee, 2022). Thus, this study, inspired by the findings of these studies, explores pre-service EFL teachers' TPACK growth through design-based collaborative projects focused on chatbot-integrated lesson study. The study was guided by two research questions (RQs): RQ1 examined the participants' TPACK resulting from chatbot-integrated lesson study activities (Crosthwaite et al., 2023; Nami et al., 2016) while RQ2 focused on investigating their in-depth voices on the affordances and constraints of these activities for TPACK.

1. What were the levels of participants' TPACK as manifested in their lesson plans after the AI chatbot-integrated lesson study activities? How do chatbot-integrated lesson plans relate to their TPACK?
2. What were the perceived affordances and constraints of the training activities in facilitating their TPACK?

Method

Participants and Context

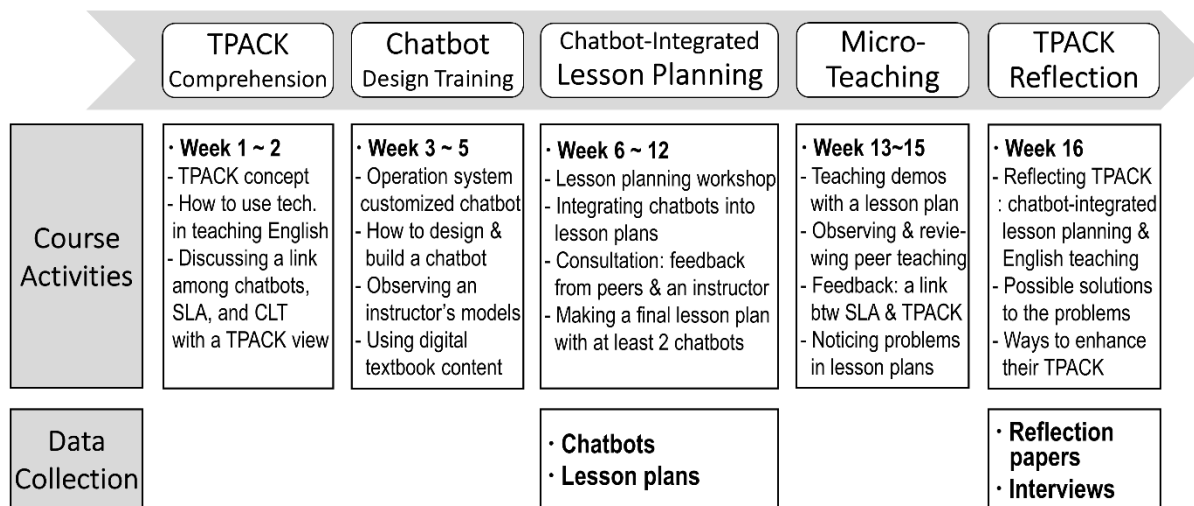
Twenty-one Year 3 students (7 males and 14 females, aged 21-24) from a teacher-preparation program of a Korean university consented to participate in this study. We selected this group because they had not taken any courses addressing CALL prior to this study, and thereby their TPACK levels were relatively low. They were considered a homogeneous group because they obtained similar scores in English on their college entrance exam and reported that their English communication skills were medium to high. They acquired basic knowledge of SLA by completing required courses, including Educational Linguistics and Second Language Acquisition. We selected a course named English Language Teaching Methods, as it aimed to equip pre-service EFL teachers with teaching approaches from a CLT perspective. We incorporated CALL into this course, encouraging students to create customized chatbots for their lesson plans. Following the ethical guidelines recommended by the Research Foundation of South Korea, we informed potential participants about the research procedures, their right concerning data contribution and privacy, the use of collected data, data storage, and more.

Research Procedure: Chatbot Development Project in Lesson Planning

Combining technology-integrated lesson planning for pre-service CALL teachers (Crosthwaite et al., 2023) with TPACK approaches (Ma et al., 2024; Tai, 2015; Tseng et al., 2022), we prepared a five-module TPACK training model for chatbot-integrated lesson planning (see [Figure 1](#)): (1) TPACK comprehension; (2) chatbot-design training; (3) chatbot-integrated lesson planning; (4) micro-teaching; (5) TPACK reflection. Guided by Crosthwaite et al. (2023), this model was tailored for pre-service teachers, emphasizing specific technology training and lesson planning, followed by teaching demonstrations and TPACK reflections.

Figure 1

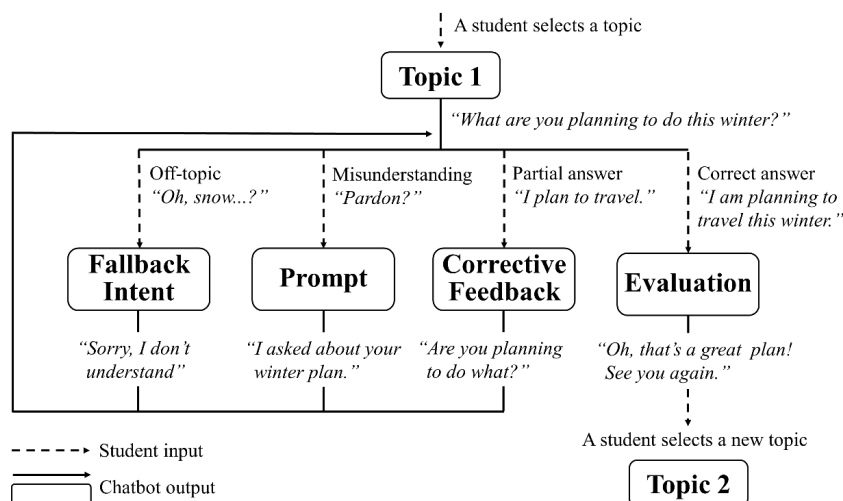
TPACK Development Model with Chatbot-integrated Lesson Planning



