

Enhancing EFL Preservice Teachers' Digital Tool Integration through a TPACK-Based Module

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Abstract: *The integration of digital collaborative tools has become increasingly important in English as a Foreign Language (EFL) teacher education, particularly in preparing preservice teachers to design and implement technology-enhanced instruction. However, in many Normal Universities in Northwest China, limited resources and insufficient training hinder the development of these skills. This study aimed to design, implement, and evaluate a collaborative teaching Technological Pedagogical Content Knowledge (TPACK) module to address this gap. The module incorporated various digital platforms, including instant messaging, learning management systems, short video, and AI-driven tools, and emphasized collaborative practices such as peer teaching, group discussions, and lesson planning. To address these issues, a structured intervention was evaluated in this study. A single-group pretest–posttest quasi-experimental design was employed with fifty-eight EFL preservice teachers. Data were collected through a pedagogical usability survey and a test of collaborative tool integration, complemented by interviews with the module instructor and selected participants. The findings indicated that preservice teachers reported high levels of satisfaction with the module, particularly regarding clarity of objectives, collaboration, feedback, and resource integration. The t-test results showed a significant improvement in participants' knowledge and use of digital collaborative tools following the intervention. Interview data provided further insights, highlighting both the module's benefits and challenges, such as managing multiple platforms and assessing formative performance. Overall, the collaborative teaching TPACK module effectively enhanced preservice teachers' ability to integrate digital tools into EFL instruction while fostering engagement and professional growth. Findings indicate meaningful improvements in tool-integration competence; however, results should be interpreted with caution given the one-group design and the regional sample. These results suggest that structured, technology-supported collaborative learning experiences can play a critical role in advancing teacher education programs in resource-limited contexts.*

Keywords: Collaborative Learning, TPACK, Digital Collaborative Tools, EFL Preservice Teachers

1. Introduction

The rapid advancement of digital technology has transformed teaching and learning practices across disciplines. In English as a Foreign Language (EFL) education, the integration of

technology has become increasingly vital for enhancing learner engagement and supporting innovative instructional approaches. Among these, **collaborative learning (CL)** has emerged as a widely adopted pedagogical strategy that emphasizes active participation, shared responsibility, and the co-construction of knowledge among learners (Riivari et al., 2021). In higher education, CL is often implemented through discussion, cooperation, problem-solving, and teamwork, which are essential for developing critical thinking and communication skills. Previous studies have demonstrated that CL benefits both teachers and students by fostering meaningful interaction and improving learning outcomes (Lei & Medwell, 2021; Gao et al., 2022).

For preservice teachers, CL serves as a crucial component of professional development. Engaging in collaborative practices allows them to design and implement lessons collectively, refine instructional strategies, and gain hands-on experience in real classroom contexts. These experiences help teachers identify appropriate teaching approaches and select suitable technologies to support their pedagogical goals (Lei & Medwell, 2021). From the learner's perspective, CL enhances performance by promoting mutual support and shared problem-solving, leading to higher achievement compared to individual learning (Kühl et al., 2019; Pietarinen et al., 2021).

In recent years, the integration of **digital collaborative tools** has further strengthened the potential of CL in EFL classrooms. Tools such as instant messaging (IM), learning management systems (LMS), short video platforms, and AI-driven systems have expanded opportunities for interaction, feedback, and personalized learning. For instance, platforms like WeChat and Rain Classroom provide real-time communication and feedback, creating dynamic and engaging learning environments (Yeung et al., 2023; Hanbin, 2020). Similarly, short video platforms such as Douyin have been shown to enhance motivation and participation, especially in oral English practice (Lu & Lu, 2019). These technologies foster collaborative activities such as peer teaching, resource sharing, and reflective practice, supporting both language learning and digital literacy development (Teng et al., 2020). AI-driven tools also play a significant role in tailoring learning content to individual needs, promoting creativity and independent problem-solving (Suchanova, 2023).

To effectively integrate these technologies into teaching, preservice teachers require a comprehensive understanding of the **Technological Pedagogical Content Knowledge (TPACK)** framework. TPACK emphasizes the interrelationship between technological, pedagogical, and content knowledge, providing a foundation for designing technology-enhanced instruction. It highlights that successful teaching with technology depends not only on mastery of digital tools but also on the ability to align these tools with pedagogical strategies and subject matter. Research indicates that digital collaborative tools can support preservice teachers in developing TPACK by offering authentic opportunities for lesson co-design, real-time feedback, and progress tracking (Teng et al., 2020; Lu & Lu, 2019). Collaborative teaching models based on TPACK also encourage peer cooperation, enhance teaching effectiveness, and contribute to sustainable professional growth (Yeung et al., 2023).

Despite these advances, **Normal Universities in Northwest China** face particular challenges, including limited educational resources and insufficient collaborative training for preservice teachers. These constraints hinder the effective preparation of future teachers, especially in integrating digital tools into their teaching practice. Addressing this gap is essential to ensure that preservice teachers are equipped with the necessary skills to meet the demands of modern language classrooms.

In response to this need, this study implemented a **collaborative teaching TPACK module** aimed at improving EFL preservice teachers' abilities to integrate digital collaborative tools into their instructional practices. The module incorporated a range of digital platforms and emphasized collaborative activities such as peer teaching, lesson planning, and group discussions. This study addresses a documented gap in structured, technology-supported collaborative preparation for preservice teachers by implementing and evaluating a TPACK-based collaborative module in a resource-limited context. The purpose of this study was twofold: (1) to evaluate preservice teachers' perceptions of the pedagogical usability of the module and (2) to examine its effectiveness in enhancing their knowledge and skills in using digital collaborative tools. By addressing these objectives, the study contributes to the understanding of how structured, technology-supported collaborative learning experiences can strengthen teacher education programs in resource-limited contexts. Accordingly, we ask: (1) How do preservice teachers perceive the pedagogical usability of the module? (2) To what extent does the module improve their competence in integrating digital collaborative tools? The following section reviews the key theoretical foundations and prior research that guided the design of the module.

