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EFL Teachers' Digital Competence and Cognitive Skills: Evidence from Teachers' Perceptions and Experiences

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ABSTRACT

This study examined the relationship between EFL teachers' digital competence and cognitive skills while exploring teachers' perceptions of digital competence in teaching. A convergent parallel mixed-methods design was employed. Quantitative data were collected from 78 EFL teachers using the Subjective Self-Assessment Instrument (SSAI) and the Cognitive Abilities Questionnaire (CAQ), while qualitative data were obtained through semi-structured interviews with 30 teachers and analyzed using reflexive thematic analysis. Results revealed a significant positive relationship between teachers' self-assessed digital competence and self-reported cognitive skills. Teachers viewed digital competence as a multidimensional capability integrating technological expertise, pedagogical judgment, learner-centered instruction, professional development, and ethical responsibility. Reported barriers included inadequate infrastructure, limited professional development, implementation challenges, teacher diversity, and digital assessment issues. The findings highlight digital competence as a cognitive and pedagogical capability, underscoring the importance of integrating cognitive skill development into teacher education and ongoing professional learning.

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Introduction

Rapid advances in digital technologies have deeply reshaped education, influencing instructional practices, learning experiences, assessment methods, and teachers' professional development across educational settings. Within EFL education, digital technologies have expanded opportunities for authentic language input, intercultural interaction, collaborative learning, learner autonomy, and more personalized instructional approaches (Shadiev & Yang, 2020). Recent developments in artificial intelligence (AI), adaptive learning technologies, and learning analytics have further enhanced technology-supported language education while simultaneously increasing the professional demands placed on teachers (Holmes et al., 2022). Therefore, EFL teachers are now expected to move beyond the basic use of digital tools by critically evaluating their pedagogical effectiveness, addressing ethical considerations, and adapting instruction to continuously changing evolving learning contexts.

Consequently, digital competence has emerged as one of the crucial professional capabilities required of contemporary educators. Rather than representing a purely technical skill, digital competence is broadly understood as a construct encompassing multiple dimensions that combines technological knowledge, pedagogical expertise, awareness of ethical issues, critical thinking, and the meaningful integration of digital technologies into teaching and learning (Falloon, 2020; Redecker, 2017). The DigCompEdu and TPACK frameworks likewise emphasize that meaningful technology integration depends on the interaction of technology proficiency, pedagogical expertise, and broader professional competencies (Mishra & Koehler, 2006; Redecker, 2017). Recent research further highlights the multifaceted nature of digital competence and the importance of more comprehensive approaches to its conceptualization and assessment across educational contexts (Claro et al., 2024).

Digital competence plays a particularly significant role in EFL education because effective language instruction depends heavily on communication, collaboration, interaction, and access to authentic language resources. Digital technologies facilitate learner-centered instruction by enabling the use of digital resources, online learning platforms, and AI-assisted language learning tools that enrich students' learning experiences (Shadiev & Yang, 2020; Tai et al., 2022). Nevertheless, the educational value of these technologies depends primarily on teachers' ability to integrate them into sound pedagogical practice rather than simply possessing the technical skills to operate them.

Earlier studies have indicated that educators' digital competence is shaped by multiple elements, such as access to digital resources, organizational support, professional learning opportunities, pedagogical beliefs, and the culture of educational organizations (Caena & Redecker, 2019; Esteve et al., 2020; Tiar et al., 2025; Tondeur, van Braak, et al., 2017a). While contextual factors remain important, teachers' cognitive processes also shape the effectiveness of technology use in instructional practice. Teacher cognition refers to the knowledge, beliefs, and thought processes underlying instructional decision (Borg, 2015). Within technology-enhanced learning environments, teachers are required to evaluate digital resources, address instructional challenges, monitor student engagement, and continually adjust their teaching strategies to meet changing classroom needs (Diamond, 2013; Friedman & Miyake, 2017;

Instefjord & Munthe, 2017). Metacognitive regulation further support reflection and informed pedagogical decision-making (Stanton et al., 2021).

Despite these theoretical connections, empirical evidence explaining the relationship between digital competence and cognitive skills remains limited, particularly in EFL contexts. Therefore, the present convergent parallel mixed-methods study investigates whether cognitive skills predict Iranian EFL teachers' digital competence while also exploring their perceptions of digital competence, effective digital practices, and challenges related to technology integration. Drawing on qualitative and quantitative findings, this research adds to research on educational technology, teacher cognition, and language teacher education by emphasizing the cognitive dimensions of effective technology-enhanced teaching.