Specifically, TPACK-based pre-service teacher training was conducted over 16 weeks (Figure 1). Module 1 (Week 1-2) aimed to enhance participants’ understanding of TPACK, including TPACK concepts, technology use in ELT, and an association among technology, SLA, and CLT from TPACK. They were introduced to diverse tools for language teaching and technology-enhanced lesson planning. Finally, they reflected on CALL based on SLA-informed TPACK (Tseng, 2018; Tseng et al., 2022). Module 2, lasting three weeks, provided comprehensive chatbot-design training for ELT in two steps (Hew et al., 2023; Kim et al., 2022). First, the participants learned basic technological functions of Dialogflow powered by Google. Next, they were randomly divided into six groups through a drawing and collaboratively built chatbots for language learning. This module emphasized design-based learning of chatbot customization for goal-oriented conversational tasks (Hew et al., 2023; Lee et al., 2024). Figure 2 shows a sample flowchart of a customized chatbot used in the training module.

Figure 2

A Sample Flowchart of Customized Chatbots



Module 3 (Week 6-12) addressed chatbot-integrated lesson planning. The participants first joined a workshop to learn lesson planning for language teaching. They initially designed drafts referencing an instructor-provided model (Tai, 2015). Next, the participants integrated their chatbots into these lesson plans, determining how they would use chatbots based on the CLT approach. It is notable that it was the pre-service teachers who chose the types of chatbots to develop and determined where in the lesson plans to integrate them. They received peer/instructor feedback to improve their chatbot integration skills. Finally, the six groups finalized their lesson plans by integrating the chatbots into their lesson plans.

During Module 4 (Week 13-15), students engaged in teaching demonstrations, which reflected chatbot-integrated lesson plans. The pre-service teachers observed other groups' teaching demonstrations and shared feedback focusing on TPACK, such as chatbot use in lesson objectives, language activities, and reviews. In Module 5, which occurred in Week 16, they reflected on their experiences with the project, including discussions on their chatbot tasks, lesson plans, teaching demonstrations, and TPACK enhancement. Following this activity, they were asked to write a reflection paper in English to be submitted by the end of Week 16. The reflection paper needed to be at least one page in length and independently written by each participant.

Data Collection

As suggested by prior studies on TPACK (Crosthwaite et al., 2023; Harris et al., 2010; Koh, 2013; Tseng et al., 2022), qualitative data were collected from two types of data sources for TPACK assessment, such as teaching materials (e.g., lesson plans and chatbot tasks) and self-reports (e.g., interviews and reflection papers). To be specific, for RQ1, lesson plans alongside chatbot tasks were collected during Module 3 (Week 6 to Week 12, see [Figure 1](#)), as it is a pivotal source of data for lesson study that may illuminate teachers' PD with technology (Crosthwaite et al., 2023; Jeon et al., 2022; Nami et al., 2016; Tai, 2015). For RQ2, interview data and reflection papers were collected to explore the affordances of the AI chatbot-integrated lesson study in relation to their TPACK growth through the participants' perceptions and experiences (Bustamante, 2020; Tai, 2015). Each group participated in interviews lasting approximately 41 to 57 minutes, discussing their experiences with chatbot development, lesson planning, and integration into lesson objectives, activities, and closings (see [Appendix A](#)). Interviews were audio-recorded and transcribed verbatim for analysis. Next, they submitted reflection papers in English, focusing on their perceptions and feelings about chatbot use in lesson planning. A total of 21 reflection papers were collected, amounting to 8,713 words.

Data Analysis

For RQ1, drawing on Crosthwaite et al. (2023) that analyzed and evaluated pre-service teachers' TPACK demonstrated in DDL-enhanced lesson plans, we first evaluated participants' chatbot-enhanced lesson plans through Harris et al.'s (2010) Technology Integration Assessment Rubric. As Koh (2013, p. 888) noted, the results of evaluating teachers' artifacts (e.g., lesson plans, teaching materials, and learning tasks) with this rubric can be used "as an indication of performance-based TPACK... [because] these activities are expressions of teachers' TPACK; the outcomes of the pedagogical decisions made as teachers combine their technological, pedagogical, and content knowledge into subject-specific ICT lesson activities, which are also termed TPACK activity types." As outlined in Harris et al. (2010), we adopted a three-point scale: low, medium, and high levels of TPACK. While Crosthwaite et al. (2023) used four criteria from the TPACK rubrics, including Curriculum Goals and Technologies, Instructional Strategies and Technologies, Technology Selection(s), and Fit (See [Figure 3](#)), we excluded Technology Selection(s) because the current study utilized only one technology: chatbots. Two authors separately scored the students' lesson plans using the modified rubrics and then had a conference to reach the final decisions on their scores. Also, content analysis of the lesson plans that integrated chatbot tasks was conducted in terms of the description of lesson objectives and chatbot-enhanced language activities to explore how their TPACK was manifested in their lesson plans, as guided by Crosthwaite et al. (2023) and Tseng (2018).