2. Literature Review

2.1 Collaborative Learning

Collaborative learning (CL) is a generic form of learning which covers a wide range of study methods. With CL, students' contributions to group engagement and subject matter are examined while students cooperate in their knowledge presentation (Riivari et al., 2021). This topic holds considerable weight concerning its positive impact on each party's collaboration regarding teacher and student, student and student. In higher education, CL is implemented through viewpoint exchange within discussion, cooperation, problem-solving, and teamwork (Riivari et al., 2021).

It has been shown that CL is a practical learning approach for both teachers' professional development and students' learning process. To be concise, CL tools benefit preservice teachers' development programs, as teachers' instructional strategies and hands-on expertise in education are reported to be improved with collaborative tools (Lei & Medwell, 2021; Gao et al., 2022). CL also enhances teachers' strategies to identify teaching approaches and choose appropriate technology in different contexts (Lei & Medwell, 2021). In terms of advantages to students' learning process, students who prepare knowledge presentations with mutual support from peers are found to outperform students who work alone, especially in the assessment of the task of finding a solution to the course material (Kühl et al., 2019), as the purpose of CL is to foster learning with comprehending and constructing information with peer assistance based on their same objective of good achievement (Pietarinen et al., 2021). With the rapid development of technology, collaborative learning has increasingly been supported by digital tools, which will be discussed in the following section.

2.2 Collaborative Learning Tools for EFL learning

The integration of digital collaborative tools in EFL classrooms has gained increasing attention in recent years. These tools, including instant messaging (IM), learning management systems (LMS), AI-driven platforms, and short video applications, offer new ways to support interaction, feedback, and learner autonomy. Studies have shown that IM platforms such as WeChat can create flexible and interactive learning environments, encouraging active participation and improving learning satisfaction (Yeung et al., 2023). Similarly, Rain Classroom provides real-time feedback and immediate interaction through bullet screens and

instant messaging, which significantly enhance student engagement (Liang, 2023; Hanbin, 2020).

Short video platforms like Douyin have been reported to increase learners' motivation and participation, particularly in oral English activities (Lu & Lu, 2019). These tools provide opportunities for collaborative learning, allowing preservice teachers to co-design and implement teaching activities, share resources, and reflect on their practice. Collaborative learning, supported by digital platforms, fosters group interaction and promotes knowledge co-construction, aligning with the goals of EFL teaching and professional development (Teng et al., 2020).

AI-driven collaborative tools have also emerged as powerful resources for personalizing learning content and meeting diverse learner needs. Suchanova (2023) highlighted that these tools provide adaptive content creation and personalized pathways, encouraging independent problem-solving and creativity. This adaptability is particularly relevant in EFL contexts, where learners benefit from tailored activities that support language acquisition and digital literacy simultaneously.

2.3 Technological Pedagogical Content Knowledge (TPACK)

The Technological Pedagogical Content Knowledge (TPACK) framework (see figure 1) provides a theoretical foundation for understanding how teachers integrate technology into their teaching. It emphasizes the interconnectedness of technological, pedagogical, and content knowledge, highlighting the need for teachers to develop these domains collectively rather than separately. For EFL preservice teachers, TPACK offers a lens to design and implement technology-supported language instruction effectively (Mishra & Koehler, 2006).

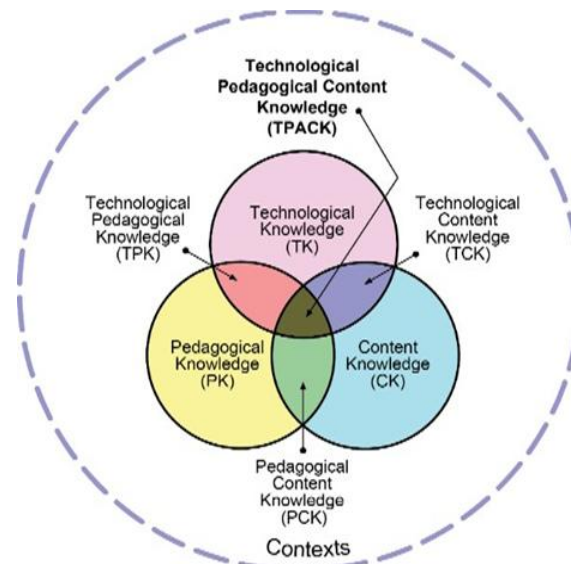


Figure 1: Technological Pedagogical Content Knowledge (TPCK) Framework and its Subconstructs
 Source : <http://www.tpack.org/>. Reproduced by permission of the publisher. Copyright 2012 by tpack.org

Research has demonstrated that digital collaborative tools can enhance preservice teachers' TPACK development by promoting reflective practice and interactive learning experiences. Through these tools, teachers can engage in lesson co-design, receive real-time feedback, and track learning progress, which strengthens both pedagogical and technological competencies. This process helps bridge the gap between theoretical knowledge and classroom practice,

fostering greater confidence and skill in using digital tools for language teaching (Teng et al., 2020; Lu & Lu, 2019).

Moreover, collaborative teaching models supported by digital platforms align closely with current trends in teacher education. By encouraging cooperation between preservice teachers and their peers, these models provide opportunities for shared learning and mutual support. Previous studies have confirmed that such approaches not only improve teaching effectiveness but also promote sustainable professional growth and readiness for future educational challenges (Liang, 2023; Yeung et al., 2023).

Synthesizing prior work, we conceptualize digital collaborative tools as pedagogical means to enact CL principles within a TPACK-aligned design, which guided the module’s learning objectives, tasks, and assessments.

3. Methodology

The study took place at a Normal University in Northwest China. The university is a typical Normal University in one of the five provinces in Northwest China. The five provinces in Northwest China are Gansu, Ningxia, Qinghai, Shanxi, and Xinjiang (“Five Provinces in Northwest China”, 2024). The location of the study was chosen based on the situation of this context that normal universities in Northwest China are experiencing the lack of educational resources and collaborative training of TPACK, this is related to the research rationale and gap of the study. Also Normal university is the university where they train preservice teachers, and they are the target sample for this study. Ethical approval was obtained from the university’s review board, and all participants provided informed consent prior to data collection.

