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EDITED BY
Chayanika Uniyal,
University of Delhi, India

REVIEWED BY
Metin Kus,
Hittite University, Türkiye
Fiorela Anaí Fernández Otoya,
Universidad Católica Santo Toribio de Mogrovejo, Peru
Suruchi Bhatia,
University of Delhi, India

*CORRESPONDENCE
Zou Deping
✉ 20153429@qlnu.edu.cn;
✉ 20176791@qlnu.edu.cn

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From challenges to chances in the digital age: psychological transformation in EFL teachers in Chinese teacher education institutions

Zou Deping* and Song Xiukui

Department of Foreign Language, Qilu Normal University, Jinan, China

Introduction: Traditional teaching methodologies in Chinese teacher education institutions, especially in English as a Foreign Language (EFL) instruction, are undergoing rapid transformation due to digital education initiatives. While the *Digital Literacy of Teachers* (DLT) framework has been introduced by the Ministry of Education, limited research exists on the psychological adaptation of EFL teachers to digitalization.

Methods: This qualitative study explored the psychological transformation of 18 EFL teachers from six Chinese institutions who participated in a specialized 60-h digital literacy training program. Participants were purposively sampled for diversity, kept teaching reflection diaries, and engaged in in-depth interviews.

Results: Post-training, teachers demonstrated a comprehensive digital mindset, including enhanced digital awareness, technology knowledge and skills, application, professional growth, and social responsibility. This shift not only improved their teaching abilities but also promoted positive psychological adaptation to digital change.

Discussion: The findings underscore the importance of DLT-aligned training programs in supporting EFL teachers' psychological transformation during digital transitions. Despite the qualitative approach and reliance on self-reported data limiting generalizability, this study illustrates the psychological impacts of digital training and provides practical guidance for implementing the DLT framework. Future research should employ quantitative methods and larger samples to further validate and extend these results.

KEYWORDS

EFL teachers, chances, challenges, psychological transformation, Chinese teacher education institutions

1 Introduction

The digital age has brought about transformative changes to the global educational landscape (Zhang, 2023; Akram et al., 2022), and the benefits of digital technology have become increasingly apparent in EFL teaching and learning, especially during the COVID-19 pandemic (Li, 2022; Pratolo and Solikhati, 2020). The trend of merging digital technology with education is irreversible and ongoing (Bottino, 2020). This shift has redefined not only instructional practices but also the psychological roles and responsibilities of teachers in digitally mediated classrooms. Substantial research has accumulated on EFL teachers' DL. In particular, recent literature has incorporated wide-ranging themes related to EFL education, including the development of EFL teacher training programs, the integration of DL into EFL classrooms, and teacher-student interaction dynamics (Liu et al., 2024; Zhang, 2023).

Building on global developments, China has also advanced DL efforts in teacher education. Chinese teacher education institutions are higher education establishments in China that are responsible for training and developing teachers. They focus on equipping future and current teachers with the necessary skills, knowledge, and methodologies required for effective teaching. Specifically, these institutions equip EFL teachers with the skills they need for their professional careers and emphasize DL through classroom engagement and practical teaching (Wang and Xue, 2024).

However, opportunities and challenges coexist in digitally assisted EFL instruction. On the one hand, EFL teachers exhibit positive attitudes toward integrating DL into teaching (Feng, 2024). Technology facilitates the creation of engaging language learning environments (Rassaei, 2022), supported by research demonstrating benefits associated with integrating various technologies into education (Soyoof et al., 2023). Additionally, online learning has proven significant in enhancing language skills (Fathali and Okada, 2018). On the other hand, the effective use of technology in teaching requires more than mere technical skills (Hendriyani et al., 2020); it demands innovative pedagogy to boost student motivation and facilitate learning (Wang and Xue, 2024). Numerous studies have examined factors influencing DL among EFL teachers, highlighting the importance of expertise, methodologies, and emotional factors in ensuring teaching quality (Núñez-Canal et al., 2022). A key factor identified is insufficient DL, which may hinder EFL teachers' ability to impart essential skills to students (Pan et al., 2024). Inadequate training contributes significantly to this issue, leaving many teachers ill-prepared and uncertain about implementing educational technologies (Caena and Redecker, 2019).

To enhance DL in teachers within practical teaching scenarios, varied frameworks have been established at both international and national levels. These frameworks highlight the needs and standards of DL skills teachers require (Bilbao Aiastui et al., 2021; Crompton and Sykora, 2021). In the Chinese context, the DLT framework establishes benchmarks for teachers' DL and substantially influences pedagogical practices in higher education (Zou and Burhanudeen, 2023). However, given the recent release of the DLT framework, there remains a significant research gap regarding the psychological transformations experienced by EFL teachers in Chinese teacher education institutions. Despite recognition of the importance of teachers' mindset shifts in digital contexts, the notion of "psychological transformation" has not been clearly conceptualized or empirically linked to DL frameworks in current literature. In this study, psychological transformation refers to changes in teachers' beliefs, attitudes, self-efficacy, and instructional identities as they engage with digital teaching tools. Therefore, aligned with the DLT framework, this study seeks to bridge this gap by examining the psychological transformations of EFL teachers, thereby contributing to advancing their DL.

1. What are the perspectives of EFL teachers on DL in EFL classrooms?
2. What chances and challenges do EFL classrooms introduce in the digital era?
3. To what extent are EFL teachers familiar with the DLT framework?
4. How can EFL teachers enhance their DL according to the DLT-aligned training programs?

The rapid adoption of digital technologies in education has fundamentally altered teaching and learning paradigms, necessitating a shift in the psychological mindsets of EFL teachers (Sundarwati and Pahlevi, 2021; Syaniah and Fithriani, 2023). Therefore, this study will use in-depth interviews and reflective diaries to explore EFL teachers' psychological transformation. The qualitative findings of this study empower EFL teachers to improve their DL in conformance with the guidelines of the DLT framework. Understanding EFL teachers' psychological transformation concerning DL will assist policymakers in formulating effective guidelines and standards for digital education. While the DLT framework provides a structural foundation for digital competence, it does not explicitly address how such competencies are enacted in subject-specific pedagogy. To address this, the technological pedagogical content knowledge (TPACK) framework is considered in this study as a complementary lens, highlighting how technological, pedagogical, and content knowledge intersect in actual teaching practice (Luo and Zou, 2024). Therefore, this study also explores how EFL teachers are adapting to the digital environment and probes its impact on their TPACK, teaching methods, and implications for teacher training programs. These findings are beneficial for enhancing their DL and further exploring the psychological transformation of EFL teachers in Chinese teacher education institutions.

2 Literature review

2.1 Theoretical frameworks for EFL teacher DL

To understand how EFL teachers develop and apply DL, scholars have drawn upon a range of psychological theories and pedagogical knowledge models. These frameworks, although not exclusive to EFL, have proven effective in exploring digital competence and its pedagogical integration.

From a psychological perspective, theories are commonly categorized around motivation, engagement, and behavioral regulation:

- Motivation: The Self-Determination Theory (Ryan and Deci, 2020), Expectancy-Value Theory (Wigfield and Eccles, 2000), and Achievement Goal Theory (Senko et al., 2011) explain how intrinsic motivation and value beliefs influence teachers' willingness to adopt digital tools.
- Engagement: The Basic Psychological Needs Theory (Arifani et al., 2023) and Control-Value Theory (Pekrun et al., 2017) examine how digital environments satisfy teachers' psychological needs and emotions, shaping their engagement.
- Behavioral Regulation: Self-Efficacy Theory (Prior et al., 2016) highlights the role of perceived competence in determining whether teachers persist in using digital technologies under varying conditions.

The Will-Skill-Tool model of technology integration (Petko, 2012) synthesizes these elements, identifying three necessary factors: teachers' willingness (motivation), competence (skills), and access to digital tools and resources.

Complementing these psychological lenses is the TPACK framework, which addresses how teachers integrate digital tools within pedagogically sound instructional designs. TPACK emphasizes the dynamic interaction between technological knowledge, pedagogical knowledge, and subject content knowledge. This framework has been found to significantly predict actual classroom implementation of technology (Guo et al., 2024) and serves as a critical indicator of EFL teachers' readiness to deliver technology-enhanced instruction (Nazari et al., 2019; Su, 2023).

The transition from psychological readiness to pedagogical application underscores the importance of combining internal (motivation and beliefs) with external (instructional design and tool use) factors. TPACK thus complements psychological theories by offering a structural foundation for operationalizing DL in real classrooms.