Figure 3*Technology Integration Assessment Rubric (Harris et al., 2010)*

Criteria	4	3	2	1
Curriculum Goals & Technologies (Curriculum-based technology use)	Technologies selected for use in the instructional plan are <u>strongly aligned</u> with one or more curriculum goals.	Technologies selected for use in the instructional plan are <u>aligned</u> with one or more curriculum goals.	Technologies selected for use in the instructional plan are <u>partially aligned</u> with one or more curriculum goals.	Technologies selected for use in the instructional plan are <u>not aligned</u> with any curriculum goals.
Instructional Strategies & Technologies (Using technology in teaching/ learning)	Technology use <u>optimally supports</u> instructional strategies.	Technology use <u>supports</u> instructional strategies.	Technology use <u>minimally supports</u> instructional strategies.	Technology use <u>does not support</u> instructional strategies.
Technology Selection(s) (Compatibility with curriculum goals & instructional strategies)	Technology selection(s) are <u>exemplary</u> , given curriculum goal(s) and instructional strategies.	Technology selection(s) are <u>appropriate, but not exemplary</u> , given curriculum goal(s) and instructional strategies.	Technology selection(s) are <u>marginally appropriate</u> , given curriculum goal(s) and instructional strategies.	Technology selection(s) are <u>inappropriate</u> , given curriculum goal(s) and instructional strategies.
“Fit” (Content, pedagogy and technology together)	Content, instructional strategies and technology <u>fit together strongly</u> within the instructional plan.	Content, instructional strategies and technology <u>fit together</u> within the instructional plan.	Content, instructional strategies and technology <u>fit together somewhat</u> within the instructional plan.	Content, instructional strategies and technology <u>do not fit together</u> within the instructional plan.

For RQ2, we employed thematic analysis of focus-group interviews and reflection papers to identify emerging themes regarding the perceived affordances and constraints of the chatbot-integrated lesson planning activities for their TPACK (Braun & Clarke, 2021; Crosthwaite et al., 2023; Tai, 2015; Tseng, 2018). First, to code themes regarding their TPACK, we utilized [Appendix B](#) that presents the coding scheme of TPACK definitions and examples grounded in Boschman et al. (2015), Tai (2015), and Tseng et al. (2022). Next, for coding the qualitative data to identify affordances and constraints of the chatbot-enhanced training modules, we employed the integrated perspective of educational affordances by which to identify the benefits of using technology for educational purposes (Bower & Sturman, 2015; Jeon et al., 2022). While affordances are general opportunities for potential action as perceived by actors in a given environment (Gibson, 1986), educational affordances are “characteristics of an educational resource that indicate if and how a particular learning behaviour could possibly be enacted within the context” (Bower & Sturman, 2015, p. 346). Thus, we categorized any pedagogical opportunities as educational affordances in the present study “as long as educational agents perceive them as providing educational benefits” (Jeon et al., 2022, p. 7). [Appendix B](#) provides the affordances coding scheme and the results alongside the frequency of codes as guided by Jeon et al. (2022) and Nami (2022).

Findings

Participants' TPACK Manifested in Lesson Plans

TPACK Levels of the Lesson Plans

The analysis of participants' lesson plans reveals that the mean score for TPACK evaluation was 9.67 across all six groups. Further breakdown by TPACK constructs resulted in a mean score of 3.00 for Curriculum Goals & Technologies, 3.33 for Instructional Strategies & Technologies, and 3.33 for Fit (see [Figure 3](#)). Using these mean scores as a basis (Crosthwaite et al., 2023), each group's TPACK level was subsequently categorized as low (total score of 8 or below), medium (total score between 9 and 10), or high (total score between 11 and 12). Accordingly, one group was classified as low, whereas three as medium, and the other one as high (see [Table 1](#)). This result indicates that the participant pre-service teachers' lesson plans attained different levels of TPACK resulting from the TPACK training modules with chatbot-integrated lesson study (Crosthwaite et al., 2023; Harris et al., 2010; Koh, 2013).

Table 1

TPACK Evaluation Results for Lesson Plans

Group	Curriculum Goals & Technologies	Instructional Strategies & Technologies	Fit	Total	TPACK Level
1	2	2	2	6	Low
2	4	4	4	12	High
3	3	4	3	10	Medium
4	3	4	4	11	High
5	3	3	4	10	Medium
6	3	3	3	9	Medium
Mean	3.00	3.33	3.33	9.67	

Low-level TPACK: Inadequate Integration of Chatbot Activities with Pedagogical Goals

[Table 1](#) indicates that Group 1's TPACK level was classified as low, with a score of 2 across all sections. The content analysis reveals that their lesson plan does not explicitly demonstrate the alignment between chatbot use and lesson objectives (see [Figure 4](#)). Specifically, it lacks information about chatbot activities that support learning outcomes. The lesson objectives do not encompass all chatbot-enhanced language learning activities, including warm-up, form-focused, and review activities; that is, the use of AI chatbots is not explicitly integrated into the objectives beyond basic practice. This indicates a low level of alignment as a chatbot is used more as an add-on rather than as an integral component that enhances learning outcomes.

Concerning Instructional Strategies & Technologies, it involves listening activities, group discussions, and a presentation while utilizing the chatbot as a practice tool. This way of chatbot integration seems limited to rehearsing preset expressions rather than promoting deeper engagement or content comprehension. Moreover, the lesson plan lacks creative strategies that leverage technology to foster interactive or innovative learning experiences.

Regarding Fit, although the content focuses on expressing interests and discussing event frequencies, a notable disconnection is found between the content, the instructional strategies, and the technology used. Chatbot use is restricted to practice sessions without a clear link to enhancing engagement with the content. A more effective approach might include designing chatbot interactions that reflect real-life conversations

to make the technology use more relevant to achieving the lesson objectives.