The overall objective of phase three is to investigate two aspects: the technical and pedagogical usability of the collaborative module, and the effectiveness on the knowledge of using digital collaborative tools. The usability of the module is determined by a survey, the effectiveness of the module in improving TPACK is defined by the compared means of the pre- and post-survey before and after the module implementation, and the effectiveness of the module in using collaborative tools is decided by the compared means of a pre and posttest. Thus, this study employed a single group pre and post-test quasi-experiment, which has proved useful in module evaluation (Alias & Siraj, 2012; Luo et al., 2024; Techanamurthy et al., 2020).

One group pretest-posttest design refers to a single group of participants tested before and after the intervention, as in Figure 2. According to the figure below, O1 refers to the participants’ level of TPACK and use of digital collaborative tools before applying the intervention in the experiment, and X signifies the intervention or treatment to the participants as a variable. Moreover, O2 refers to their level after the intervention in the experiment.

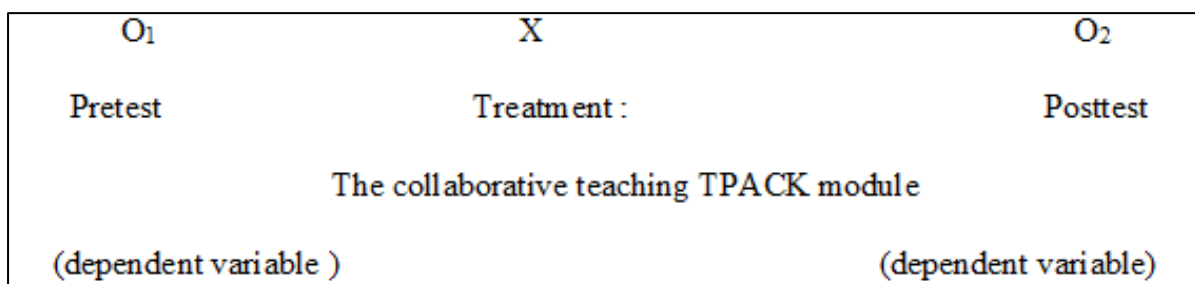


Figure 2 : The Illustration of the Single Group Pre- and Post-test Quasi-Experiment

Moreover, a quasi-experiment rather than a true experiment was used in this phase because it is difficult to assign the participants randomly in a natural setting, and using existing groups of participants is the advantage of a quasi-experiment (Cohen et al., 2007; Creswell, 2012). Random assignment was impractical in this naturalistic setting; intact classes preserved ecological validity while limiting internal validity.

The population in this phase is around 300 preservice teachers enrolled in the English program in this specific Normal University in China, and they are in their third and fourth year of the program and waiting for internship or graduation, and among them the sample is fifty-eight preservice teachers in two administrative classes. Inclusion criteria were enrolment in the English education program and availability across the six-week module; no additional exclusion criteria were applied, and no baseline group differences were analysed due to intact classes.

For t test of two dependent means (matched pairs), the recommended sample size is at least 27. Hence, the participants are fifty-eight preservice teachers in two administrative classes at this university. This is the sample size of the post-survey of TPACK, as well as the pre-and post-test on technology integration of digital collaborative tools. The achieved sample exceeded the a priori minimum, providing adequate power for within-group comparisons.

The sample is determined by purposive sampling. As mentioned, purposive sampling produces information-rich data if this is an intense case (Richey & Klein, 2007).

There are, in total, two main instruments in this phase, the pre-and post-test concerning collaborative tools integration, and a pedagogical usability questionnaire. The pedagogical usability questionnaire is adapted from the Pedagogical Meaningful Learning Questionnaire (PMLQ) by Nokelainen (2006). The survey includes twenty items regarding pedagogical usability.

The pre-and post-tests (see Appendix 1) concerning integrating collaborative tools were adapted based on the Taxonomy of Learning and TPACK model. It comprised three sections: participants' demographic information, multiple choices for participants' collaborative tools, and an open question. And a rubric for assessing the pre-and post-tests is developed (see Appendix 2). The validity and reliability of the pre and post-test are ensured by the pilot test, and also reviewed by an expert. In contrast, the validity and reliability of the PMLQ questionnaire was validated by the pilot study and expert review.

Before the implementation of the study, the participants accessed the Rain Classroom platform and tested their current use of collaborative tools as the pretest result as the orientation. Then, the module's outline, the module's purpose, and the researcher's introduction, including the researcher's contact number, were provided. When distributing the information sheet and consent forms, the participants were informed about the data collected from the module, the information anonymity, and their rights to withdraw the implementation at any time. Moreover, the instructions for installing the digital collaborative tools were given based on the experts' validation.

Then, implementing the collaborative teaching TPACK module will take eighteen hours and ten minutes in total during nearly one and a half months, including a fifty-minute orientation, four lessons, one hour and fourteen minutes in each lesson, a two-hour peer-teaching assessment, and another eight hours forty minutes for the additional self-regulation work. The module

instructor is the preservice teachers' teacher in the program instead of the researcher, and the module is integrated into the last two units of teaching Listening and Speaking in the course of English Subject Curriculum and Instructional Design. During the implementation, preservice teachers learn the contents around the TPACK framework, the First Principle of Instruction, the taxonomy of learning outcomes and the use of digital collaborative tools such as AI, VR, microblog, instant messaging, short video, and learning management systems, as well as a number of technologies that could integrate into teaching English listening and speaking. The self-regulation work is the study of theoretical knowledge and the preparation for the lesson plan and peer-teaching. The module is made collaborative through group work such as peer teaching, group discussion, lesson plan design, and peer assessment on the collaborative tools.

After the implementation, preservice teachers accessed the test of using collaborative tools from the Wen Juan Xin mini program in WeChat. These data were used to assess the changes in preservice teachers' use of collaborative tools. At the same time, the survey was distributed to preservice teachers also from Wen Juan Xin mini program to investigate the pedagogical usability of the module.

The pre and post-test on collaborative tools used, were analysed with SPSS software using statistical tests such as the T-test. This analysis is to see if their use of collaborative tools has any improvement, and can draw a conclusion about the module's effectiveness. Moreover, the pedagogical usability questionnaire results are analysed using the Jamovie software, which is accomplished with descriptive analysis.