Recent studies have affirmed the close relationship between DL and pedagogical effectiveness. For example, teachers with high TPACK levels report greater confidence in using digital tools and stronger links between technological competencies and instructional outcomes (Raygan and Moradkhani, 2022; Wu et al., 2024; Yao and Wang, 2024; Aslam et al., 2021).

2.2 Technology integration in EFL teaching and learning

DL encompasses a comprehensive set of skills, knowledge, and attitudes required to effectively and responsibly use digital tools in instructional and learning settings (UNESCO, 2018; Redecker and Punie, 2017; Crompton, 2017). For EFL teachers, developing DL is essential not only for leveraging technology to improve language proficiency, but also for ensuring its ethical and pedagogically meaningful use.

DL has transformed EFL instruction by enabling innovative teaching methods, fostering interaction, and supporting differentiated learning (Hijón-Niera et al., 2023). Technology-enriched environments—ranging from adaptive software and virtual labs to mobile applications—offer EFL learners' diverse opportunities to engage with authentic language input and develop communicative competence (Zhou and Hou, 2024; Brocca et al., 2024). When properly implemented, these tools support learner autonomy and flexible, needs-based learning pathways (Zhang and Zou, 2022; Wang, 2024).

Beyond customization, research also highlights digital tools' potential to boost cognitive functions such as reading comprehension and vocabulary retention (Kang and Kim, 2024), and to improve learners' motivation through immersive and interactive activities (Derakhshan and Ghiasvand, 2024). Carefully designed tasks that integrate technology can foster deeper engagement and enhance DL among students themselves (Khojah and Thomas, 2021).

However, the pedagogical benefits of digital technology should be critically examined alongside its limitations. Overreliance on technology may reduce teachers' initiative in lesson design and weaken learners' interpersonal communication if not balanced with offline interaction (Rahimi, 2024a; Hoang, 2024). Moreover, infrastructure disparities, insufficient training, and the digital divide remain pressing concerns, particularly in under-resourced regions (Yang and Wang, 2024). These challenges underscore the need for context-aware DL development that aligns technological integration with curriculum goals and equitable access.

In sum, digital technology presents immense opportunities for EFL instruction when integrated thoughtfully and critically. Teachers must continuously enhance their DL not only to stay abreast of evolving tools but also to make informed pedagogical decisions that prioritize learning outcomes over novelty (Zou and Wang, 2024).

2.3 Opportunities and challenges of digital EFL teaching

Digital EFL teaching has become an irreversible trend, presenting both transformative opportunities and pressing challenges (Gutiérrez-Ángel et al., 2022; Jia and Bava Harji, 2022; Manalao, 2022; Peng and Yu, 2022; Yang and Lou, 2024). The shift was accelerated during the COVID-19 pandemic, when DL became indispensable for sustaining educational continuity (Thaheem et al., 2022; Momdjian et al., 2024). Digitally integrated instruction offered flexible, scalable alternatives to traditional face-to-face formats, expanding educational access and innovation (Akram et al., 2021; Hollands and Escueta, 2020). Many EFL teachers have gained experience with digital tools, enriching classroom practices and promoting collaborative learning environments (Tejedor et al., 2020; Liu et al., 2024). When faced with an abrupt shift to online learning, both teachers and students adapted by mastering digital platforms and tools, expanding their technological repertoires (Khan and Abid, 2021; Huang, 2024).

2.3.1 Opportunities

Studies have revealed that teachers with advanced digital skills are more likely to leverage technology for diverse instructional purposes (Jang et al., 2021; Shadiev and Yang, 2020). Such competencies enable them to design creative tasks, differentiate instruction, and engage students in multimodal learning. Self-efficacy beliefs also strongly predict technology adoption (Aslam

et al., 2021). Enhanced DL has been associated with increased use of blended, flipped, and gamified instructional strategies (Abubakir and Alshaboul, 2023). In China, EFL teachers generally demonstrate high technological readiness due to low technophobia and strong TPACK foundations (Aslam et al., 2021). These positive factors collectively underscore the transformative potential of digital teaching to promote learner autonomy, curricular innovation, and student-centered pedagogy.

2.3.2 Challenges

Despite these advantages, various structural and pedagogical barriers hinder full integration. Key challenges include time constraints for lesson design and material creation (Karanjakwut and Sripicharn, 2024; Wang and Zou, 2021), limited access to stable digital infrastructure, and inconsistent institutional support (Soomro et al., 2020). Notably, many EFL teachers still lack confidence in producing effective technology-supported materials or aligning digital tools with specific language-learning outcomes (Yang and Wang, 2024). Furthermore, overreliance on digital tools without sufficient pedagogical adaptation can lead to superficial engagement, diminished student-teacher interaction, and increased screen fatigue.

To address these issues, targeted professional development, peer mentoring, and context-sensitive support systems are essential. Building a supportive digital ecosystem—where EFL teachers are empowered to experiment, reflect, and collaborate—can help overcome these limitations and maximize the affordances of digital EFL instruction.

2.4 Psychological impact of digitalization on EFL teachers

The increasing integration of digital tools in education has prompted scholars to examine their psychological implications for EFL teachers, particularly in terms of perceptions, attitudes, and self-efficacy (Dogan et al., 2023; Lee and Drajati, 2020). Positive attitudes have been repeatedly identified as critical enablers of successful technology use, influencing teachers' willingness to experiment with digital tools and innovative instructional practices (Zhang et al., 2024). Teachers who perceive digital tools as beneficial are more likely to explore and adopt them in classroom contexts.

Moreover, teachers' DL has been empirically linked to their instructional self-efficacy and confidence in facilitating technology-enhanced learning (Zhi et al., 2023). Several studies have observed that increased DL correlates with a greater sense of control and effectiveness when integrating digital tools (Abbasi et al., 2022; Chen, 2024). This relationship underscores a key psychological mechanism: enhanced DL often strengthens teachers' beliefs in their instructional competence.

In addition to self-efficacy, digitalization influences other psychological dimensions. EFL teachers frequently report that technology integration makes instruction more dynamic and interactive, contributing to improved student engagement and teaching satisfaction (Khatoon et al., 2024; Yan and Wang, 2022). Teachers also indicate that digital tools reduce cognitive load by simplifying instructional planning and delivery, particularly in blended and remote contexts (Rahimi, 2024b). For example, Chinese EFL teachers have observed that integrating digital resources fosters innovation, reduces classroom anxiety, and promotes professional growth (Shen and Guo, 2024). Furthermore, digital tools enhance time efficiency and reduce routine burdens, contributing to a more fulfilling teaching experience (Taguchi, 2024; Nguyen and Habók, 2024).

However, these psychological benefits are not universal. Studies have shown that technostress, digital fatigue, and inadequate institutional support can diminish motivation and hinder technology adoption (Yang and Wang, 2024; Nuroh et al., 2023). In resource-constrained settings, lack of infrastructure and insufficient training remain key barriers that negatively affect teachers' digital confidence and long-term engagement (Rezai et al., 2024; Song and Lee, 2024). Thus, while digitalization holds promise for enhancing EFL teachers' psychological well-being, it also introduces new stressors and disparities that must be addressed through sustained support and policy intervention.

2.5 Strategies to enhance EFL teachers' DL

Enhancing the DL of EFL teachers requires targeted, multifaceted strategies that address both general digital competencies and emerging tools such as AI-based applications. Drawing on recent studies, this section outlines four key approaches to support teacher development in digital environments.

First, ongoing professional development (PD) programs are essential for keeping teachers updated on emerging technologies and instructional design principles (Zhang and Zhang, 2024). Effective PD should move beyond technical training to integrate pedagogical knowledge, including strategies for lesson planning, interactive language activities, and classroom management in virtual or blended contexts (Esfandiari and Arefian, 2024; Hendriyani et al., 2020). These programs should also emphasize fostering learner autonomy, supporting cognitive and metacognitive growth, and creating inclusive learning environments (Han et al., 2024; Sumarno et al., 2023).

Second, the availability of adequate digital infrastructure remains foundational (Zhi et al., 2024; Yuan and Liu, 2025). Institutions must invest in both hardware and software, including AI-enhanced platforms (e.g., ChatGPT) for lesson planning and language skill development (Liu and Ma, 2023; Derakhshan and Ghiasvand, 2024). However, access alone is insufficient. Teachers require concrete training on aligning these tools with instructional goals. DL must be coupled with pedagogical intentionality to ensure technology supports meaningful learning (Abbasi et al., 2022; Raygan and Moradkhani, 2022).