A brief note of previous works and theoretical framework

Digital Competence in EFL Education

Digital competence encompasses considerably more than the technical use of digital tools; it also requires teachers to make informed pedagogical decisions when working in technology-supported learning environments. Teachers demonstrate digital competence by critically evaluating digital resources, modifying instructional approaches to meet learning needs, responding to emerging challenges, and reflecting on their professional practice (Falloon, 2020; Redecker, 2017). According to the DigCompEdu and TPACK frameworks, effective technology integration results from combining technological knowledge with pedagogical expertise and sound professional judgment (Mishra & Koehler, 2006; Redecker, 2017). These cognitive and reflective demands indicate that digital competence is supported by several cognitive abilities, including planning, problem-solving, cognitive flexibility, and metacognitive regulation. Recent evidence has also emphasized the multidimensional nature of digital competence and advocated more consistent approaches to its definition and assessment across diverse educational settings (Claro et al., 2024).

Within EFL contexts, digital competence is especially significant because language learning relies heavily on communication, interaction, collaboration, and exposure to authentic language input. When used purposefully, digital technologies facilitate multimedia instruction, collaborative online learning, automated feedback, and AI-assisted language learning activities (Shadiev & Yang, 2020; Tai et al., 2022). Their effectiveness in educational settings however, is largely determined by teachers' capacity to align digital tools with learning objectives, students' needs, and appropriate assessment practices.

Earlier studies have shown that teachers' digital capability is influenced by various contextual factors, including institutional support, professional learning opportunities, availability to technological tools, pedagogical beliefs, and the broader organizational culture (Caena & Redecker, 2019; Esteve et al., 2020; Tondeur, van Braak, et al., 2017a; Tseng & Lin, 2026). Although digital technologies are becoming increasingly common in education, teachers still face barriers associated with technological infrastructure, unequal access, insufficient professional training, and ethical concerns, including privacy and the responsible use of technology (Gillespie, 2020; Holmes et al., 2022; Zhao et al., 2021).

Accordingly, digital competence is best understood as a professional capability that emerges from the combination of teachers' individual expertise and the educational contexts in where they teach.

Teacher Cognition and Cognitive Skills

Teacher cognition helps explain how teachers make instructional decisions in increasingly complex educational settings (Dizajtekie & Nemati, in press). Borg (2015) defines teacher cognition as the knowledge, beliefs, judgments, and thinking that shape professional practice. In language teaching, teachers interpret classroom events, monitor learners' progress, evaluate instruction, and adapt practice through cognitive skills.

Technology-enhanced teaching has intensified these cognitive demands. Besides managing content and pedagogy, teachers coordinate digital platforms, evaluate resources, monitor engagement, solve problems, and adapt instruction in real time (Instefjord & Munthe, 2017; Runge et al., 2023). Executive Function Theory emphasizes the role of working memory, selective attention, decision-making, planning, inhibitory control, and cognitive flexibility in managing complex tasks and adapting to dynamic learning environments (Diamond, 2013; Friedman & Miyake, 2017). These abilities are especially important in EFL classrooms, where teachers manage language interaction, instructional goals, learner participation, and digital tools simultaneously.

Metacognitive processes also support effective teaching by helping teachers monitor, evaluate, and regulate instructional decisions, including the pedagogical use of digital technologies (Jalili Kia & Soodman Afshar, in press; Stanton et al., 2021). Therefore, digital competence involves a technological knowledge as well as higher-order cognitive processes supporting professional judgment, problem-solving, adaptation, and reflection.

Connecting Digital Competence and Cognitive Skills

In technology-enhanced EFL teaching, teachers must select relevant information, coordinate instructional goals with digital resources, respond to disruptions, and adjust activities to learners' needs. Executive cognitive functions like inhibition can support attention to task-relevant information and resistance to distraction, working memory can support the coordination of concurrent demands, and cognitive flexibility can support switching between instructional approaches (Diamond, 2013; Friedman & Miyake, 2017). Planning and decision-making may help teachers translate these cognitive resources into purposeful technology use, while metacognitive regulation supports monitoring and evaluating instructional choices (Stanton et al., 2021). These mechanisms provide a theoretical rationale for expecting an association; they do not establish that cognitive skills cause digital competence or that technology use improves cognition.

This account complements frameworks that conceptualize teacher digital competence as the integration of technological knowledge, pedagogical judgment, and reflective professional practice. TPACK emphasizes the interaction of technological, pedagogical, and content knowledge (Mishra & Koehler, 2006), while DigCompEdu situates technology use within broader professional and instructional activities (Redecker, 2017). The teacher digital competency framework likewise extends beyond

operational skills to include pedagogical and professional considerations (Falloon, 2020). Together, these perspectives suggest that cognitive resources may support the enactment of digital competence, while institutional conditions and opportunities for professional learning also shape its development (Caena & Redecker, 2019). Accordingly, the present study examines an association between self-reported constructs rather than testing a causal mechanism. These theoretical considerations motivate the present investigation of the association between Iranian EFL teachers' self-reported cognitive skills and self-assessed digital competence, alongside their accounts of digital teaching practices and challenges.