During the whole process of the research, the 'participants' well-being was prioritized at all times. Constant dialogue with participants about their well-being during the research was taking place. Also, the final thesis, report, publication, or presentation of this study avoided a detailed description of the participants and the university. Instead, all participants or informants were given numbers, aliases, or pseudonyms to identify their responses and protect their privacy and anonymity (Cohen et al., 2007; Creswell, 2013; Creswell & Creswell, 2018).

As the participants are over eighteen years old, they are responsible for their decisions. However, the participants were informed about the possibility of addiction to these social media apps, such as Douyin and Sina Microblog and the right to withdraw from the research at any time. Moreover, they were informed that their academic results would not be affected by their performance in this study.

4. Results

The following section presents the findings from the implementation and evaluation of the module.

4.1 The Implementation of the Module for Each Class

Once the collaborative teaching TPACK module had been evaluated and modified based on the experts' opinion, the module was implemented among fifty-eight PSTs assigned to two classes in one of the Normal Universities in northwest China. The module was integrated in the last two units, namely teaching English listening and teaching English speaking, within their prior existing course of English Subject Curriculum and Instructional Design. The module was conducted by the instructor from this course. The process of implementing the collaborative teaching TPACK module is illustrated in Table 1.

Table 1: Implementation Phase of the Collaborative Teaching TPACK Module

Week	Teaching & Learning	Duration	Learning Activities
1	Orientation	50 mins	Introducing the researcher and the research, distributing participants' information sheets and consent forms to both the instructor and participants, distributing the pre-survey and pre-test, installing apps, and signing up accounts.
1	Lesson One	1 hour 40 minutes	The instructor teaches Lesson One with 30 preservice teachers
2	Lesson Two	1 hour 40 minutes	The instructor teaches Lesson Two with 30 preservice teachers
3	Lesson Three	1 hour 40 minutes	The instructor teaches Lesson Three with 30 preservice teachers
4	Lesson Four	1 hour 40 minutes	The instructor teaches Lesson Four with 30 preservice teachers
5	Peer Teaching	2 hours	Preservice teachers demonstrate their teaching based on the lesson plan, distributing the usability survey, post-survey and post-test.
All Weeks	Self-Study	8 hours 40 minutes	Theoretical Knowledge, Lesson Plan and Peer Teaching Preparation

4.2 Preservice Teachers' Perceptions on the Pedagogical Usability of the Collaborative Teaching Module

The survey received responses from fifty-five preservice teachers in two classes. In general, the preservice teachers agreed with the pedagogical usability of the collaborative teaching TPACK module as shown in Table 2. Among the twenty-eight items under six sections, the EFL preservice teachers either agree or strongly agree with the twenty items. For the remaining eight items, half received less than 5% of neither 'agree' nor 'disagree' responses, whereas the other half received responses ranging from 7.3% to 9.1% that were neither 'agree' nor 'disagree'.

Table 2: Preservice Teachers' Perception of the Pedagogical Usability of the Collaborative Teaching TPACK Module

Scale Items	Frequency of use (%)				
	1 Strongly Disagree	2 Disagree	3 Neither Agree nor Disagree	4 Agree	5 Strongly Agree
Section A: General Perception					
1. The collaborative teaching TPACK module allowed me to control my own learning.	-	-	3.6 (2)	32.7 (18)	63.6 (35)
2. The module encouraged me to think and create unique solutions for assignments.	-	-	-	30.9 (17)	69.1 (38)
3. The learning material was interactive and required active engagement.	-	-	-	38.2 (21)	61.8 (34)
4. The module provided clear learning goals and objectives.	-	-	-	20.0 (11)	80.0 (44)
5. The module content was relevant and applicable to my teaching practice.	-	-	-	32.7 (18)	67.3 (37)
Section B: Usability and Engagement					
6. I felt responsible for my learning while using the module.	-	-	-	65.5 (36)	34.5 (19)
7. The module allowed me to choose the order in which I completed tasks.	-	-	7.3 (4)	63.6 (35)	29.1 (16)

8. The assignments made me think critically and solve problems independently.	-	-	-	41.8 (23)	58.2 (32)
9. The learning material was well-organised and easy to navigate.	-	-	-	70.9 (39)	29.1 (16)
10. I was able to immerse myself in the learning material without distractions.	-	-	9.1 (5)	49.1 (27)	41.8 (23)
Section C: Collaboration and Interaction					
11. The module facilitated communication with my classmates (e.g., through chat or discussion board).	-	-	-	65.5 (36)	34.5 (19)
12. The module allowed for group work and collaboration with peers.	-	-	-	67.3 (37)	32.7 (18)
13. It was easy and enjoyable to use the module with other students.	-	-	-	78.2 (43)	21.8 (12)
14. I could see the activities and progress of other users within the module.	-	-	7.3 (4)	80.0 (44)	12.7 (7)
15. The module supported real-time interaction and collaboration.	-	-	-	74.5 (41)	25.5 (14)
Section D: Tools and Resources					
16. I could save my work and review others' work within the module.	-	-	-	90.9 (50)	9.1 (5)
17. The module included links to various external resources for further learning.	-	-	1.8 (1)	89.1 (49)	9.1 (5)
18. The learning material was challenging yet appropriate for my skill level.	-	-	-	81.8 (45)	18.2 (10)
Section E: Feedback and Assessment					
19. The module provided immediate and helpful feedback on my work.	-	-	-	70.9 (39)	29.1 (16)
20. The assessment methods were effective in measuring my progress.	-	-	-	63.6 (35)	36.4 (20)
21. The module allowed me to track my learning progress.	-	-	9.1 (5)	81.8 (45)	9.1 (5)
22. I received motivating feedback that encouraged further learning.	-	-	-	63.6 (35)	36.4 (20)
23. The module included examples of correct solutions before assignments.	-	-	3.6 (2)	89.1 (49)	7.3 (4)
Section F: Overall Experience					
24. I felt proud of the solutions I created using the module.	-	-	1.8 (1)	60.0 (33)	38.2 (21)
25. The module improved my understanding of TPACK and digital collaborative tools.	-	-	-	70.9 (39)	29.1 (16)
26. I feel more confident in integrating digital tools such as AI, short videos, LMS, and instant messaging in my teaching.	-	-	-	58.2 (32)	41.8 (23)
27. The module was more effective than traditional classroom methods.	-	-	-	69.1 (38)	30.9 (17)
28. I would recommend the collaborative teaching TPACK module to other preservice teachers.	-	-	-	67.3 (37)	32.7 (18)

A total of fifty-five EFL preservice teachers participated in the survey, and the overall findings demonstrated a highly positive perception of the collaborative teaching TPACK module. Among the twenty-eight items across six sections, twenty received unanimous positive ratings, while the remaining eight items had only a small proportion of neutral responses ranging from 5% to 9%. This indicates that the module was generally well accepted by the participants and perceived as pedagogically effective.