Third, institutional support plays a pivotal role in promoting sustainable technology integration (Arifani et al., 2023; Guo et al., 2024). When school leaders prioritize PD and cultivate a culture of innovation, teachers become more confident in adopting digital tools (Audrin and Audrin, 2022; Sun and Shi, 2024). Supportive environments also reduce common barriers such as technostress, lack of time, and limited technical assistance (Yang and Wang, 2024; Koenig et al., 2024).

Finally, establishing peer-based professional learning communities (PLCs) can strengthen digital teaching practices. Collaborative networks encourage knowledge sharing, co-creation of digital content, and reflective dialog on technology use (Esfandiari and Arefian, 2024; Zhang et al., 2024). Teachers benefit from peer modeling, collective problem-solving, and ongoing feedback, which can drive innovation in lesson design and delivery (Yüce et al., 2024; Svihus, 2024). PLCs also foster a sense of shared responsibility for digital transformation, motivating teachers to apply digital tools creatively and effectively (Feng and Sumettikoon, 2024; Wang, 2022).

2.6 Cultural and contextual considerations

At the international level, widely recognized frameworks such as the UNESCO ICT Competency Framework for Teachers (UNESCO, 2018), the European Commission's DigCompEdu (Redecker and Punie, 2017), and the ISTE Standards (Crompton, 2017) guide teacher development in DL. These models emphasize a continuum of competencies, ranging from basic digital operations to advanced pedagogical applications, and are designed to meet global educational demands.

While these frameworks share common elements—such as ethical use of technology, instructional integration, and lifelong digital development—they differ in emphasis. For instance, DigCompEdu stresses competence progression across roles; ISTE focuses on creativity and collaboration; and UNESCO aligns with policy-level standards. By comparison, China's Digital Literacy of Teachers (DLT) framework emphasizes "awareness, ability, and responsibility" within the cultural and educational landscape of China, making it highly relevant for this study (Zou and Burhanudeen, 2023).

The DLT framework, issued by the Ministry of Education in 2022, specifies five first-level dimensions: digital awareness, technological knowledge and skills, application, social responsibility, and professional development. These are further divided into 13 second-level and 33 third-level indicators that detail the expectations for teacher DL. A summary of the first- and second-level dimensions is presented in Table 1, and the complete framework can be found in Appendix A.

Distinctively, the DLT framework promotes pedagogical innovation grounded in ethical responsibility. It advocates for the effective use of digital tools, such as intelligent scoring systems and dynamic question banks, to support personalized learning and informed instructional decision-making. It also guides teachers in identifying and solving classroom challenges through digital means.

Although substantial research has explored the digital transformation of EFL teaching (e.g., Prior et al., 2016; Zhi et al., 2024; Yüce et al., 2024; Lai et al., 2024; Yan and Wang, 2022), few studies have employed the DLT framework due to its recent introduction. This study fills that gap by using the DLT framework to examine EFL teachers' psychological transformation in Chinese teacher education institutions. In doing so, it contributes to a contextualized understanding of DL enhancement through both theoretical grounding and applied exploration.

3 Methodology

3.1 Participants

This study adopted a qualitative methodology to explore the integration of digital technology into EFL teaching in Chinese teacher education institutions. The participants comprised 18 EFL teachers with prior teaching experience, selected from six different institutions via purposive sampling. This method targeted individuals most likely to yield detailed and relevant insights (Campbell et al., 2020), ensuring a diverse range of perspectives due to their experiences and willingness to contribute. The selection was made strategically for three main reasons. First, each participating teacher had completed two rounds of digital education training, providing them with direct experience relevant to the study. Second, they were willing and available to share their experiences, which helped ensure the collection of rich, detailed data. Third, they represented a wide range of demographic characteristics, including gender, age, educational background, familiarity with digital technology, and digital teaching experience.

The purposive sampling process involved three steps: initial contact, where invitations were sent to six Chinese teacher education institutions to identify potential participants; screening for eligibility, where interested participants were evaluated based on their teaching experience, completion of digital training programs, and willingness to participate; and final selection, where 18 teachers were chosen to ensure a balanced demographic representation.

The research methods included in-depth interviews and analyses of teaching reflection diaries (Jarvis, 1992). Data collection was concluded in accordance with the principle of data saturation, which is defined as the point at which no new themes, codes, or insights emerge from continued analysis (Francis et al., 2010). Specifically, after coding the 16th interview and its corresponding 40 reflective diaries, no additional subthemes or novel categories were identified in the subsequent two interviews and diary entries. The thematic consistency and conceptual redundancy observed across these later data sources indicated that saturation had been reached. In total, 18 interviews were conducted and 42 teaching reflection diaries were analyzed, ensuring both the depth and breadth necessary to capture the psychological transformations experienced by EFL teachers during the DL training.

Table 2 presents an overview of the demographic characteristics of the study participants.

As shown in Table 2, which provides detailed information about each participant, pseudonyms were assigned to ensure confidentiality. To further protect participant privacy, the EFL teachers are referred to as T1 through T18 throughout the study. Some points must be noted at this juncture. First, previous technology applications signified the application of digital technology resources in educational instruction and included general or subject-specific software, smart educational platforms, intelligent assessment tools, and smart classrooms. Second, short-term workshops denote professional training sessions of varying durations, ranging from 2 h to half a day or 1 full day. Long-term workshops indicate professional training sessions lasting a few days. Finally, the abbreviation "N/A" suggests that the specific information is unavailable.

TABLE 1 The digital literacy of teachers (2022) framework.

Digital literacy of teachers	
First-level dimensions	Second-level dimensions
Digital awareness	Digital cognition Digital intention Digital willingness
Digital technology knowledge and skills	Digital technology knowledge Digital technology skills
Digital application	Digital instructional design Digital teaching implication Digital academic evaluation Digital collaborative education
Digital social responsibility	Legal, ethical, moral norms Digital security protection
Professional development	Digital learning and research Digital teaching research and innovation

Source: Ministry of Education of the People's Republic of China (2022).

Significant effort was dedicated to ensuring voluntary participation. Before commencing the study, ethical approval was obtained from the Chinese teacher education institutions with which the participants were affiliated to underscore the study's commitment to ethical protocols. Scrupulous attention was paid to ethical aspects, and signed consent forms were obtained from all participants. These forms comprehensively delineated the study objectives, noted the rights of participants to withdraw from the study, and provided the authors' contact details. All interviews and teaching reflection diaries were meticulously recorded with the explicit consent of the participating EFL teachers.

To further ensure participant confidentiality, specific measures were implemented throughout the data management process. All interview transcripts and reflection diaries were anonymized immediately upon collection by replacing identifiable information (such as participants' names and institution names) with assigned pseudonyms (T1–T18). Digital data was securely stored on encrypted, password-protected computers accessible only to the research team members directly involved in data analysis. Physical consent forms and any paper-based records were securely stored in a locked cabinet within a restricted-access office. Additionally, only aggregated findings without personally identifiable details were reported in any publications or presentations arising from this research.

3.2 Data collection and procedures

3.2.1 Preparation (the training program)

A comprehensive 60-h training program was developed in this study for EFL teachers and was structured according to the Chinese national DLT framework. This framework was specifically chosen because it represents the most up-to-date standards for teacher development related to DL, ensuring the training program aligns with current educational policies and practices in China.

As shown in Figure 1, the core training content includes three main components: digital technology knowledge and skills, digital application, and evaluation. These components were designed not only to improve technical competence but also to promote pedagogical insight and professional responsibility.

The first module spanned 30 h and focused on digital technology knowledge and skills. EFL teachers were equipped with advanced digital knowledge: mastering information retrieval, evaluating online sources, and using digital tools such as UMU and Unipus. The participating teachers also explored virtual simulation labs and learning management systems such as SuperStar, ZhiDao, and Rain Classroom. Further, they developed creative digital content, including videos and podcasts, and devised interactive activities tailored to language learning objectives. To address participants' varied DL levels, diagnostic self-assessments were administered before training. Based on the results, differentiated guidance was provided—novice users received scaffolded technical tutorials, while more experienced participants were assigned advanced integration tasks. Mixed-ability peer collaboration was also encouraged to promote reciprocal learning.