The Present Study

Previous research indicates that competence has evolved from a technology-focused concept into a multidimensional capability involving pedagogical knowledge, ethical awareness, reflection, and higher-order cognitive processes (Caena & Redecker, 2019; Falloon, 2020; Redecker, 2017). Similarly, teacher cognition research identifies planning, decision-making, cognitive flexibility, working memory, and metacognitive regulation as essential for effective teaching (Borg, 2003, 2006, 2015; Diamond, 2013; Friedman & Miyake, 2017). These perspectives provide a rationale for examining how self-reported cognitive skills relate to self-assessed digital competence in the Iranian EFL teaching context.

Previous studies have primarily observed digital competence in relation to institutional support, technological resources, professional development, pedagogical beliefs, and technology acceptance (Caena & Redecker, 2019; Claro et al., 2024; Tiar et al., 2025; Tondeur, van Braak, et al., 2017b; Zhao et al., 2021). By contrast, teacher cognition research has focused on beliefs, professional knowledge, reflection, and instructional decision-making (Borg, 2003, 2015), giving limited attention to digital competence as an outcome of these cognitive processes. This gap is mostly evident in EFL settings, where teachers simultaneously manage language instruction, learner interaction, digital resources, assessment, and evolving technologies.

Methodologically, previous research has mainly used either quantitative approaches to digital competence (e.g., Claro et al., 2024; Runge et al., 2023; Zhao et al., 2021) or qualitative investigations of technology integration (e.g., Instefjord & Munthe, 2017; Tondeur, van Braak, et al., 2017a). Only limited research has used a mixed-methods approach to observe the relationship between cognitive skills, digital competence and teachers' perceptions of its role and challenges.

Accordingly, this study investigates digital competence among Iranian EFL teachers through these research questions:

1. To what extent are EFL teachers' levels of digital competence associated with their cognitive skills?
2. How do EFL teachers perceive the role of digital competence in supporting their teaching experiences?
3. What challenges do EFL teachers encounter in developing and implementing digital competence in language teaching?

Method

A convergent parallel mixed-methods design was employed (Creswell & Plano Clark, 2018) to investigate the relationship between EFL teachers' digital competence and cognitive skills while exploring their perceptions and challenges in technology integration. A mixed-methods approach was appropriate because it combined quantitative evidence with qualitative insights into teachers' experiences. Collecting both datasets concurrently enabled integration of statistical findings with participants' perspectives, providing a broader understanding of digital competence (Johnson et al., 2007)

Participants

Participants were 78 Iranian EFL teachers from universities, secondary schools, and private language institutes. Convenience sampling through professional teaching networks and online communities was used. Participation was voluntary and offered no financial or academic incentives.

The sample comprised 51 female (65.4%) and 27 male (34.6%) teachers. Twenty-five participants (32.1%) taught at university, whereas 53 (67.9%) worked in schools or private language institutes. Participants represented diverse professional backgrounds and experience across educational settings (see Table 1).

Table 1. Demographic Characteristics of the Participants (N = 78)

Variable	Category	Female (n = 51)	Male (n = 27)
Affiliation	University professor	16	9
	School/Institute teacher	35	18
Age	Under 20	3	0
	21–30 years	12	5
	31–40 years	21	15
	41–50 years	15	7
Teaching Experience	Less than 5 years	11	4
	6–10 years	16	8
	More than 11 years	24	15
Educational Degree	B.A.	17	8
	M.A.	22	11
	PhD	12	8

Materials and Instruments

Before data collection, three subject specialists evaluated all instruments to confirm content validity, consistent with recommendations for instrument validation (Lynn, 1986; Polit & Beck, 2006). Their feedback resulted in minor wording revisions that improved clarity while preserving the original constructs.

Subjective Self-Assessment Instrument (SSAI)

Digital competence was assessed using the original 45-item Subjective Self-Assessment Instrument (SSAI) Maderick's (2013). The instrument comprises eight digital topic sections: Technology Awareness, General Computer Literacy, E-mail/Internet, Presentation Software, Spreadsheets, Word Processing, Web 2.0 Applications, and Databases. Responses were redorded on a five-point Likert scale

ranging from 1 (strongly disagree) to 5 (strongly agree). Negatively worded items were reverse-scored so that higher scores indicated greater self-assessed digital competence. In the present study, the total score demonstrated high internal consistency (Cronbach's $\alpha = .96$), while subscale coefficients ranged from .61 to .93, indicating variability in internal consistency and warranting caution when interpreting findings involving subscales with comparatively low coefficients.