In the **general perception** section, preservice teachers expressed strong satisfaction with the module's clarity and relevance. All participants agreed or strongly agreed that the module provided clear learning goals and objectives, with 80% selecting "strongly agree." Similarly, the relevance of the module content to their teaching practice was affirmed by over two-thirds of participants, while 69.1% strongly agreed that the module encouraged them to think creatively and develop unique solutions for assignments. These results suggest that the module successfully established meaningful and applicable learning experiences.

Regarding **usability and engagement**, the responses showed that participants felt actively involved and responsible for their learning. Every respondent agreed or strongly agreed that they felt responsible for their own learning, and all participants indicated that the assignments encouraged critical thinking and independent problem-solving. Most participants (70.9%) agreed that the learning materials were well-organized and easy to navigate. While two items displayed minor neutrality—such as flexibility in task order (7.3% neutral) and the ability to stay focused without distractions (9.1% neutral)—the overall trend remained highly positive.

The module also demonstrated strong potential for **collaboration and interaction**. Almost all participants reported that the module facilitated communication and collaboration with peers, supported group work, and allowed for real-time interaction. For instance, over 97% of participants expressed agreement or strong agreement that the module supported group work and real-time collaborative activities. Moreover, 92.7% agreed that they could easily view their peers' activities and progress, further enhancing a sense of shared learning and community.

In the **tools and resources** section, participants appreciated the module's practical features and resource integration. Nearly all respondents (90.9%) indicated they could save their own work and review others' work within the module, and 98.2% found the external links to additional learning resources helpful. Furthermore, all participants felt that the learning material was challenging yet appropriate for their skill levels, highlighting the module's balance between difficulty and accessibility.

With respect to **feedback and assessment**, preservice teachers gave consistently positive evaluations. All participants reported receiving immediate and helpful feedback on their work, and nearly all agreed that the assessment methods were effective in measuring their progress. Additionally, 90.9% of respondents confirmed that the module allowed them to track their learning progress, while motivating feedback was highlighted as a key factor in encouraging further learning.

Finally, under the **overall experience** section, participants expressed a high level of satisfaction and personal growth. Almost all participants agreed that the module enhanced their understanding of TPACK and increased their confidence in integrating digital tools such as AI, short videos, learning management systems, and instant messaging into their future teaching practices. Moreover, 100% of respondents believed the module was more effective than

traditional classroom methods, and all indicated that they would recommend it to other preservice teachers.

In summary, the findings clearly show that the collaborative teaching TPACK module was well-received and perceived as an effective tool for developing pedagogical skills and technological competence among preservice teachers. Across all dimensions—clarity of objectives, usability, collaboration, resource integration, feedback, and overall impact—the module achieved overwhelmingly positive evaluations, with only minimal neutral responses. This suggests that the module has strong potential to enhance EFL preservice teachers' preparation for technology-integrated, collaborative teaching practices.

4.3 Post-Module Interview

The pedagogical usability of this collaborative teaching module can also be confirmed by the findings from the interview with the instructor after the module implementation. Two interview questions were proposed to the instructor to gain insights into the classroom experience. Was the module easy to use and implement in your teaching? What challenges did you encounter during the implementation of the module? Three broad themes emerged from the analysis: lack of technical familiarity, difficulties in frequently switching platforms, and difficulties in score summarisation.

Participant Zoe described the challenging experience of using software such as Rain Classroom and Praat, expressing that the unfamiliarity with these apps causes a time-consuming lesson plan.

You know, we primarily used Rain Classroom during the COVID-19 pandemic, and it was beneficial to utilise Rain Classroom and Tencent Meeting for online courses. After COVID, we seldom use it. I forgot many functions, especially how to manage resources within the system. Now I have no reply in the WeChat group, which the university created to support instructors in using this software. Some new software in the module, such as Praat, is new to me, and I am less confident in explaining this knowledge to the students. (Zoe, line 8-12)

This indicates that the instructor needs to learn not only the basic operation of the new software but also the effective integration of these apps in teaching English. If they are not familiar with the software, the teaching practice is not smooth, which will influence preservice teachers' confidence.

Closely related to the above issue, participants also discussed the challenges of managing multiple platforms.

There is a great number of software involved in the module. Only one session requires the use of more than three software programs. I'm kind of busy bustling around all these apps, and sometimes forget the content when shifting between processes. I used to focus on students' linguistic performance. I would feel confused if I were an English teacher or a technology teacher. (Zoe, line 13-15)

This response suggested that the use of a great number of platforms causes English teachers to feel lost in their identity and forget the flow of their teaching practice.

Building on the idea of difficulties in switching between different platforms, the next theme focuses on the difficulties in score summarisation. The instructor found it difficult to assess PSTs’ performance in using technology, especially in formative assessments.

For example, on one hand, regarding students’ performance in posting videos or leaving comments on short video platforms. Should I assess their English performance? Or should I rate their exemplary performance as long as they can post a video? Although the final lesson plan and peer teaching can show the ability of technology integration in English teaching, what about the formative assessment of teaching with technology? On the other hand, even if I want to rate their performance in these different apps or platforms, sometimes they use a nickname or are anonymous, it’s difficult to collect all their performance; otherwise, their performance on these social media like Douyin or WeChat Moment is a waste, and cannot be used. (Zoe, line 17-21)

Such a response reveals that there are certain difficulties in formative assessment of PSTs’ performance in technology integration in the English subject, and the anonymous comments under social media apps make the assessment difficult to realise.