The second training module lasted 20 h and focused on digital applications in a well-equipped computer lab in which participants were grouped in teams of three. One member of each group had prior digital application experience, and the participants were required to implement their digital skills actively. In this module, the participants generated a variety of digital teaching materials involving predetermined educational topics, including infographics, mind maps, interactive videos, and animated presentations. This part of the program emphasized the integration of digital technology into EFL instruction. It also utilized the TPACK framework alongside innovative teaching methods such as blended learning and gamification. Participants were also required to conduct peer reviews of each group's teaching design, facilitating deeper engagement with pedagogical concepts. These peer reviews followed a rubric assessing both the technological functionality and pedagogical coherence of the digital materials.

The final 10-h module, while comparatively shorter, was intentionally designed to emphasize structured evaluation and reflective practice. The digital materials produced by participants were assessed for their pedagogical quality and impact by a panel of four instructional technology trainers and three trainees, who were

TABLE 2 Demographic information of the participating EFL teachers.

Participant	Age	Degree	Years of Teaching	Courses primarily taught	Prior digital technology application	Prior digital education training
T1	44	D.A. (Education)	18	College English I	Smart educational platforms	Short-term workshops
T2	43	M.A. (English)	17	Comprehensive English	Smart educational platforms	Long-term workshops
T3	29	M.A. (English)	3	Business English	Intelligent assessment tools	Short-term workshops
T4	38	M.A. (Education)	12	Curriculum Standard Interpretation	Smart classrooms	Short-term workshops
T5	27	M.A. (English)	1	English Writing	General software	N/A
T6	28	M.A. (English)	2	Critical Reading	General software	N/A
T7	43	D.A. (Linguistics)	18	English Linguistics	Smart educational platforms, intelligent assessment tools	Long-term workshops
T8	28	M.A. (English)	2	College English II	Smart educational platforms	Short-term workshops
T9	51	M.A. (Literature)	27	British and American Literature	General software	N/A
T10	30	M.A. (English)	3	English Interpretation	Smart educational platforms	Short-term workshops
T11	42	M.A. (English)	16	Advanced English	Smart educational platforms	Long-term workshops
T12	40	M.A. (English)	17	College English III	Subject-specific software, smart educational platforms	Short-term workshops
T13	34	M.A. (English)	4	Chinese–English Translation	Smart classrooms, intelligent assessment tools	Short-term workshops
T14	36	M.A. (English)	10	Cross-cultural Communication	Digital educational resources, intelligent assessment tools	Long-term workshops
T15	32	D.A. (Education)	6	Spoken English	Smart educational platforms, intelligent assessment tools	Short-term workshops
T6	35	D.A. (Education)	10	English Phonetics	Smart educational platforms, intelligent assessment tools	Short-term workshops
T17	41	M.A. (English)	15	College English IV	General software, subject-specific software; digital educational resources	Short-term workshops
T18	50	M.A. (Education)	27	Curriculum and Teaching Methodology	General software, subject-specific software, digital educational resources, smart educational platforms	Long-term workshops

presented with the produced materials and provided structured feedback to ensure the practical relevance and effectiveness of the training program. The evaluation was based on dual criteria: (1) technical quality (e.g., tool appropriateness, content clarity, interface design), and (2) pedagogical effectiveness (e.g., alignment with learning objectives, student engagement potential, and adaptability for real EFL classrooms). Participants also engaged in guided self-reflection sessions to analyze their growth and identify remaining gaps.

This feedback loop was crucial for the refinement of the skills of the participants and for fostering their PD. Moreover, it functioned pivotally to effectively integrate DL into the teaching practices of the EFL teachers and underscored the significance of continual assessment in the achievement of educational objectives.

Throughout the process, the program fostered PD by linking digital technology integration with broader educational goals and enhancing digital awareness among teachers. Ultimately, it aimed to actualize digital social responsibility in teachers, ensuring that they could use digital tools and were committed to using these technologies in ethically responsible ways. This holistic approach helped achieve a sustainable integration of DL into the professional teaching practices of the participants.

The effectiveness of the training was evaluated by comparing in-depth interview responses collected before and after the training, allowing for the identification of clear changes in teachers' perceptions, attitudes, and reported practices concerning DL. Additionally, reflective teaching diaries provided ongoing, real-time documentation of participants' growth, challenges, and evolving understanding of DL throughout the training process.

To strengthen reliability and objectivity, data triangulation between pre- and post-training interviews and reflective diaries was employed. Consistency and changes observed across

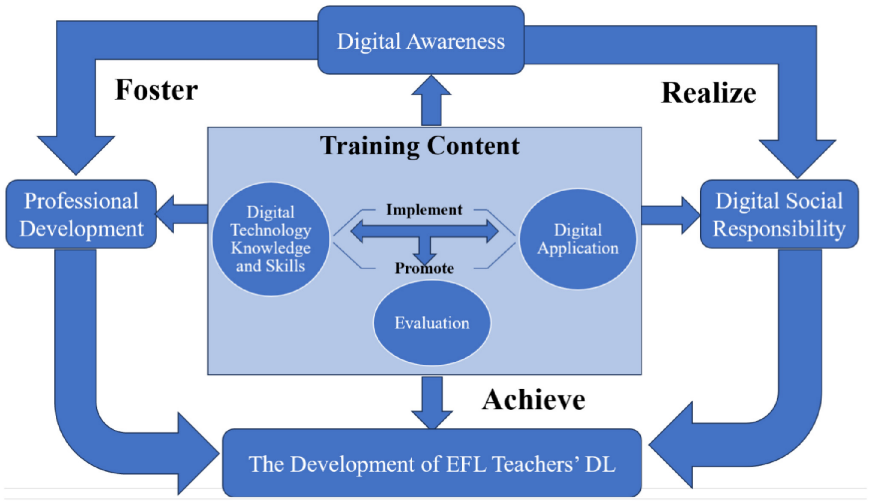

FIGURE 1
Study design.

multiple qualitative data points provided credible evidence of the training program's impact on teacher' psychological and pedagogical transformations related to DL. However, future research could benefit from incorporating objective performance-based evaluations, such as practical demonstrations or formal competency tests, to complement qualitative findings.

3.2.2 In-depth interview and reflective diary

In-depth interviews were conducted with the participating EFL teachers before and after the training program to glean real and insightful perspectives. Participants were also asked to maintain daily teaching reflection diaries throughout the training. After completing each training module, they were required to chronicle their experiences and reflect on how the module impacted their teaching beliefs, digital awareness, and instructional practices.

To guide the process, all participants received a reflection journal instruction sheet before the training began. This sheet provided prompts aligned with the DLT framework. Specifically, teachers were instructed to address the following aspects in each diary entry: the new digital knowledge or skills they acquired in the module; their plans for integrating this knowledge into their teaching practices; any challenges or changes they perceived during the training; and the module's influence on their professional development or sense of digital responsibility.

Participants were encouraged to submit one to five diary entries, and each entry was expected to touch upon at least one of the five DLT dimensions: digital awareness, digital technology knowledge and skills, digital application, digital social responsibility, and professional development. These diaries not only documented participants' learning journeys but also helped stimulate their metacognitive reflection and deeper engagement with digital transformation in education.

In summary, the teaching reflection diaries and in-depth interviews provided complementary qualitative data sources for understanding the EFL teachers' development of DL and psychological transformation. Each interview session lasted approximately 45 min and was conducted following detailed interview protocols (see Appendix B and C). All interviews were transcribed and translated by the corresponding author, and member checking was used to ensure the accuracy of interpretations.

3.2.3 Pilot study

A pilot interview refined questions and interview procedures and ensured clarity and effectiveness. Therefore, a pilot study was conducted with three EFL teachers with qualifications analogous to those of the primary participants. The pilot study revealed that the participants were unaware of the DLT framework or had read about it but could not recall the details. Therefore, the DLT framework was printed out for the participants so they could read and familiarize themselves with it during the formal interviews. Further refinements centered around the DLT framework were made to the questions designed for the in-depth interviews. Reviews of the reflection diaries presented in the pilot study disclosed that the entries were not generally relevant to DL.

Thus, the participants were requested to focus specifically on recording content related to DL in their reflection diaries. After completing the pilot study, the research framework–comprising in-depth interviews and reflection diaries—was formally implemented. Both instruments were conducted in Chinese, enabling participants to articulate their ideas more comfortably. All data were later translated into English for analysis.