Cognitive Abilities Questionnaire (CAQ)

Teachers' cognitive skills were measured with the Cognitive Abilities Questionnaire (CAQ; Nejati, 2013). The 30-item CAQ measures seven dimensions: Memory, Inhibitory Control and Selective Attention, Decision Making, Planning, Sustained Attention, Social Cognition, and Cognitive Flexibility. Items were rated on a five-point Likert scale (1=Almost Never, 5=Almost Always), with higher scores reflecting stronger cognitive abilities.

The original validation reported satisfactory reliability (Cronbach's $\alpha = .83$). Internal consistency was found to be excellent (Cronbach's $\alpha = .92$), with subscale coefficients ranging from .61 to .90.

Semi-Structured Interview Protocol

Semi-structured interviews were conducted to collect qualitative data exploring teachers' perceptions of digital competence and challenges in technology integration. Based on the literature, the interview protocol comprised two questions designed to address the qualitative study objectives:

1. How do you define digital competence in the context of language teaching?
2. What challenges have you encountered when integrating digital competence into your teaching practices?

The semi-structured format encouraged detailed responses while allowing follow-up questions.

The interview material analyzed for this article also included responses concerning effective digital competences and the perceived influence of digital competence on cognitive skills. These accounts provided qualitative context for interpreting the quantitative associations; perceived cognitive development was distinguished from measured change.

Data Collection Procedure

The data collection phase lasted three months during the 2025 academic year. Before data collection, ethical approval was secured, and participants received information about the study purpose, the voluntary nature of participation, and the privacy of their responses. Electronic informed consent was obtained before questionnaires and interviews.

Following the convergent parallel design, quantitative and qualitative evidence was gathered concurrently. The quantitative phase used an online survey created with Google Forms. The questionnaire included the Subjective Self-Assessment Instrument (SSAI), and the Cognitive Abilities Questionnaire (CAQ). The survey link was shared through professional networks, institutional channels, social media, and personal contacts. After excluding incomplete responses, 78 questionnaires were included in the quantitative analysis.

Qualitative data were obtained through semi-structured interviews involving 30 volunteers who agreed to participate. Interviews were conducted online and lasted approximately 20–40 minutes. After obtaining participants' consent, all interviews were recorded in audio format and transcribed word by word, and anonymized before analysis. Collecting both datasets concurrently enabled examination of the relationship between digital competence, cognitive skills, and teachers' perceptions.

Data Analysis

Quantitative Data Analysis

Quantitative data were processed with IBM SPSS Statistics (version 27). Before conducting inferential analyses, the dataset was examined for missing data, outliers, and statistical assumptions. Means, standard deviations, frequencies, and percentages summarized demographic characteristics and questionnaire responses. Cronbach's alpha coefficient was used to evaluate the internal consistency of the SSAI and CAQ.

To examine the first research question, Pearson correlation was employed to evaluate the association between teachers' digital competence and cognitive skills. Correlation coefficients were interpreted based on Cohen's (1988) guidelines. Simple linear regression examined whether cognitive skills predicted digital competence. Regression assumptions were assessed beforehand. Statistical significance was set at $p < .05$.

Additional correlation analyses examined the association between overall digital competence and the seven cognitive domains described for CAQ: memory, inhibitory control and selective attention, decision making, planning, sustained attention, social cognition, and cognitive flexibility.

Qualitative Data Analysis

Interview data were examined through Reflexive Thematic Analysis (RTA) guided by Braun and Clarke's (2006, 2022) six-phase framework. The rigor of the qualitative analysis was established according to Lincoln and Guba's (1985) framework of credibility, dependability, confirmability, and transferability. Credibility was strengthened through peer debriefing and prolonged engagement with the data, whereas dependability and confirmability were reinforced through structured records of coding decisions and analytic memos. Transferability was supported by comprehensive descriptions of participants and research procedures.

Results

Preliminary Analyses

Before performing inferential analyses, the dataset was evaluated for completeness, normality, and internal consistency. Reverse scoring was applied to negatively worded items to ensure that higher scores uniformly reflected greater levels of digital competence and stronger cognitive skills. One cognitive-skills response without a corresponding digital competence response was excluded, resulting in a final matched sample of 78 participants.