Figure 4

Lesson Plan of Group 1 (Low TPACK Level)

Lesson Plan (Group 1)		
Unit Title / Students	Ch. 8 Have fun this winter! 2nd grade; Intermediate level	
Language items	I'm interested in...; How often do you...; My favorite thing to do is...	
Objectives	Students are able to: 1. Express their interest using key vocabulary while talking to chatbot. 2. Do question and answer activities about the frequency of events with AI chatbot. 3. Present a poster that includes today's expressions.	
Procedure	Teaching-Learning Activities	Aid & Materials
Listening & Speaking Activity 1	<Listening activity> Tr plays the listening material and encourages Ss to understand it. <Key expression 1> Tr asks Ss to explore key expressions and example sentences in a group. <Chatbot activity> Tr instructs Ss to use chatbot to practice speaking using the expressions. <Talk & Find> Tr instructs Ss to go around and ask friends what their favorite activities are. T appoint one student for presentation.	Textbook Handout PPT Chatbot

This analysis suggests that the participants' chatbot-integrated lesson plans reflect their low TPACK, as evidenced by the superficial use of chatbots which fails to enhance the pedagogical objectives and undermines the potential affordances of chatbots for language learning.

Medium-level TPACK: Developmental Progress in Chatbot Integration for Lesson Planning

Three groups demonstrated the medium TPACK level after the chatbot-integrated lesson planning activities. For example, Group 6's lesson plan was evaluated as medium-level due to the partial alignment between the chatbot use and the lesson objectives (Figure 5). It specifies that the chatbot supports an information gap activity designed to enhance students' understanding of key expressions. This demonstrates the pre-service teachers' understanding of how technology can support specific educational objectives for language learning. However, the lesson plan lacks fully demonstrating the ways in which the chatbot scaffolds students' learning throughout the different phases of the lesson.

On Instructional Strategies & Technologies, it outlines a warm-up activity using chatbots to initiate conversation practice, which helps familiarize students with the topic. This suggests a basic alignment of technology with instructional strategies that is intended for interactive engagement of students in learning. The lesson plan mentions that the teacher provides timely feedback during these activities, which indicates their potential efforts to integrate technology in a supportive role. Nonetheless, the strategies lack detailed elaboration on how the chatbot interactions are structured on student responses, which may be a characteristic more evident in higher TPACK levels according to the rubric.

Figure 5

Lesson Plan of Group 6 (Medium TPACK Level)

Lesson Plan (Group 6)		
Unit Title / Students	Manage Yourself! / Middle school 2nd grade, Intermediate level	
Key vocabulary	manage, work to do, set goals, achieve, master	
Language items	1. Gerund (V-ing): spend time -ing 2. Expressions: What's the matter? I think you should~ I will~	
Objectives	Students are able to: 1. Understand today's content by exploring key words with AI chatbot. 2. Analyze key expressions using AI chatbot in an information gap activity. 3. Use "spend time -ing" and key expressions using AI chatbot in a role-play activity. 4. Show their understanding of today's content using AI chatbot in a review activity.	
Procedure	Teaching-Learning Activities	Aid & Materials
Introduction : Warm-up	1. Tr asks Ss to read the topic about "Manage your time". 2. Tr asks Ss to discuss "How to manage my time" with peers. 3. Tr encourages some Ss to present their ideas about the topic. 4. Tr asks Ss to open their chatbots to practice key vocabulary items. 5. Ss start a conversation with their chatbots to practice communication using key language items. 6. Tr gives feedback to students about their chatbot activity.	1. Digital Textbook 2. Chatbot

Regarding the fit among content, instructional strategies, and technology, the lesson plan indicates that these three aspects are coordinated to some extent. The chatbots are used to prompt discussions and review material, fitting them into the instructional strategy. However, the lesson plan does not clearly depict how these elements are orchestrated to enhance learning outcomes.

Therefore, while Group 6's lesson plan utilizes technology to support educational objectives and instructional strategies, it demonstrates a medium-level TPACK due to its incomplete articulation of how the combination of technology, instructional strategies, and content is cohesive. This level of TPACK reflects a developmental stage where the pre-service teachers have yet to fully realize the integration of these elements in their lesson plan.

High-level TPACK: Enhancing Language Learning through Chatbot Integration

Two groups' lesson plans revealed high-level TPACK by demonstrating a successful chatbot integration with lesson plans. For example, Group 2's lesson plan exemplified robust alignment between technology use and lesson objectives (Figure 6). Specifically, it systematically incorporates chatbot activities to reinforce language skills such as self-introduction and family description using the simple present tense. For instance, the lesson integrates a chatbot in the introduction activity, where students practice speaking through scripted interactions. This approach aligns strongly with the lesson objectives to enhance oral communication skills, thereby fulfilling the criterion of Curriculum Goals & Technologies.

In terms of Instructional Strategies & Technologies, Group 2's lesson plan strategically uses technology to support pedagogical methods. The chatbot serves not only as a practice tool but also as an engaging medium to apply learned expressions in a simulated conversational context. For example, during the "While-activity 1" and "While-activity 2", students can engage in group and pair activities where they use the chatbot to review and practice language structures and vocabulary. This integration in the lesson plan shows that the

technology use optimally supports the instructional strategies aimed at improving language proficiency.