3.3 Data analysis method

This study primarily employed in-depth interviews and reflective teaching diaries to explore the psychological transformations experienced by EFL teachers. All textual data were analyzed using MAXQDA 2020 software to support content visualization and basic statistical interpretation (Santos et al., 2021). Coding and thematic analysis were deployed to uncover the viewpoints of EFL teachers regarding DL and to ascertain their projections about applying the DL expertise acquired from the

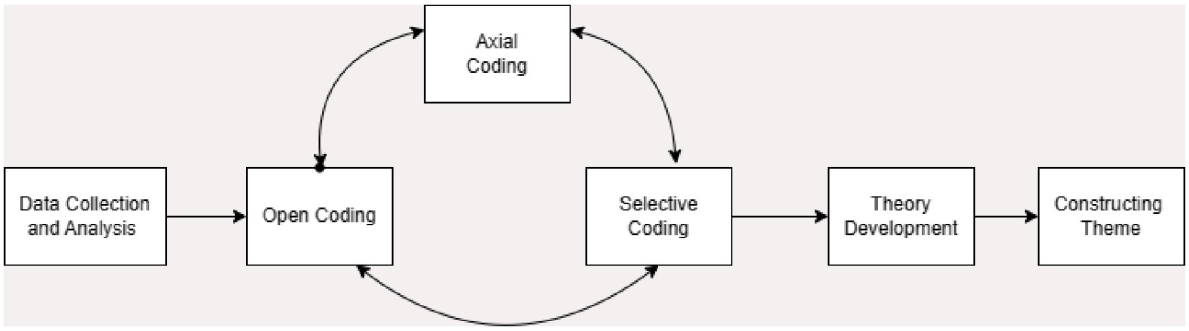

FIGURE 2
Non-linear process: qualitative research. Source: Williams and Moser (2019).

training program to their forthcoming professional progression. The thematic analysis delved into qualitative data to actively seek and interpret recurring patterns of meaning (themes) through analysis and identification (Fereday and Muir-Cochrane, 2006).

From Figure 2, it can be seen that the analysis followed an iterative three-stage coding process—open, axial, and selective coding—based on the procedures recommended by Williams and Moser (2019). First, during the open coding phase, the researchers identified initial codes by thoroughly reading the transcripts and diary entries, grouping data into broad categories reflecting participants' perspectives on DL. These preliminary codes were aligned with the five core dimensions of the DLT framework, ensuring theoretical consistency and facilitating cross-source comparison.

In the axial coding phase, relationships were established among the codes, and subthemes were refined. Codes that shared conceptual meaning were clustered, enabling the researchers to identify recurring teacher beliefs, practices, or challenges related to DL. This process helped reduce redundancy and construct meaningful thematic patterns from a large volume of qualitative data.

The final selective coding phase involved integrating themes into a coherent narrative, with one or two overarching themes per research question. These themes were compared with the DLT domains to ensure interpretive coherence. At this stage, key patterns related to psychological transformation and professional development in digital contexts were fully conceptualized.

To enhance trustworthiness, intercoder reliability was ensured. After the initial themes and codes were established, an independent researcher reviewed the full set of coded data over 3 months (Noble and Smith, 2015). This process yielded an intercoder agreement coefficient of 0.84, indicating high reliability (McHugh, 2012). As the principal researcher also served as both the designer and facilitator of the DLT-aligned training program, a reflexive stance was maintained throughout the analytical process. To minimize potential bias and enhance interpretive transparency, reflexive memos were written during and after each coding cycle to record decisions, personal assumptions, and evolving interpretations. This process allowed the researcher to remain critically aware of their dual role and its possible influence on data interpretation. Triangulation with an independent coder and member checking further mitigated this risk and ensured the analytical outcomes were grounded in participants' authentic voices rather than researcher preconceptions (Berger, 2015).

To better visualize the study design, a flowchart is provided in Figure 3, illustrating the sequential steps involved in the study, from participant recruitment to data analysis.

The collected data were analyzed using classification coding aligned with the DLT framework, focusing particularly on the psychological transformation experienced by teachers. The consistency between pre- and post-training interview data and the reflective diary entries was used as process-based evidence of cognitive and behavioral change, allowing for a rigorous evaluation of 60-h training effectiveness beyond subjective impressions.

4 Results

4.1 EFL Teachers' perceptions of digital literacy

This section explores how participating EFL teachers perceived DL in the EFL classroom, focusing not merely on perceived advantages or disadvantages, but on the evolving relationship between teachers and digital tools. The results reflect a psychological shift in how teachers view their roles, pedagogical approaches, and the affordances of digital environments. These changes can be interpreted through the lens of the DLT framework, particularly regarding the development of digital awareness and digital technology knowledge and skills.

4.1.1 Advantages of digital technology in the EFL classroom

Table 3 displays detailed information on the study's findings on the advantages of digital technology in EFL classrooms.

In terms of fostering EFL language immersion, one teacher noted the enhanced language exposure provided by digital tools:

> *"The digital age has had a significant impact on college English education in several ways. One of the most notable changes is the increased use of technology in language learning, such as online resources, video conferencing, mobile apps, and online teaching platforms. These digital resources have made language learning*

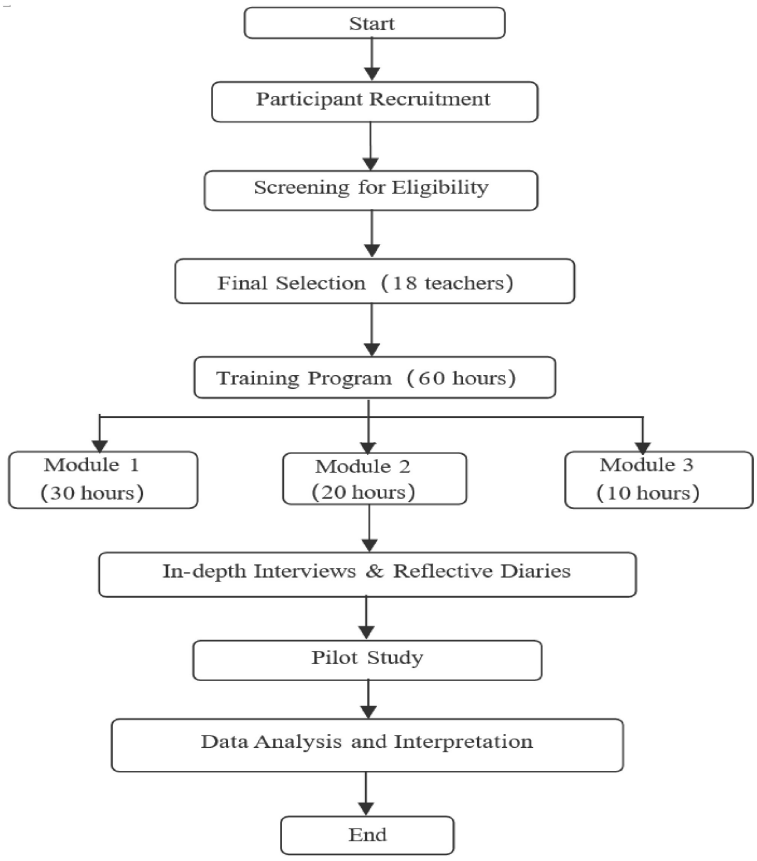

FIGURE 3
Flowchart of the study design.

> *more accessible, flexible, and personalized, allowing students to learn at their own pace and from anywhere." (T2, interview)*

This statement illustrates not only a recognition of digital affordances but also an emerging belief in their pedagogical value. Such awareness aligns with the "digital awareness" dimension of the DLT framework, in which teachers begin to conceptualize digital tools not as optional enhancements but as integral components of effective language education.

Another participant reflected on the practical advantages of digital materials:

> *"Some advantages of using digital technology in English education include the ability to easily access authentic language materials, such as news articles, blogs, and videos, giving learners more exposure to real-world language materials. Digital tools can also offer more interactive and engaging learning experiences, such as multimedia activities and short video production." (T13, interview)*

A reflective diary entry highlighted the role of AI tools:

> *"ChatGPT, the most updated artificial intelligence product, can deliver interactive language practice along with immediate feedback and correction." (T3, reflective diary)*

4.1.2 Disadvantages of digital technology in EFL classroom

Table 4 presents the themes, subthemes, and codes related to the disadvantages of digital technology in EFL classrooms.

Teachers expressed concerns about digital technology through interviews and reflective diaries. One teacher noted challenges with proficiency:

> *"I feel I lack the energy to master these complex digital platforms, what's more, I don't have the background of DL, and I find traditional teaching methods more straightforward and preferable." (T5, Interview)*

Another teacher highlighted risks of overreliance:

> *"However,. . .One is the risk of relying too heavily on technology and neglecting other important aspects of language learning, such as face-to-face communication and cultural immersion. Additionally, there may be concerns about the quality and accuracy of some online resources and the potential for distractions or information overload. Also. . .er. . .the use of digital technology may transcend the use of language, making language learning an adjunct to digital products." (T1, Reflective Diary)*

TABLE 3 Themes, subthemes, and codes for the advantages of digital technology in EFL classrooms.