The internal consistency of the research instruments was evaluated through Cronbach's alpha. The total scores of the Subjective Self-Assessment Instrument (SSAI) and the Cognitive Abilities

Questionnaire (CAQ) demonstrated high internal consistency, with coefficients of .96 and .92, respectively. Subscale coefficients ranged from .61 to .93, indicating variability in internal consistency, with some subscales showing comparatively low coefficients. Findings involving these subscales should therefore be interpreted cautiously.

Table 2 provides descriptive statistics for the primary study variables. Participants demonstrated moderate to high levels of digital competence ($M = 3.43$, $SD = 0.62$) and cognitive skills ($M = 3.95$, $SD = 0.53$). Inspection of skewness, kurtosis, and normality statistics indicated that both variables met the assumptions for parametric analyses. Furthermore, Shapiro–Wilk tests and visual inspection of histograms suggested that the assumptions required for correlational and regression analyses were satisfactorily met.

Table 2. Descriptive Statistics for the Main Variables (N = 78)

Variable	Mean	SD	Minimum	Maximum
Digital Competence	3.43	0.62	1.98	4.82
Cognitive Skills	3.95	0.53	2.83	5.00

Quantitative Findings

Relationship between Digital Competence and Cognitive Skills

To investigate the first research question, Pearson’s product–moment correlation was employed to assess the association between EFL teachers’ digital competence and cognitive skills. The findings indicated a statistically significant positive association between the two variables, $r(76) = .679$, $p < .001$.

According to Cohen’s (1988) guidelines, this coefficient represents a strong positive relationship, indicating that higher levels of cognitive skills were associated with higher levels of digital competence. The coefficient of determination ($r^2 = .461$) further indicated that approximately 46.1% of the variance in digital competence was associated with teachers’ cognitive skills. The results indicate that teachers reporting higher levels of cognitive skills also reported higher levels of digital competence.

Table 3. Pearson Correlation between Digital Competence and Cognitive Skills

Variables	1	2
1. Digital Competence	—	.679***
2. Cognitive Skills	.679***	—

Note. *** $p < .001$.

Relationships between Digital Competence and Individual Cognitive Domains

To further examine the relationship between digital competence and specific cognitive abilities, additional correlations were conducted between overall digital competence and each CAQ cognitive domain.

The analyses identified significant positive correlations between digital competence and several cognitive domains. The strongest correlations were found for decision making ($r = .646, p < .001$), social cognition/cognitive flexibility ($r = .633, p < .001$), planning ($r = .613, p < .001$), inhibitory control ($r = .554, p < .001$), and selective attention ($r = .550, p < .001$).

In contrast, memory ($r = .155, p = .175$) and sustained attention ($r = .218, p = .056$) showed no significant relationships with digital competence.

Table 4. Correlations between Digital Competence and Cognitive Skill Domains

Cognitive Domain	r	p
Memory	.155	.175
Inhibitory Control	.554	< .001
Selective Attention	.550	< .001
Decision Making	.646	< .001
Planning	.613	< .001
Sustained Attention	.218	.056
Social Cognition/Cognitive Flexibility	.633	< .001

Relationships between Digital Competence Dimensions and Overall Cognitive Skills

Additional analyses examined the associations between overall cognitive skills and individual dimensions of digital competence. Significant positive correlations were found across all dimensions.

The strongest relationship was observed for General Computer Literacy ($r = .703, p < .001$), followed by Technology Awareness ($r = .649, p < .001$), E-mail/Internet ($r = .612, p < .001$), Word Processing ($r = .559, p < .001$), Presentation Software ($r = .545, p < .001$), Spreadsheets ($r = .459, p < .001$), Databases ($r = .426, p < .001$), and Web 2.0 Applications ($r = .246, p = .030$). These results suggest that cognitive skills are broadly associated with digital competence rather than with a single technological domain.

Table 5. Correlations between Digital Competence Dimensions and Overall Cognitive Skills

Digital Competence Dimension	r	p
Technology Awareness	.649	< .001
General Computer Literacy	.703	< .001
E-mail/Internet	.612	< .001
Presentation Software	.545	< .001
Spreadsheets	.459	< .001
Word Processing	.559	< .001
Web 2.0 Applications	.246	.030
Databases	.426	< .001

Predictive Role of Cognitive Skills in Digital Competence

To examine whether cognitive skills predict digital competence, a standard linear regression analysis was conducted using cognitive skills as the predictor, with digital competence serving as the outcome. The regression analysis yielded statistically significant results, $F(1, 76) = 64.87, p < .001$, confirming cognitive skills positively and significantly predicted digital competence. The model explained for 46.1% of the variance in digital competence ($R^2 = .461$).

Regression coefficients further showed that cognitive skills significantly and positively predicted digital competence ($B = 0.792, \beta = .679, t(76) = 8.054, p < .001$). Higher cognitive skill levels were associated with higher digital competence scores. Overall, the findings confirmed that cognitive skills significantly predicted teachers' digital competence.