Figure 6

Lesson Plan of Group 2 (High TPACK Level)

Lesson Plan (Group 2)		
Unit Title / Students	Lesson 1. Great things about yourself / 2 nd grade, Low intermediate	
Language items	Key expression: ① I want to be ~ ② I'm good at ~ ③ ... a man who has a special talent Structure: Relative pronoun (subject)	
Objectives	Students are able to: 1. Warm-up: Understand the topic by practicing key expressions in a dialogue with a chatbot. 2. Task 1: Practice making sentences by using relative pronouns and creating the structure in a form-focused dialogue activity with a conversational chatbot. 3. Task 2: Demonstrate their use of relative pronouns in an information-gap activity, "Where's Waldo?" by using a chatbot as a host. 4. Task 3: Discuss their heroes by using key expressions and relative pronouns while using a chatbot as a conversation partner. 5. Closure: Check their comprehension by talking with a chatbot.	
Procedure	Teaching-Learning Activities	Aid & Materials
TASK 2 - SPEAKING <i>Information Gap Activity</i>	<Where's Waldo?> <input type="checkbox"/> Tr instructs Ss to sit in groups of three or four. <input type="checkbox"/> Tr introduces the activity by showing sample expressions. <ul style="list-style-type: none"> • Introduce the "Where's Waldo?" activity • Each group chooses 2 characters <input type="checkbox"/> Tr helps Ss do group activities to find Waldo on a map. <ul style="list-style-type: none"> • Ss use English to discuss • Ss describe where Waldo is. • Ss share the information with group members. <input type="checkbox"/> Information gap activity: Ss use a chatbot to find Waldo <ul style="list-style-type: none"> • Chatbot asks Ss about their chosen Waldo. • Chatbot provides clues step by step. • Ss answer with their own information. • S complete the task. 	<ul style="list-style-type: none"> • PPT • Worksheet ("Where's Waldo?") • Chatbot

Finally, the fit among content, instructional strategies, and technology is particularly effective. The lesson content, which includes introducing oneself and family members in English, is seamlessly integrated with chatbot technology that prompts students with specific questions to guide the conversation. This fit is evident in the post-activity where students use all the expressions they have learned to play a game that includes true and false statements, which may demonstrate a practical application of their skills in an engaging way. In this way, the technology can enhance students' learning experience by providing a dynamic platform for practical application.

This chatbot-integrated lesson plan may indicate the pre-service teachers' enhanced application of TPACK. The successful integration of chatbot technology not only aligns with the lesson objectives but also enhances instructional strategies and fits the content, thereby demonstrating a high-level of technology incorporation for language teaching purposes.

Perceived Affordances and Constraints of the Training Modules for TPACK

RQ2 addressed the participants' perceptions of chatbot-integrated lesson planning in relation to their TPACK. The findings from reflection papers and focus-group interviews are presented in terms of their perceived affordances and constraints for their TPACK (see [Appendix C](#) for the findings), and which aspects of the training modules aided in the emergence of TPACK affordances (Bower & Sturman, 2015;

Jeon et al., 2022; Tai, 2015).

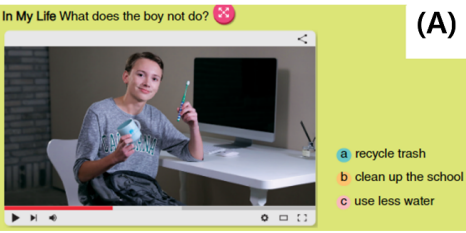
TPACK: Enhancing Design and Integration of ELT through Chatbots

The qualitative data show that the TPACK training modules provided diverse affordances for the pre-service teachers to enhance their capabilities in integrating technology and pedagogy, particularly through the design and use of chatbot activities. According to [Appendix B](#), TPACK ($n = 81$) was the most frequently mentioned domain in both reflection papers ($n = 27$) and interviews ($n = 54$), with six themes. The most notable impact observed was on the participants' abilities to design engaging and interactive tasks using chatbots, with 23 instances highlighted in the data. The participants utilized the affordances of the training modules to transform digital textbook materials into interactive language learning tasks. This transformation process was not only a technical application of tools but also a creative engagement with the content to develop pedagogically useful activities. For instance, as shown in [Figure 7](#), Group 4 created an information transfer activity aimed to facilitate dialogic interactions between a chatbot and students. One participant in Group 4 elaborated on the task design affordance by illustrating how the training enabled the creative and effective use of digital tools for language teaching:

Throughout the training, I had many opportunities to transform digital textbook materials into engaging English learning activities. Customizing chatbots allowed me to explore different interactive tasks that could be effectively integrated into our lesson plans. (Participant 12, Interview)

Figure 7

(A) Information Transfer Activity; (B) A Dialogue Transcript

<p>(A)</p>  <p>Main task (information transfer)</p> <ul style="list-style-type: none"> • Tr asks Ss to watch a video about recycling. • Tr asks Ss to figure out what the boy does and doesn't for environmental conservation. • After watching the video, Tr ask Ss to have a conversation with a chatbot using expressions about conversation. 	<p>(B)</p> <p>USER Hi Jim, let's talk!</p> <p>AGENT OK. Let's talk about conservation. What do you usually for environment?</p> <p>USER I am sorry? (Pardon me?)</p> <p>AGENT I mean, what can you do to protect the environment? How about trash?</p> <p>USER I can recycle trash.</p> <p>AGENT Great. How about water? Can you make a suggestion about it?"</p> <p>USER I will use less water.</p> <p>AGENT Excellent!</p>
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Participants perceived that the design-based training further facilitated the integration of chatbots into lesson plans, which enabled a seamless blend of technology and pedagogy to optimize learning outcomes ($n = 21$). They often reflected on their planning processes and the strategic choices made for the effective technology integration, as one participant shared on the technology integration affordance in her reflection paper below:

During the planning stages, I continually considered the most suitable parts of the lesson plan for chatbot activities. I believe such design strategies are crucial in optimizing learning experiences and making the activities more effective. (Participant 15, Reflection Paper)

In addition to knowledge enhancement of chatbot use for ELT ($n = 17$) and that of developing chatbot-assisted ELT content ($n = 10$), the training was perceived to enable the enhancement of ELT content authenticity ($n = 5$). Developing such technology-enhanced ELT content was seen as being essential to

creating realistic and engaging learning environments to enrich students' learning experiences through chatbot use. Participant 7 mentioned in her interview on this content authenticity affordance:

Due to the flexibility to create diverse English language tasks with chatbots, like information gap and role-play tasks we made, I believe it could enhance the authenticity of the learning environment, and it made the task more engaging for students. (Participant 7, Interview)

Finally, the qualitative data show that the training modules fostered a growth mindset ($n = 5$), which could allow them to embrace challenges and continuously adapt in their use of technology for education. This aspect was highlighted as participants described their experiences with designing and integrating technology into their teaching practices, as participant 5 described the chatbot-building projects as "challenging yet rewarding," and participant 8 stated, "I'm now eager to learn more about using other technology tools like chatbots for ELT."

TK: Cultivating Confidence and Technological Capability

The participants noted the educational affordances of the training modules for TK enhancement, including collaborative work, multiple stages, instructor modeling, and reflections on their work ($n = 31$). Many mentioned that their initial lack of confidence in customizing chatbots shifted to a high level of self-efficacy through the training modules ($n = 18$). For instance, one participant acknowledged the importance of teamwork by saying, "I couldn't have completed this project without wonderful teamwork in my group" while another appreciated the sample chatbots provided by the professor as useful models. Instructor modeling was also perceived as an affordance to enhance their computational thinking ($n = 7$), as participant 11 believed that their problem-solving skills improved through the modules focused on designing dialog flow charts for chatbot tasks. Computational thinking abilities were also enhanced through practical exercises such as designing dialogue flow charts, which is essential for programming and customizing chatbots:

My problem-solving skills improved significantly through the modules focused on designing dialogue flow charts for chatbot language tasks (Participant 9, Interview)

As a result, they felt confident in becoming technologically capable person at school ($n = 6$), as evident in one participant's reflection: "I feel happy because I can present myself as a capable person well-versed in tech use" (Participant 12, Reflection Paper).

Other Constructs: Broadening Pedagogical and Content Knowledge

Although less frequently mentioned compared to TPACK and TK, the training modules also provided significant affordances for enhancing pedagogical and content knowledge through the use of chatbots. Several participants reported on gaining a deeper understanding of the pedagogical applications of chatbots (TPK, $n = 2$), enhancing their teaching methodologies, as one participant reflected:

The training made me more aware of how effectively chatbots can be used in pedagogy, opening up new chances for engaging students and enhancing learning outcomes. (Participant 13, Reflection Paper)

Collaborative design tasks in the modules not only improved their content knowledge but also their ability to work effectively with peers, facilitating a richer educational experience (TCK, $n = 2$). The modules also encouraged them to adapt digital textbook content, integrating it into their teaching practices effectively (PCK, $n = 1$). This adaptation was crucial for developing tailored educational materials that met the specific needs of their students.

Finally, the participants discussed other themes related to PK and CK, including enhancing understanding of teaching methods ($n = 1$) and valuing digital textbook content ($n = 1$). These findings underscore the multifaceted impact of the TPACK training modules, highlighting the extensive range of affordances they provided in enhancing pre-service teachers' TPACK. Each affordance contributed uniquely to their PD and readiness to integrate technology into their future teaching.

Constraints of TPACK Training: Lack of Full Support for Individual Participants

The pre-service teachers also reported two salient themes regarding the training modules' constraints. The first theme pertains to the lack of support for a tutoring system, as identified by seven participants. They highlighted the insufficient support for personal technological innovation as a barrier to their work in designing chatbots, as exemplified in the interview excerpt below:

I found no one in my group was good at using technology, so sometimes we didn't notice problems in the work. Actually, I've never thought that I would learn about technology like chatbots. (Participant 2, Interview)

They suggested additional individual tutoring to tackle technical issues frequently encountered in chatbot-building projects. Participant 3 specifically emphasized the need for a tutoring system, stating, "I don't believe we can master chatbot design skills in a class, and a single instructor cannot answer all questions from students."

Another constraint on the participants' TPACK development is related to a more fundamental issue of the training system: insufficient time to integrate all modules into a single course ($n = 18$). Many participants felt that a 16-week course was inadequate for addressing all three topics, including chatbot designing, lesson planning, and subject-matter content development. For instance, Participant 9 reflected, "I wish I could have secured enough time to learn each topic because I felt every single module was overwhelming."

Furthermore, some participants raised concerns about progressing to the next stage of chatbot integration without fully understanding how to create effective chatbots for language tasks. Regarding such technological readiness, Participant 19 commented in her interview, "I think one semester is not enough to learn all of these things, especially for humanities-major students like us because we are not ready to learn technology." From a different perspective, Participant 20 mentioned, "I found the chatbot-building project quite challenging because we are not fully experienced even in developing lesson plans and ELT materials." To address these issues, Participant 18 suggested that "Chatbot design and lesson planning should be covered in separate courses to ensure adequate time to fully engage with the training."