Taken together, the survey and the post module evaluation indicate that the EFL preservice teachers have excellent general perception and overall experience towards the collaborative teaching TPACK module, and they are very satisfied with the usability and engagement, collaboration and interaction, tools and resources, and feedback and assessment of the module, the instructor find challenges in frequently switching platforms and score summarisation, as well as the unfamiliarity towards the technologies.

4.4 The Effectiveness of the Module on Improving EFL Preservice Teachers’ Use of Collaborative Tools

The third research question in this implementation and evaluation phase is: Is the collaborative teaching TPACK module effective in improving preservice teachers’ knowledge of using digital collaborative tools? The results of the pre- and post-tests were mainly used to answer this research question. The test focuses on the use of digital collaborative tools based on the taxonomy of learning. At the same time, the findings from an interview with two EFL preservice teachers were used to triangulate the results of the pre- and post-tests.

4.4.1 Normality Test for Pre and Post-Test

The normality test was carried out prior to analysing the pre- and post-test data to identify the statistical approach to be used. The null hypothesis is that a normal distribution is assumed.

Looking at Table 3, the p-value in the pre-test (0.164) is greater than 0.05, so the researcher fails to reject the null hypothesis, and the normal distribution of the pre-test is assumed. However, the p-value in the post-test (0.05) equals 0.05. Thus, this result was supplemented with a graphic method as shown in Figure 3.

Table 3: The Normality Test for Pre and Post-Test

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
pre test	.115	58	.052	.970	58	.164
post test	.134	58	.011	.959	58	.050

a. Lilliefors Significance Correction

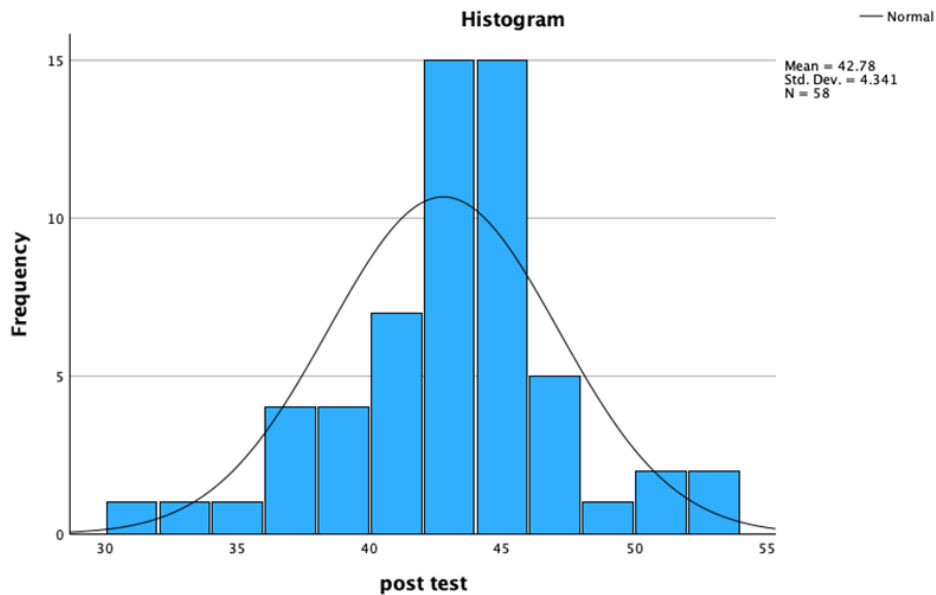


Figure 3: The Histogram for the Post Test

From the above histogram (Figure 3), it can be seen that the data generally presents a bell-shaped curve, with slight departures in the tails. The analytical and graphical analyses together show a nearly normal distribution for both the pre- and post-tests. Therefore, the researcher fails to reject the null hypothesis, and the normal distribution of both pre- and post-tests is assumed. The result is sufficiently normal for a statistical test, such as a t-test.

4.4.2 Pre and Post-Test of EFL Preservice Teachers' Use of Collaborative Tools

To compare the means of the pre- and post-test, a t-test was used to gain insights into the module's effectiveness. The null hypothesis is that the collaborative teaching TPACK module does not improve EFL preservice teachers' use of collaborative tools.

As shown in Table 4, the significance in the paired samples test table is smaller than 0.01. Therefore, the t-test result is statistically significant ($t = -8.619$, $df = 57$, $p < 0.01$). The researcher rejects the null hypothesis. The results show that the collaborative teaching TPACK module improved the use of digital collaborative tools among EFL preservice teachers.

Table 4: Paired Sample Test for Pre and Post Test

	Paired Differences					Significance			
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	One-Sided p	Two-Sided p
				Lower	Upper				
pre-test - post-test	-4.276	3.778	.496	-5.269	-3.282	-8.619	57	<.001	<.001

4.4.3 Interview with Two EFL Preservice Teachers

To triangulate the data from the test, an interview was conducted to examine the module's effectiveness on EFL preservice teachers' use of collaborative tools. The two PSTs were selected because one has shown the most improvement in test performance, and the other has shown the least progress. The interview question is proposed: In what way has the course enhanced your use of collaborative tools in teaching English listening and speaking? Two

concrete themes emerged from this: the recognition of tools based on the teaching objective, as well as collaborative learning and mutual support.

A standard view among both participants was that the module helped identify various technological tools with different teaching objectives. The module raised the participants' awareness of determining the reason behind selecting certain technological tools, especially under the Taxonomy of Learning. As they put it:

The module has had a significant impact on me. I can choose the most suitable platform based on different learning objectives. In later practice, I will try to demonstrate verbal information with a short video on Douyin, teach intelligent skills using AI, and also try to use voice messages within WeChat groups to simulate a context. (PST A, line 5-9)

I learnt to ask myself before I use any tools. Which teaching objective can the tools help me achieve? I tried to record a speaking video on Douyin, practice my pronunciation using an AI system, and the purpose is now more straightforward. (PST B, line 16-20)

Another important aspect is the collaborative learning and mutual support. The participants recognised that the module has effectively expanded the opportunities for peer assessment and motivated students' engagement.