Table 6. Model Summary for Linear Regression Predicting Digital Competence

R	R ²	Adjusted R ²	Std. Error
.679	.461	.453	.46

Table 7. Regression Coefficients Predicting Digital Competence

Predictor	B	SE	β	t	p
Constant	0.299	0.392	—	0.763	.448
Cognitive Skills	0.792	0.098	.679	8.054	< .001

Qualitative Findings

Using reflexive thematic analysis, four overarching themes and fourteen subthemes emerged, reflecting teachers' conceptualizations of digital competence, effective digital practices, implementation challenges, and the perceived link between digital competence and cognitive skills.

Theme 1: Conceptualizing Digital Competence in Language Teaching

Technological–Pedagogical Integration

Teachers defined digital competence as the purposeful integration of technical skills and pedagogical judgment. One participant described it as “being able to use technology effectively to support learning, communication, and assessment.” The emphasis was on choosing resources for instructional purposes rather than technical proficiency alone.

Learner-Centered and Interactive Learning

Participants associated digital competence with interactive, collaborative, and learner-centered instruction. Their accounts emphasized learner autonomy, authentic communication, and opportunities to extend language practice beyond the classroom.

Professional Growth and Adaptability

Teachers viewed digital competence as an evolving capability requiring continuous professional learning. One participant described it as “a dynamic skill that evolves as technologies change,” highlighting the need to update technological and pedagogical knowledge.

Ethical and Responsible Technology Use

Ethical responsibility was integral to participants' definitions. Their accounts emphasized online safety, digital citizenship, and “data privacy awareness,” positioning responsible technology use as part of professional competence.

Theme 2: Effective Digital Competences for Language Teaching

Communication and Collaboration

Communication platforms and collaborative tools were valued for supporting interaction and cooperative learning. One teacher explained that “language learning depends heavily on interaction and meaningful communication.”

Multimedia Integration and Content Creation

Participants valued videos, audio, presentations, and interactive content for engaging learners and supporting comprehension. One teacher reported that multimedia resources “greatly enhance language comprehension and retention.”

Assessment and Pedagogical Decision-Making

Teachers prioritized aligning tools and assessments with instructional goals. As one participant stated, “technology should always serve instructional goals rather than drive them.” Digital competence therefore involved pedagogical selection as well as tool operation.

Theme 3: Challenges in Developing and Implementing Digital Competence**Infrastructure and Technological Constraints**

Unstable internet, software failures, limited device access, and insufficient institutional resources disrupted technology use. One teacher identified “unstable internet access, which can interrupt online activities and waste class time” as a key challenge.

Learner-Related Challenges

Differences in learners’ digital skills, confidence, and engagement complicated implementation. Participants also reported distraction when students focused on devices rather than learning objectives.

Professional Development Demands

Learning new applications and keeping pace with technological change required time and effort. Teachers reported limited training opportunities, identifying continuing professional support as a condition for effective integration.

Assessment, Ethics, and Classroom Management

Participants raised concerns about fair online assessment, academic integrity, privacy, and classroom management. These challenges required teachers to coordinate technological choices with pedagogical and ethical responsibilities.

Theme 4: Perceived Connections between Digital Competence and Cognitive Skills**Problem-Solving and Decision-Making**

Teachers perceived technology use as supporting problem-solving and instructional decisions. One participant reported becoming “better at solving problems and finding quick solutions during class.” These statements describe perceived benefits rather than demonstrated cognitive improvement.

Creativity and Critical Thinking

Participants associated digital teaching with creative lesson design and critical evaluation of resources. Their accounts linked experimentation with new instructional approaches to more deliberate resource selection.

Adaptability and Lifelong Learning

Teachers described becoming more adaptable, reflective, and willing to learn. One participant stated, “I have learned to adapt more quickly to changes and new situations.”

Together, these accounts illustrate perceived connections between digital competence and cognitive skills. Table 8 summarizes the four themes and fourteen subthemes in thirteen rows, with Creativity and Critical Thinking and Adaptability and Lifelong Learning grouped in one summary row.