Discussion

Utilizing two main sources of qualitative data, including pre-service teachers' artifacts (e.g., chatbot tasks and lesson plans) and their self-reports (e.g., reflection papers and interviews) as guided by previous research on teacher training for TPACK (e.g., Crosthwaite et al., 2023; Harris et al., 2010; Koh, 2013; Tai, 2015; Tseng, 2018), this study explored how chatbot-integrated lesson planning modules supported pre-service teachers' TPACK. Overall, the findings provided qualitative evidence of their TPACK growth through the training modules in two distinct aspects: (1) participants' TPACK demonstrated in lesson plans; (2) perceived affordances and constraints of the modules.

For RQ 1, the findings showed that the participants' TPACK levels, as reflected in their lesson plans, were medium to high on average. This demonstrates that their TPACK was enhanced through the training modules, enabling them to integrate concrete chatbot-enhanced English learning tasks into their lesson plans. Specifically, the participants displayed high TPACK levels for Instructional Strategies & Technologies and Fit between pedagogy, content, and technology use while demonstrating a medium level for Curriculum Goals & Technologies, although the differences were relatively small. This result somewhat contrasts with Crosthwaite et al.'s (2023) findings, which reported Indonesian student teachers' high TPACK levels for Curriculum Goals & Technologies and Fit and a lower one for Instructional Strategies & Technologies. They explained that their participants were not fully trained to teach language using DDL technology, as they still focused on "learning and/or researching language" (p. 1413). In contrast, the participants in this study were trained to use customized AI chatbots for teaching purposes from the outset according to the design perspective (Hew et al., 2023; Kim et al., 2022). Furthermore, the chatbot design activities for language teaching were conducted using course content and goals explicitly illustrated in

digital textbooks. This might explain their high TPACK levels for Instructional Strategies & Technologies and Fit.

Notably, the lesson plans with high-level TPACK aimed at maximizing students' engagement and learning through the innovative use of chatbots. For instance, Group 2's lesson plan not only supports the curriculum objectives but also enhances the learning environment by integrating chatbots into activities that focus on language skills such as self-introductions and family descriptions. This way of designing chatbot-integrated lesson plans demonstrates the enactment of TPACK as language teachers' CALL competence (Tai, 2015). This progression in their lesson design resonates with Tseng (2018) who highlighted that EFL teachers' TPACK could evolve from simply raising student motivation with relevant teaching materials to fostering their communicative competence through chatbot-assisted L2 interaction. The sophistication of the TPACK observed in the chatbot-integrated lesson plans further suggests that the pre-service teachers benefitted in their lesson planning from well-structured TPACK training modules, similar to those described by Crosthwaite et al. (2023) and Tai (2015). These modules, which focus on integrating specific technological tools within the context of foreign language teaching, appear to support developing a nuanced understanding of how technology can be effectively integrated with pedagogical strategies and content knowledge. This finding underscores the importance of deliberate and context-specific TPACK training in preparing future educators to exploit technological tools for L2 education.

Regarding RQ2, the qualitative findings revealed diverse themes regarding the affordances and constraints of the chatbot-enhanced lesson planning for pre-service teachers' TPACK. First, this study reported 'enhancing design and integration of ELT through chatbots' as the most salient affordance of the training modules in this study. As previous studies underscore the significance of providing teacher candidates with technology-design experiences, rather than a simple use of technology tools, in enhancing their TPACK (Bustamante, 2020; Kim et al., 2022), the integration of chatbot-based tasks within design-based learning modules has been quoted as a highly effective strategy to enhance the participants' CALL competence. Our data specify that the use of chatbots in task design facilitated the pre-service teachers to create interactive, reflective, and iterative learning experiences, as exemplified by the adoption of textbook materials into dynamic chatbot-mediated tasks. As seen in Participant 15's reflection in this study, the seamless integration of AI chatbots into designing in-class tasks prompted her to optimize students' learning experiences for SLA. Thus, this indicates that design activities in TPACK training may bolster pre-service teachers without enough actual knowledge of teaching in developing effective teaching materials with technology when aimed at specific pedagogical goals (Nami, 2022; Tseng et al., 2022).

In addition, the findings indicated that the structured sequence of instructor modeling, collaborative work, instructor and peer feedback, and reflection stages provided opportunities for the participants to enhance their TPACK (Jeon et al., 2022; Tai, 2015; Tondeur et al., 2016). In this study, one participant highlighted the role of collaborative designing and actual chatbot use in raising her technological self-efficacy. In particular, Tondeur et al. (2016) emphasizes the transformative affordances of structured, iterative training modules on pre-service teachers' TPACK growth. Training with sequential modules not only equips teacher candidates with the necessary technical skills but also facilitates a nuanced understanding of pedagogical strategies in specific subjects (Bustamante, 2020; Tseng et al., 2019, 2022). This holistic approach to CALL teacher education underscores the educational affordances of the training modules in preparing pre-service teachers in developing engaging teaching content as well as conducting appropriate pedagogical choices by seamlessly integrating technology to enrich educational outcomes (Ma et al., 2024; Nami, 2022).