I can post the daily check-in activity in the WeChat group, allowing friends to complete instant assessments, and the interaction, such as likes and comments, under the short video platform has motivated their participation. (PST A, line 14-15)

My friends' likes and written encouragement help me release the speech anxiety, compared to asking questions face-to-face. (PST B, line 24-26)

Overall, the results from the pre- and post-test, as well as the interview, together suggest that the collaborative teaching TPACK module made a significant difference in EFL preservice teachers' use of collaborative tools.

5. Discussion

5.1 Discussion of the Findings from the Implementation and Evaluation Phase

This study evaluated the pedagogical usability of the collaborative teaching TPACK module and its effectiveness in developing preservice teachers' use of digital collaborative tools. Overall, the findings revealed highly positive perceptions of the module, indicating that it was well-received and beneficial for preservice teachers' professional development.

Participants strongly agreed that the module provided clear learning goals and objectives, which reflects the value of integrating explicit objectives into each unit as suggested by experts during the design phase. They also reported that the module encouraged creativity and independent problem-solving, consistent with Suchanova's (2023) findings on the potential of AI-driven collaborative tools to personalize learning content and foster learner autonomy.

Collaboration and interaction were key strengths of the module. Preservice teachers found the module highly engaging, interactive, and effective in facilitating communication, group work, and real-time collaboration. These results align with previous studies highlighting the role of

digital tools—such as Douyin for enhancing engagement in oral English learning (Lu & Lu, 2019), WeChat for promoting active and flexible learning environments (Yeung et al., 2023), and Rain Classroom for providing real-time feedback and immediate interaction (Liang, 2023; Hanbin, 2020).

Participants also valued the module's tools and resources, especially the ability to save and review their work and access external resources, echoing Lee et al.'s (2023) findings on the benefits of shared digital spaces. They reported that the learning materials were challenging yet appropriate, supporting earlier claims about the adaptability of AI-driven tools (Suchanova, 2023).

Two areas for improvement emerged. First, a small number of neutral responses related to maintaining focus may be attributed to the addictive nature of certain tools, such as Douyin (Du et al., 2022). Second, neutral responses regarding tracking personal and peer progress suggest the need to integrate features for recording and monitoring learning activities in future iterations of the module.

In summary, the module effectively enhanced preservice teachers' engagement, collaboration, and use of digital tools while providing meaningful, personalized learning experiences. Addressing the minor concerns identified will further optimize its design and impact.

5.2 Discussion of Effectiveness of the Module on the Knowledge of Using Collaborative Tools

Having discussed the module's effectiveness on TPACK improvement, it is important to discuss the module's effectiveness on the knowledge of using collaborative tools. The results of this study show that the researcher rejects the null hypothesis, and confirms that the collaborative teaching TPACK module improved EFL preservice teachers' use of digital collaborative tools. This is a relatively unsurprising finding given that a variety of collaborative tools are demonstrated in this module, not only for the strategies of managing classroom activities, but also as the content of this teaching module.

This result generally supports previous research (Backfisch et al., 2023; Sun et al., 2023) into this area, which links the teacher training with technology integration. Backfisch et al. (2023) found that collaborative TPACK enhanced technology integration, and Sun et al (2023) reported that a TPACK-based professional development program specifically developed teachers' AI teaching skills. In addition, this finding corroborates the ideas of Seufert et al. (2021) who suggested that the employment of Merrill's first principle of instruction in a module design helps determine the factors that affect the use of particular technology in specific teaching context.

6. Conclusion

This study implemented a **collaborative teaching TPACK module** designed to enhance preservice teachers' integration of digital collaborative tools in English as a Foreign Language (EFL) instruction. Conducted with preservice teachers at a Normal University in Northwest China, the module addressed critical challenges such as limited resources and insufficient training opportunities in the region. By combining collaborative learning strategies with technology integration principles, the module provided a structured and interactive environment for preservice teachers to engage in peer teaching, lesson planning, and reflective practice.

Participants reported highly positive perceptions of the module, particularly regarding collaboration, feedback, and clarity of instructional goals. In addition, pretest–posttest comparisons revealed significant improvements in preservice teachers’ competence in integrating digital collaborative tools into EFL teaching. Together, these findings demonstrate that the module was both pedagogically usable and effective in enhancing technological and pedagogical skills.

These results have several practical implications. For teacher education programs, the study provides evidence that structured, TPACK-aligned collaborative modules can effectively prepare preservice teachers for technology-enhanced teaching, even in resource-limited contexts. By incorporating real-time feedback, peer collaboration, and authentic teaching tasks, such modules can bridge the gap between theoretical knowledge and classroom practice. Institutions may consider adopting similar approaches to strengthen preservice teacher preparation and improve technology integration in EFL classrooms.

However, certain limitations should be acknowledged. The study employed a **single-group pretest–posttest design** without a control group, which limits causal inferences. The research was also conducted at a single institution, and findings may not generalize to other contexts or populations. Future studies should replicate this work using controlled or multi-site designs and explore the long-term sustainability of observed improvements. Additionally, further investigation is needed to refine module features, such as streamlining digital tools and enhancing progress-tracking mechanisms.

In conclusion, this research demonstrates that a carefully designed collaborative teaching TPACK module can positively impact preservice teachers’ ability to integrate digital collaborative tools into EFL instruction. By addressing both pedagogical and technological competencies, the module offers a viable pathway for advancing teacher education and promoting innovative, technology-supported learning environments.

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Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this study.

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Appendices

Appendix 1: Pre and Post Test: Knowledge of Collaborative Learning Tools

Learning Objective of this activity is to: identify appropriate collaborative learning tools to teach specific skills and knowledge. This test comprises of s sections excluding participant details. Please select the response which would best answer the questions.