Table 8. Selected Qualitative Themes, Subthemes, and Representative Quotations

Theme	Subtheme	Representative quotation
Conceptualizing Digital Competence	Technological– Pedagogical Integration	“Being able to use technology effectively to support learning, communication, and assessment...”
	Learner-Centered Learning	“Create interactive and student-centered learning experiences”
	Professional Growth & Adaptability	“Requires teachers to continuously update their technological and pedagogical knowledge...”
	Ethical & Responsible Use	“Ethical and safety considerations... data privacy awareness...”
Effective Digital Competences	Communication & Collaboration	“Language learning depends heavily on interaction and meaningful communication...”
	Multimedia & Content Creation	“videos, audio clips, and images greatly enhance language comprehension and retention”
	Pedagogical Decision-Making	“Technology should always serve instructional goals rather than drive them...”
Challenges	Infrastructure Constraints	“Unstable internet access can interrupt online activities...”
	Learner Differences	“Students have different levels of digital skills...”
	Professional Development	“Learning new applications requires time and effort...”
	Assessment & Ethics	“Assessing students fairly in online environments can be difficult...”
Perceived Connections between Digital Competence and Cognitive Skills	Problem-Solving & Decision-Making	“Better at solving problems and finding quick solutions...”
	Creativity & Adaptability	“It has improved my creativity because I am always looking for new ways to present lessons.”

The qualitative findings contextualize the quantitative association in three ways. Teachers' emphasis on resource selection and instructional decisions is consistent with the reported links involving planning and decision making. Their accounts of creativity and adaptability offer a perceived connection between technology use and cognitive engagement, without establishing its direction. Reported infrastructural, learner-related, and training barriers further indicate that cognitive resources operate within conditions that can support or constrain digital practice.

Discussion

This study investigated the association between EFL teachers' digital competence and cognitive skills using a mixed-methods approach with a convergent parallel design. By integrating quantitative and qualitative evidence, it aimed to offer a broader understanding of the relationship between cognitive abilities and digital competence, as well as teachers' perceptions of technology in contemporary language education. The findings revealed a robust positive association between digital competence and cognitive skills, while the qualitative data showed that teachers perceive digital competence as a multifaceted professional capability encompassing technological, instructional, cognitive, and ethical aspects. The findings contribute to the growing body of research emphasizing the importance of cognitive processes in technology-enhanced teaching and learning.

Digital Competence and Cognitive Skills as Interconnected Professional Capabilities

The first outcome of this study revealed a statistically significant positive association between digital competence and cognitive skills. The quantitative results indicated that cognitive skills were strongly associated with digital competence and accounted for a considerable proportion of the variance. This result supports that teacher possessing stronger cognitive abilities are more likely to demonstrate greater of digital competence.

This result aligns with theoretical frameworks that view digital competence as more than technical knowledge and encompassing higher-order cognitive processes required for information management, problem-solving, critical evaluation, and decision-making (Ferrari, 2013; Redecker, 2017). The effective use of digital technologies requires teachers to evaluate information critically, select appropriate technological tools, monitor instructional effectiveness, and adapt to rapidly changing technological environments. Such activities inherently involve cognitive processes that support planning, reasoning, and self-regulation.

The finding can be considered alongside research highlighting the relationship between teachers' pedagogical beliefs and their use of technology in education (Tondeur, van Braak, et al., 2017). Although that research did not directly examine cognitive skills, it provides a complementary perspective on the role of teachers' beliefs in technology integration. In the present study, teachers reporting stronger cognitive skills also reported higher digital competence.

Importantly, the qualitative findings reinforced this interpretation. Participants consistently described digital competence as requiring problem-solving, critical thinking, adaptability, and reflective decision-making. Teachers frequently emphasized that technology integration involves strategic choices rather

than routine technical operations. The integration of quantitative and qualitative results therefore supports the argument that digital competence and cognitive skills constitute closely interconnected dimensions of teacher professionalism. Overall, these findings extend existing conceptualizations of teacher digital competence by indicating that digital competence represents more than a technological or pedagogical capability, instead functioning as a cognitively mediated professional capability. In other words, technological knowledge alone appears insufficient for effective technology integration unless supported by the cognitive processes that enable teachers to evaluate instructional situations, regulate professional actions, solve emerging problems, and make pedagogically appropriate decisions.

The Central Role of Executive Functions in Technology Integration

A particularly noteworthy finding concerned the differential relationships between specific cognitive domains and digital competence. Among the cognitive dimensions examined, decision-making, planning, inhibitory control, selective attention, and cognitive flexibility demonstrated the strongest associations with digital competence. By contrast, memory and sustained attention did not exhibit statistically significant relationships.

These results indicate that executive functions may have a particularly influential role in teachers' digital competence. Executive functions encompass higher-order cognitive abilities that guide goal-directed behavior, including planning, cognitive flexibility, self-monitoring, inhibition, and decision-making (Diamond, 2013). These findings further suggest that executive functions may represent an underlying cognitive mechanism through which teachers transform technological knowledge into effective classroom practice. Consequently, executive functioning may help explain why teachers with comparable technological knowledge often demonstrate different levels of digital competence in authentic educational settings. Technology-enhanced teaching environments often require teachers to process multiple sources of information simultaneously, make rapid instructional decisions, adapt to technological disruptions, and regulate classroom interactions across both physical and digital spaces.