Theme	Subtheme	Code	*f*
Fostering EFL language immersion	Enhanced language exposure	Providing access to authentic EFL materials to improve listening and cultural understanding	8
	Motivation through contextualized tools	Using EFL-specific apps to boost student motivation in language tasks	7
	Awareness of pedagogical shifts	Recognizing the need for digital integration to align with modern EFL curriculum reforms	7
Empowering EFL teaching precision	Targeted skill development	Employing digital tools for tailored language practice with immediate feedback	6
	Collaborative digital practices	Facilitating peer-to-peer language practice through digital platforms (e.g., online forums for speaking tasks)	8
Enhancing EFL instructional innovation	Interactive language tasks	Integrating multimedia tools (e.g., digital storytelling) to enhance EFL students' narrative writing and speaking skills	7
	Streamlined feedback processes	Using digital tools (e.g., UMU quizzes) to provide real-time feedback on EFL students' language output	5
	Innovative assessment methods	Designing diverse digital assessments to evaluate EFL competencies	8
	Contextualized digital training	Engaging in digital training to integrate digital tools into EFL lesson planning	6
Promoting EFL teacher growth	Peer-driven digital innovation	Sharing EFL-specific digital strategies through professional networks to enhance teaching practices	5
	Adaptability	Improving adaptability to new technologies	4
	Lifelong digital competence	Continuously updating digital skills to meet evolving EFL teaching demands	4
	Ethical tool integration	Promoting responsible use of digital tools in EFL classrooms (e.g., verifying source authenticity)	6
Cultivating ethical EFL digital practices	Ethical usage	Promoting ethical usage of digital tools	5
	Digital footprint awareness	Educating students on managing digital identities during EFL online discussions	3
	Responsible content creation	Guiding students to create ethical digital content (e.g., blogs, videos) for language practice	3

4.2 Challenges and chances in EFL classrooms in the digital era

4.2.1 Chances in EFL classrooms in the digital era

Table 5 elaborates on the chances that the participating EFL teachers associated with using digital technology in EFL classrooms.

Novice teacher T5 lacked extensive teaching experience and DL skills. He did not exhibit a superior understanding of digital chances during his first interview. However, after attending the training program, he spoke highly of digital education. For example, he praised Massive Open Online Courses (MOOC), which are free online courses that can facilitate blended learning and are available to all (Çakiroğlu et al., 2024). T4 also expressed his opinions in the following manner:

> "*Some digital platforms, such as Pigai, iWrite, iLearning2.0, Unipus, and IELTS Smart Learning, enhance convenience, involvement, and interaction in my teaching. These online platforms are not only used primarily by students to independently complete lower-level content, but they also serve to expand course content and facilitate assessments.*" (T4, interview)

4.2.2 Challenges in EFL classrooms in the digital era

Table 6 presents a detailed analysis of the challenges reported by the participating teachers in EFL classrooms.

T9, an instructor with a decade of teaching experience, echoed this sentiment:

> "(. . .) *online classes lack the face-to-face, on-site, and interactive aspects of regular classroom teaching, which may lead to reduced effectiveness. Additionally, digital education requires teachers to continuously learn about and utilize new educational platforms, software, etc., to enhance our ability to reform teaching and improve the effectiveness of using digital resources for teaching.*" *(T9, interview)*

T17, an EFL teacher who had also accrued 10 years of teaching experience, recorded her perspective in her teaching reflection diary.

TABLE 4 Themes, subthemes, and codes for the disadvantages of digital technology in EFL classrooms.

Theme	Subtheme	Code	*f*
Lacking EFL digital policy insight	Insufficient policy engagement	Lack of awareness of EFL-specific digital teaching policies (e.g., DLT guidelines)	7
	Limited digital integration insight	Utilizing inappropriately or without careful consideration	5
	Neglect of reflective practice	Failing to reflect on digital tool effectiveness in EFL lesson planning	3
Impeding EFL teaching proficiency	Skill deficiency in EFL tools	Lacking proficiency in EFL-specific platforms (e.g., Pigai, Unipus) for language instruction	10
	Overreliance on digital aids	Overusing digital tools, reducing focus on EFL oral and interpersonal skills	6
Undermining EFL instructional focus	Ineffective tool utilization	Inappropriate use of digital tools leading to reduced EFL student engagement	7
	Distraction from language goals	Prioritizing digital interfaces over core EFL skills (e.g., face-to-face communication)	
Hindering EFL teacher development	Inadequate targeted training	Limited access to digital training for EFL digital integration	4
	Overdependence on digital materials	Relying on pre-made digital resources, neglecting tailored EFL lesson preparation	8
	Lack of personalized engagement	Diminishing individualized EFL student interaction	7
Compromising EFL ethical standards	Misuse of digital resources	Using unverified or misleading digital content in EFL assignments	4
	Neglect of platform maintenance	Failing to update EFL digital platforms to ensure reliability	3

> *"I am faced with elevated expectations regarding their professional expertise, classroom management skills, and proficiency in utilizing new technologies. Additionally, students are expected to possess stronger independent learning capabilities and adeptness in utilizing new technology. Else. . .there is a risk of teachers resorting to blind usage of new technology without considering the unique characteristics of the teaching content and the specific needs of their students." (T17, reflective diary)*

A reflective diary entry emphasized the burden of managing digital platforms:

> *"Digital platforms are great, but managing them constantly is exhausting and stressful." (T12, reflective diary)*

4.3 Assessing familiarity with DLT

The first round of interview data revealed that 72% of the interviewed teachers had never heard of the DLT document before attending the training program. Further, 17% claimed a fundamental understanding of the framework but had neither studied it intensively nor applied it in their pedagogy. Only 11% of the teachers reported frequent reference to DLT in their teaching practices, highlighting a notable gap in awareness and usage. For instance, one participant expressed the following opinion:

> *"I know about DLT and hope there will be more training in the future to help us understand and apply these frameworks." (T11, Interview)*

Another participant offered a different perspective:

> *"Although I am aware of the existence of DLT, I feel that its content is not very closely related to my daily teaching, so I rarely consult it." (T9, Interview)*

Conversely, one participant reflected his proactive use and knowledge of DLT:

> *"I frequently use the guidelines from DLT to design my courses, especially the parts about how to effectively integrate digital tools, which has been very helpful in improving my teaching methods." (T14, Reflective diary)*

After completing the training program, the participants reported increased familiarity with DLT and its application in their teaching.

> *"Yes, I've started using the DLT guidelines in my English classes. Recently, I integrated a digital storytelling tool to enhance narrative writing skills. This tool aligns with the DLT's emphasis on using technology to boost creativity. The students were highly engaged and produced more detailed stories, which shows the practical benefits of these guidelines." (T18, Reflective diary)*
>
> *"I have found the DLT useful, especially for fostering collaborative learning. In a recent class, I used online discussion forums as recommended by the DLT, allowing students to debate topics online before discussing them in class. This not only prepared them better but also increased participation, particularly from students who are usually more reserved during in-person sessions." (T7, Reflective diary)*

TABLE 5 Themes, subthemes, and codes for opportunities of digital technology in EFL classrooms.

Theme	Subtheme	Code	*f*
Enriching EFL language resources	Expansion of teaching material	Using digital platforms to provide authentic language materials (e.g., videos, online articles) for listening and reading	8
	Motivation through EFL-specific tools	Leveraging apps to enhance student engagement in EFL writing and speaking tasks	7
	Awareness of digital curriculum needs	Recognizing the role of digital tools in aligning with EFL curriculum reforms	7
Advancing EFL teaching expertise	Proficiency in EFL platforms	Mastering EFL-specific tools for precise language instruction	9
	AI-enhanced language practice	Using AI tools to deliver personalized feedback on EFL pronunciation and grammar	
	Collaborative digital skills	Developing skills to facilitate peer-to-peer EFL practice via digital forums	3
Innovating EFL instructional practices	Interactive EFL tasks	Integrating multimedia tools to boost narrative writing and oral skills	6
	Real-time language feedback	Using digital platforms to provide instant feedback on EFL student output	7
	Innovative EFL assessments	Designing digital assessments (e.g., interactive speaking tasks, gamified quizzes) to evaluate language competencies	5
Fostering EFL teacher collaboration	Peer collaboration for innovation	Sharing EFL-specific digital strategies (e.g., flipped classroom models) through professional networks	8
	Continuous digital skill updating	Engaging in lifelong learning to adapt to evolving EFL digital teaching demands	5
Promoting ethical EFL digital engagement	Ethical resource selection	Evaluating and sharing authentic digital content for EFL assignments	6
	Responsible digital interaction	Guiding students to engage ethically in EFL online discussions	10
	Data-driven EFL insights	Using digital analytics to inform evidence-based EFL instructional decisions	6

TABLE 6 Themes, subthemes, and codes for challenges confronted in EFL classrooms.