1. Email Address _____

Section 1: Collaborative Learning Tools

2. To what extent you have implemented the following collaborative learning tools for teaching:

1. Short Video (Douyin)
2. Microblog (Sina microblog)
3. instant messaging (Wechat, QQ)
4. Learning Management System (Rain Classroom)
5. AI
6. VR

Section 2: Different Knowledge and Skills

3. In your opinion, which digital collaborative tools would you use for teaching verbal information in English Listening and Speaking. (e.g. introduce vowels and consonants).

1. **Short Video (Douyin)**
2. **Microblog (Sina microblog)**
3. **instant messaging (Wechat, QQ)**
4. **Learning Management System (Rain Classroom)**
5. **AI**
6. **VR**

4. In your opinion, which digital collaborative tools would you use for teaching discrimination in English Listening and Speaking. (e.g. differentiate the pronunciation of 's' and 'z').

1. **Short Video (Douyin)**
2. **Microblog (Sina microblog)**
3. **instant messaging (Wechat, QQ)**
4. **Learning Management System (Rain Classroom)**
5. **AI**
6. **VR**

5. In your opinion, which digital collaborative tools would you use for teaching rules in English Listening and Speaking. (e.g. link the last consonant of first word and fist vowel of second word).

1. Short Video (Douyin)

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2. **Microblog (Sina microblog)**
3. **instant messaging (Wechat, QQ)**
4. **Learning Management System (Rain Classroom)**
5. **AI**
6. **VR**

6. In your opinion, which digital collaborative tools would you use for teaching problem solving in English Listening and Speaking. (e.g. borrow a pen using English).

1. **Short Video (Douyin)**
2. **Microblog (Sina microblog)**
3. **instant messaging (Wechat, QQ)**
4. **Learning Management System (Rain Classroom)**
5. **AI**
6. **VR**

7. In your opinion, which digital collaborative tools would you use for teaching cognitive strategies in English Listening and Speaking. (e.g. improve fluency of the English speaking).

1. **Short Video (Douyin)**
2. **Microblog (Sina microblog)**
3. **instant messaging (Wechat, QQ)**
4. **Learning Management System (Rain Classroom)**
5. **AI**
6. **VR**

8. In your opinion, which digital collaborative tools would you use for developing attitude in English Listening and Speaking. (e.g. raise their awareness of being polite in perform a request in speaking).

1. **Short Video (Douyin)**
2. **Microblog (Sina microblog)**
3. **instant messaging (Wechat, QQ)**
4. **Learning Management System (Rain Classroom)**
5. **AI**
6. **VR**

9. In your opinion, which digital collaborative tools would you use for teaching motor skills in English Listening and Speaking. (e.g. pronounce the word 'gesture').

1. **Short Video (Douyin)**
2. **Microblog (Sina microblog)**
3. **instant messaging (Wechat, QQ)**
4. **Learning Management System (Rain Classroom)**
5. **AI**
6. **VR**

Section 3:

Collaborative Learning Tools: Short Video (Douyin), Microblog (Sina microblog), instant messaging (Wechat, QQ), Learning Management System (Rain Classroom), AI, VR.

10. Please choose ONE of the above tools and briefly explain How you would use the tools for collaboration in teaching English Listening and Speaking.

Appendix 2: The Rubric for the Test in Appendix 1

Section 1: Implementation of Collaborative Learning Tools

Criteria	1 - Not at All Implemented	2 - Rarely Implemented	3 - Occasionally Implemented	4 - Frequently Implemented	5 - Extensively Implemented
Short Video (Douyin)	No evidence of implementation	Rare use with minimal impact	Occasional use with some impact	Frequent use with good impact	Extensive use with significant impact
Instant Messaging (WeChat, QQ)	No evidence of implementation	Rare use with minimal impact	Occasional use with some impact	Frequent use with good impact	Extensive use with significant impact
Learning Management System (Rain Classroom)	No evidence of implementation	Rare use with minimal impact	Occasional use with some impact	Frequent use with good impact	Extensive use with significant impact
AI Tools	No evidence of implementation	Rare use with minimal impact	Occasional use with some impact	Frequent use with good impact	Extensive use with significant impact

Section 2: Selection of Collaborative Learning Tools for Different Skills

Criteria	1 - Poor Choice	2 - Fair Choice	3 - Good Choice	4 - Very Good Choice	5 - Excellent Choice
Appropriateness of tool for teaching verbal information	Inappropriate tool selected	Marginally appropriate tool	Generally appropriate tool	Mostly appropriate tool	Highly appropriate tool
Appropriateness of tool for teaching intelligent skills	Inappropriate tool selected	Marginally appropriate tool	Generally appropriate tool	Mostly appropriate tool	Highly appropriate tool
Appropriateness of tool for teaching cognitive strategies	Inappropriate tool selected	Marginally appropriate tool	Generally appropriate tool	Mostly appropriate tool	Highly appropriate tool
Appropriateness of tool for developing attitude	Inappropriate tool selected	Marginally appropriate tool	Generally appropriate tool	Mostly appropriate tool	Highly appropriate tool

Section 3: Explanation of Tool Use for Collaboration

Criteria	1 - Poor	2 - Fair	3 - Good	4 - Very Good	5 - Excellent
Clarity of Explanation	Unclear and confusing	Somewhat clear, but lacks details	Clear, but lacks some details	Mostly clear and detailed	Very clear and highly detailed
Relevance to Teaching English Listening and Speaking	Not relevant	Marginally relevant	Generally relevant	Mostly relevant	Highly relevant
Depth of Understanding	Shows little understanding	Shows some understanding	Shows good understanding	Shows very good understanding	Shows excellent understanding

Overall Score Calculation:

- **Section 1:** Total score = Sum of ratings for each tool (maximum 20 points)
- **Section 2:** Total score = Sum of ratings for each skill category (maximum 20 points)
- **Section 3:** Total score = Sum of ratings for clarity, relevance, and depth (maximum 15 points)

Total Maximum Score: 55 points

Score Interpretation:

- **50-55 points:** Excellent understanding and implementation of collaborative learning tools
- **40-49 points:** Very good understanding and implementation
- **30-39 points:** Good understanding and implementation
- **20-29 points:** Fair understanding and implementation
- **Below 20 points:** Needs improvement in understanding and implementing collaborative learning tools