The findings also identified two themes regarding the constraints of the training for TPACK: the lack of support for a tutoring system and insufficient time to integrate all modules into a single course. On the one hand, Tseng et al. (2022) reported that a teacher support group can help language teachers develop their technological competence for teaching practices. Bustamante (2020) further explained that teacher PD programs should include concrete training modules, such as design-based learning in a contextual manner, an authentic tutoring system including teacher/peer feedback, reflection on technology use in teaching, and a professional community for teacher trainees. On the other hand, one semester of DDL-enhanced lesson

planning sessions may not fully cultivate pre-service teachers' TPACK, partially because they lack practical technology-integrated teaching experiences (Aşık et al., 2020; Jeon et al., 2022; Tondeur et al., 2016). Tondeur et al. (2016) argued that preparing pre-service teachers for technology use in teaching content knowledge should be implemented at the institutional level to comprehensively develop their TPACK in an integrated manner, including technology planning, staff training and cooperation, and access to resources.

Conclusion and Implications

This study may contribute to advancing our understanding of how to enhance pre-service CALL teachers' TPACK in specific contexts of technology use for language teaching. The findings suggest that chatbot design projects with lesson planning can foster pre-service teachers' hands-on knowledge regarding the design and utilization of chatbot-enhanced tasks for ELT. The findings provide several implications for enhancing pre-service language teachers' TPACK. First, it highlights the significance of structured TPACK training that emphasizes the use of technology within the context of SLA, as specific pedagogical goals based on subject-knowledge can facilitate pre-service teachers' capabilities to seamlessly integrate technology with pedagogical strategies and content knowledge (Crosthwaite et al., 2023; Tai, 2015; Tseng, 2018). Second, collaborative tasks as well as iterative design and reflection stages in the training modules are critical not only in boosting technological self-efficacy but in deepening pre-service teachers' in-depth understanding of pedagogical strategies, thus enhancing their overall teaching efficacy (Jeon et al., 2022; Ma et al., 2024).

Several limitations should be noted in this study. Since qualitative data were used to describe pre-service teachers' TPACK development in chatbot-integrated lesson planning, the results cannot be generalized to other research situations. Therefore, future research on a similar topic can adopt a quasi-experimental research method with inferential statistics. Also, the present study did not statistically examine how much the participants' TPACK was facilitated resulting from TPACK training modules with chatbot-integrated lesson planning. Thus, additional research is necessary to measure the relative contribution of these two factors to TPACK, employing a pre-test and post-test design to compare participants' TPACK levels before and after their involvement in chatbot development projects like those described in this study.

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Appendix A. Protocols of Interviews and Reflection Papers

Data source	Sample question / Prompt
Interview	<ol style="list-style-type: none"> 1. What is your overall experience of lesson planning with chatbots? 2. Can you describe your experience of integrating chatbots into your lesson plan for ELT? What was the outcome? 3. How did the training modules influence your approach to integrating chatbot tasks into your lesson plans? 4. What do you think are the benefits of the modules in understanding effective ELT? 5. What is your experience of collaboration in the training? 6. What were the major challenges you faced while using chatbots in lesson planning? How did you address these challenges? 7. Reflecting on the training, do you feel that the training sessions are sufficient to design your lesson plans for ELT? Why or why not?
Reflection Paper	<ol style="list-style-type: none"> 1. Reflect on a lesson plan you developed during the training. Discuss how the integration of chatbots enhanced learning objectives and student engagement. What would you improve or change in future implementations? 2. How has the TPACK training influenced your views on the role of technology in education? Discuss any shifts in your educational philosophy or teaching methods as a result of the training.

Appendix B. Examples of TPACK Coding

Code	Definition	Example
TK	Chatbot use in non-teaching contexts	“I learned how to code a chatbot.”
PK	General teaching strategies or activities	“Teaching is different from learning.”
CK	Subject-matter regarding ELT	“We used a digital textbook in this project.”
TPK	Chatbot use regarding ELT teaching	“I made this chatbot to teach speaking.”
TCK	Chatbot use to represent ELT knowledge	“I better understand English with chatbots.”
PCK	Pedagogical strategies for ELT	“I know how to adapt content for teaching.”
TPACK	Adopting chatbot affordances for ELT	“I made a role-play task with chatbots.”

Note. ELT = English language teaching

Appendix C. Perceived Affordances of the Modules for TPACK

TPACK domains	Affordances	Sources		
		A	B	Total
TPACK	▪ Designing chatbot-based language learning tasks	11	12	23
	▪ Integrating chatbots into language-teaching lesson plans	7	14	21
	▪ Using chatbots as ELT tools (conversation partner, feedback provider)	4	13	17
	▪ Developing chatbot-assisted ELT content	2	8	10
	▪ Increasing ELT authenticity using chatbots	1	4	5
	▪ Adopting a growth mindset in tech use for teaching	2	3	5
	<i>TPACK Total</i>	<i>27</i>	<i>54</i>	<i>81</i>
TK	▪ Raised technological self-efficacy	5	13	18
	▪ Enhanced computational thinking (by designing dialog flow charts)	3	4	7
	▪ Developing a tech-savvy identity	2	4	6
	<i>TK Total</i>	<i>10</i>	<i>21</i>	<i>31</i>
TPK	▪ Raised awareness of the pedagogical use of chatbots	1	1	2
TCK	▪ Enhanced ELT content knowledge through chatbot designing	0	2	2
PCK	▪ Understanding how to adapt the textbook content for ELT	0	1	1
PK	▪ Enhanced understanding of teaching methods	0	1	1
CK	▪ Valuing the digital textbook content	0	1	1
	<i>All Total</i>	<i>38</i>	<i>81</i>	<i>119</i>

Note. A: reflection, B: interview

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