Theme	Subthemes	Code	*f*
Lacking EFL digital pedagogical insight	Limited awareness of digital pedagogies	Insufficient understanding of how digital tools enhance EFL language instruction (e.g., listening, speaking)	7
	Resistance to digital reforms	Reluctance to adopt EFL-specific digital policies due to preference for traditional methods	9
Hindering EFL technical proficiency	Proficiency gaps in EFL tools	Lack of skills to use EFL-specific platforms (e.g., Unipus, Pigai) for language instruction	8
	Digital classroom management	Challenges in balancing technology use with traditional EFL teaching methods	7
	Tech proficiency struggles	Obstacles to meaningful and deep digital integration	6
Disrupting EFL instructional engagement	Ineffective digital integration	Reducing EFL student engagement in language tasks due to inappropriate use of digital tools	6
	Distraction from language objectives	Diverting attention from core EFL skills owing to overemphasis on digital interfaces	6
Impeding EFL teacher professional growth	Teaching methodology challenges	Difficulties in blending EFL online and offline learning environments	3
	Digital supervision	Struggle to enhance teaching efficacy through digital tools	2
Compromising EFL digital ethics	Ethical misuse of resources	Misusing digital content by students (e.g., plagiarizing in EFL writing assignments)	6
	Managing misinformation	Challenges in addressing inappropriate or misleading digital content in EFL classroom discussions	5

4.4 Professional development of EFL teachers to enhance their DL through DLT-aligned training programs

This section explores PD initiatives within DLT-aligned training programs aimed at enhancing teachers' DL. The study participants were categorized into three groups based on their years of teaching experience. Each group represented different levels of engagement with digital technology. Teachers with 0–10 years of experience were still building their academic foundations, those with 10–20 years had developed a robust teaching portfolio, and those with more than 20 years commanded extensive expertise and profoundly understood pedagogical complexities. This categorization aligns with prior research, which suggests that professional development strategies must be tailored to teachers' career stages to foster sustained growth (Kohnke et al., 2024a).

Table 7 details the PD of EFL teachers in efforts to enhance their DL according to the DLT framework.

The interviews revealed that EFL teachers across the three designated experience levels expressed distinct requirements for professional development in DL. For example, T15, who had accrued 4 years of teaching experience, emphasized the importance of acquiring and improving digital skills to effectively navigate and utilize digital tools and technologies:

> *"It is crucial to focus on improving our digital skills, ensuring we are equipped to effectively navigate and utilize digital tools and technologies." (T15, interview)*

T12 had garnered 17 years of teaching experience and focused more on the practical applications of digital technology in teaching:

> *"I aspire to engage in practical exercises that make the training process interesting and accessible. Overcoming apprehension and gaining hands-on experience will bolster my DL, allowing me to employ engaging and straightforward training methods." (T12, interview)*

T18 had amassed 26 years of teaching experience. He reflected on the need for more innovative approaches in digital collaborative education and academic evaluation. Digital collaborative education was defined in this study as the use of digital technologies to facilitate cooperative learning experiences among students. Thus, it could include shared projects or discussions in virtual spaces.

> *"There is little exploration in digital collaborative education, and my use of digital academic evaluation has not reached the level of wisdom. Moving forward, I will conduct more related academic research to enhance these areas." (T18, interview).*

5 Discussion

The thematic analysis of EFL teachers' interviews and reflective diaries (Sections 4.1–4.4) reveals a complex landscape of digital technology integration in EFL classrooms, encompassing advantages, disadvantages, opportunities, challenges, and professional development pathways. These findings highlight the transformative potential of DL training aligned with the DLT framework, while identifying barriers that require targeted interventions. This discussion synthesizes these results, interprets their significance within the DLT and TPACK frameworks, compares them with existing literature, and outlines implications for EFL teacher training and policy.

The advantages of digital technology (Section 4.1.1, Table 3) demonstrate its capacity to enhance EFL instruction through authentic materials, interactive tasks, and innovative assessments. The high frequency of "Enhanced Language Exposure" (f = 8) and "Collaborative Digital Practices" (f = 8) suggests that digital tools facilitate immersive and peer-driven learning environments, aligning with the DLT framework's digital awareness dimension (Mercader and Gairín, 2020). Similarly, opportunities (Section 4.2.1, Table 5) such as "Enriching EFL Language Resources" (f = 8) and "Responsible Digital Interaction" (f = 10) highlight the potential of platforms like Pigai and MOOCs to expand teaching materials and foster ethical engagement. This resonates with the TPACK framework's integration of technological, pedagogical, and content knowledge (Goodarzi and Rezai, 2024; Lee et al., 2024), corroborating findings that purposeful digital resource use enhances student engagement and diversifies learning pathways (Vnucko et al., 2024; Yeşilyurt and Vezne, 2023).

However, the disadvantages (Section 4.1.2, Table 4) and challenges (Section 4.2.2, Table 6) reveal significant barriers to effective digital integration. The prominence of "Skill Deficiency in EFL Tools" (f = 10) and "Resistance to Digital Reforms" (f = 9) indicates that many EFL teachers lack proficiency and confidence in platforms like Unipus, often preferring traditional methods (T5, T9). This aligns with the DLT framework's dimension of "Digital Technology Knowledge and Skills," particularly emphasizing that teachers require sufficient familiarity and operational proficiency with digital educational tools to effectively integrate them into their pedagogical practice. From a TPACK perspective, these findings illustrate notable deficits primarily in Technological Knowledge (TK) and Technological Pedagogical Knowledge (TPK), highlighting gaps between teachers' existing pedagogical competencies and their capacity to integrate new digital technologies effectively into their instructional approaches. These challenges also echo previous research findings regarding teacher resistance due to insufficient training and preparedness (Soomro et al., 2020; Yang and Wang, 2024). Additionally, "Distraction from Language Objectives" (f = 6) and "Ineffective Digital Integration" (f = 6) suggest that inappropriate tool use can undermine core EFL skills, such as face-to-face communication. This concern aligns with the TPACK framework, specifically the dimension of Technological Pedagogical Content Knowledge, which underscores the necessity of appropriately balancing technological tools with pedagogical goals and subject-specific teaching objectives to avoid technology overreliance (Weng and Chiu, 2023; Li and Yu, 2022).

The limited initial familiarity with the DLT framework (Section 4.3) contextualizes these barriers. With 72% of teachers initially unaware of DLT and only 11% frequently applying it, a significant policy awareness gap exists. Post-training, teachers like T7 and T18 reported increased use of DLT guidelines (e.g., digital storytelling, online forums), indicating that training can bridge this gap.

TABLE 7 Themes, subthemes, and codes found for enhancing the DL of EFL teachers through DLT.

Theme	Subtheme	Code	*f*
Enhancing EFL digital pedagogical awareness	Awareness of EFL digital pedagogies	Recognizing the role of DLT guidelines in enhancing EFL teaching with digital tools	5
	Motivation for digital adoption	Developing motivation to integrate digital tools into EFL instruction through DLT training	4
Building EFL technical expertise	Proficiency in EFL-specific tools	Mastering platforms like Pigai and Unipus for precise EFL language instruction	10
	AI tool integration skills	Learning to use AI tools for personalized EFL student feedback	6
Advancing EFL instructional design	EFL curriculum design	Incorporating digital platforms into EFL lesson planning for language skill development	7
	Innovative EFL assessments	Using digital tools for interactive EFL speaking and writing assessments	4
Promoting EFL teacher professional advancement	Career-stage-specific training	Tailoring DLT training to early career (foundational skills), mid-career (practical application), and advanced-career (research innovation) EFL teachers	2
	Peer-driven digital strategies	Sharing EFL-specific digital teaching strategies via professional networks	3
	Continuous digital competence	Engaging in lifelong learning to adapt to evolving EFL digital teaching demands	2
Fostering EFL digital ethical practices	Ethical tool use in EFL	Promoting ethical use of digital resources in EFL assignments	4
	Responsible digital collaboration	Guiding EFL teachers and students in ethical online collaboration (e.g., managing digital identities)	5

This supports the DLT framework's emphasis on professional development and aligns with studies suggesting that familiarity with technology standards enhances adoption (Fathi et al., 2021). However, the initial lack of awareness underscores the need for sustained institutional support (Mercader and Gairín, 2020; Martzoukou, 2021).

PD findings (Section 4.4, Table 7) position DLT-aligned training as a critical pathway for enhancing DL. The high frequency of "Proficiency in EFL-Specific Tools" (f = 10) and "EFL Curriculum Design" (f = 7) suggests that training equips teachers to master platforms and integrate them into lesson planning, addressing skill gaps identified in Table 4. The distinct needs across career stages—early-career teachers (e.g., T15) seeking foundational skills, mid-career teachers (e.g., T12) focusing on practical applications, and advanced-career teachers (e.g., T18) pursuing research innovation—highlight the value of tailored training (Kohnke et al., 2024b). The emphasis on "Responsible Digital Collaboration" (f = 5) reflects the DLT framework's Digital Social Responsibility dimension, emphasizing ethical practices in EFL contexts (Ding et al., 2024; Mudra, 2020).

These findings also align closely with the TPACK framework, particularly the enhancement of TK and TPK among early- and mid-career teachers, who reported increased confidence in using digital platforms for pedagogically sound lesson delivery. Furthermore, the ability of experienced teachers to innovate within curriculum design and digital assessment reflects growth in TPACK—a critical intersection where digital tools are not only used competently, but integrated meaningfully into content-specific pedagogy. By mapping the empirical outcomes onto both DLT and TPACK frameworks, this study demonstrates that effective professional development must target both the structural components of DL (as defined by DLT) and the integrative pedagogical capacities (as defined by TPACK) to support sustainable and context-aware digital teaching practices.

6 Conclusion

This study examines the transformative impact of digital technology on EFL teachers in Chinese teacher education institutions. The results highlight a significant psychological shift among teachers as they move from viewing digital tools as optional to essential components of their teaching practices. This shift was specifically observed in teachers' growing confidence and willingness to integrate digital tools into their classrooms, evidenced by the increased use of digital storytelling and interactive platforms like Pigai and Unipus for language tasks.

Challenges identified in the study include insufficient proficiency with certain EFL-specific digital tools, such as Pigai (f = 10) and Unipus (f = 9), which led to teacher resistance and a preference for traditional methods (T5, T9). Additionally, teachers faced overreliance on digital tools, which sometimes led to neglect of core language skills, particularly oral communication (f = 6). These challenges underscore the need for ongoing professional development and adequate training on how to use digital tools effectively without overshadowing essential language skills.

On the opportunity side, digital technology has significantly enhanced the personalized learning experiences of EFL students, with tools like MOOCs and online forums providing customized learning opportunities (f = 8). Teachers also reported increased

student engagement through interactive multimedia tools, which not only supported language skills development but also facilitated peer collaboration (f = 8). These findings align with the DLT framework's focus on digital awareness and pedagogical innovation, emphasizing the integrated use of digital technology to support diverse learning needs.

This study also fills an important gap in the literature by examining psychological transformations in EFL teachers as they navigate digital integration. Teachers' self-efficacy and confidence in using digital tools have grown, indicating a fundamental shift in how they view their teaching identity. DLT-aligned training played a pivotal role in enabling this transformation, suggesting that comprehensive training programs can effectively foster both technical skills and psychological adaptation to digital environments.

In conclusion, this study underscores the need for targeted, framework-aligned training that not only enhances technical skills but also facilitates the psychological adaptation of teachers to digital environments. Specifically, the study advocates for addressing teachers' resistance to technology and ensuring access to the necessary tools and professional support, which are critical for effective digital integration in EFL classrooms. By doing so, EFL teachers can embrace digital technology as an opportunity to enhance language teaching practices while fostering a responsible and ethical approach to digital education.

7 Implications and limitations

7.1 Theoretical implications

First, the findings of this study enhance the theoretical understanding of DL by emphasizing the specific competencies that are crucial for EFL teachers. These competencies include not only the technical aspects of DL but also pedagogical knowledge, particularly as it pertains to the integration of technology into language teaching. This insight can inform updates and refinements to the existing DLT framework, ensuring that it remains relevant and effective for teacher training in the digital era. Furthermore, this study provides a theoretical basis for integrating digital tools into EFL teaching, supporting the notion that DL extends beyond basic technological skills to include TPACK. This expanded perspective can influence future research in educational technology and curriculum design, suggesting that a deeper understanding of how to blend content, pedagogy, and technology is essential for effective language teaching.

7.2 Practical implications

On the practical side, the outcomes of this study can guide the development of targeted DL training programs that align with the DLT framework and cater to the specific needs of EFL teachers in various educational settings. The study revealed that many EFL teachers face skill deficiencies and resistance to digital reforms, highlighting the need for hands-on workshops, mentoring, and peer collaboration as central components of professional development. This recommendation is especially crucial for enhancing teacher engagement and fostering DL. Furthermore, the post-training increase in DLT familiarity demonstrates the importance of policy-driven training to enhance teachers' awareness, particularly in contexts where newly implemented national standards like DLT are still gaining traction. These training programs should also prioritize ongoing support, including time for training and access to reliable digital platforms, in order to alleviate teacher stress, especially regarding platform management (as noted by T12's concerns).

Moreover, AI application developers can contribute to improving EFL teaching by enhancing the usability and user-friendliness of AI tools designed specifically for language learning. Simplifying these tools would allow teachers to more easily adopt and integrate them into their classrooms, thus improving their teaching practices. For policymakers, the findings suggest that comprehensive policies supporting continuous PD should be created to equip teachers with the skills required for teaching in digital classrooms. Furthermore, curriculum designers should consider integrating comprehensive DL training into the standard curriculum for EFL teacher education to ensure teachers are adequately prepared to meet the evolving technological demands.

7.3 Limitations

Despite a rigorous selection process, some potential biases might arise from the purposive sampling method, especially if participants with more interest or experience in DL were overrepresented. The relatively small and homogeneous sample of 18 EFL teachers from six teacher education institutions may limit the transferability of these findings to broader educational contexts. Specifically, the limited sample may restrict the applicability of the findings to settings with different institutional supports, digital infrastructures, or educational policies. Additionally, the overrepresentation of participants already positively disposed toward DL might amplify the perceived benefits, potentially differing in environments where resistance to technology or resource constraints are more prominent. Therefore, the findings should be interpreted cautiously, recognizing that they reflect specific contextual conditions rather than generalizable outcomes. Future studies should consider using stratified or randomized sampling techniques and expanding the sample size to include participants from diverse institutional and geographical backgrounds. This would improve the generalizability and contextual applicability of the findings.

Another limitation lies in the context of the study. While digital infrastructure in many parts of China has improved, the realities of rural or under-resourced educational contexts may not be fully reflected in these findings. Teachers in rural areas often face significant challenges, including limited digital awareness, inadequate infrastructure, scarce professional training opportunities, and potentially lower institutional support (Li, 2024). Consequently, the positive psychological transformations observed in this study might be less prominent or manifest differently in rural settings, where teachers could experience greater resistance, anxiety, or frustration regarding digital integration. Future research is necessary to specifically investigate these contexts, exploring how rural EFL teachers' psychological

experiences and DL development differ and identifying targeted interventions, resources, and policy measures that can effectively support their unique needs.

This study also relied on self-reported data from interviews and teaching reflection diaries, which may not fully capture the complexities of teachers' interactions with digital technologies or their institutional contexts. Mixed-methods research, incorporating both qualitative and quantitative data, could be used in future studies to enhance data triangulation and analytical depth.

Lastly, while this study did not examine the relationship between teaching experience and DL, previous studies have shown that such factors may influence teachers' engagement with digital education (Fernández-Batanero et al., 2022; Negrín-Medina et al., 2022). Future research could explore this relationship further to inform more differentiated professional development programs.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found in the article/Supplementary material.

Ethics statement

This study involved teacher interviews and was approved by the Academic Ethics Committee of Qilu Normal University with approval number [xsllsc202401]. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

ZD: Conceptualization, Data curation, Formal Analysis, Software, Visualization, Writing – original draft. SX: Investigation, Supervision, Writing – review & editing.

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Conflict of interest

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2025.1606932/full#supplementary-material

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