The qualitative findings provide further support for this interpretation. Participants repeatedly reported that digital teaching environments require rapid adaptation, flexible thinking, and continuous problem-solving. Teachers described technology integration as an intellectually demanding activity that necessitates evaluating digital resources, adjusting instructional strategies, and responding effectively to unexpected situations. Such descriptions closely correspond to executive-function processes identified in cognitive psychology literature.

The prominence of executive-function-related domains may also help explain why digital competence is frequently associated with successful technology integration in educational settings. Teachers who possess stronger executive functions may be better able to manage the cognitive complexity inherent in digital learning environments and therefore demonstrate greater confidence and effectiveness when using educational technologies.

Teachers' Conceptualizations of Digital Competence Beyond Technical Skills

The qualitative findings indicated that teachers conceptualize digital competence as a multidimensional professional capability rather than a purely technical skill. Participants associated digital competence with pedagogical reasoning, learner-centered instruction, professional development, and ethical responsibility.

This finding supports contemporary perspectives on teacher digital competence, which emphasize the integration of technological, pedagogical, professional, and ethical dimensions (Caena & Redecker, 2019; Falloon, 2020; Redecker, 2017). Similarly, Cabero-Almenara et al. (2020) argue that digitally competent teachers require not only technological knowledge but also pedagogical judgement, critical reflection, and continuous professional learning. Participants' emphasis on aligning technology use with instructional goals and learner needs reflects a shift from technology-centered approaches toward meaningful pedagogical integration.

Teachers also highlighted learner engagement, collaboration, communication, personalization, and learner autonomy as important outcomes of digital competence. These perspectives align with constructivist and sociocultural approaches to language education, which encourage interaction and active learner engagement.

Overall, the results indicate that EFL teachers regard digital competence as an educational construct requiring the combination of digital technologies with instructional purposes and reflective practice (Cabero-Almenara et al., 2020; Caena & Redecker, 2019).

Contextual and Institutional Constraints on Digital Competence Development

Although teachers expressed positive perceptions of digital competence, they also identified several barriers affecting its development and implementation, including limited technological infrastructure, unequal access to digital resources, professional development needs, classroom management challenges, and ethical concerns.

These findings align with earlier research indicating that technology integration is shaped by both individual and contextual factors (Ertmer & Ottenbreit-Leftwich, 2013; Tondeur, van Braak, et al., 2017a). Even digitally competent teachers may face challenges when institutional support, resources, and infrastructure are insufficient.

Professional development emerged as a particularly important concern. Participants emphasized the need for continuous training opportunities that strengthen both technical competencies and pedagogical use of technology. Furthermore, the growing influence of AI broadens the scope of digital competence through encouraging teachers to critically assess AI-generated content, protect learner privacy, and make ethical pedagogical decisions. This highlights the importance of integrating AI literacy and ethical awareness into teacher professional learning (Holmes et al., 2022; Tai et al., 2022; Tseng & Lin, 2026; UNESCO, 2023).

The findings further indicate that digital competence should be understood as emerging from interactions among cognitive capabilities, professional knowledge, technological resources, and

institutional conditions. Therefore, enhancing teachers' digital competence requires both individual development and systemic support.

The Reciprocal Relationship between Digital Competence and Cognitive Development

A key finding from this study relates to the perceived association between digital competence and cognitive skills. While the quantitative results indicated that cognitive skills predict digital competence, the qualitative findings suggested that teachers perceive this relationship as reciprocal.

Participants reported that engagement with digital technologies enhanced their problem-solving, creativity, adaptability, critical thinking, information management, and decision-making abilities. They viewed technology-rich teaching environments as contexts that encourage continuous learning, reflection, and professional growth.

These views align with a theoretical perspective proposing that technology use can involve cognitively demanding activities requiring information evaluation, strategic decision-making, problem-solving, and adaptation to new situations. Such repeated engagement may contribute to the development of cognitive skills over time.

Although causal relationships cannot be established, the findings suggest a mutually reinforcing relationship between digital competence and cognitive functioning. Cognitive skills may facilitate the development of digital competence, while sustained engagement with digital technologies may further support cognitive growth. Thus, digital competence can be viewed as an evolving professional capability influenced by the interaction of cognitive resources, pedagogical reasoning, reflective practice, and contextual experiences. This perspective extends current understandings of digital competence by highlighting its cognitive foundations and providing a basis for future research on the mechanisms underlying technology-enhanced teaching.

Conclusion

This study examined the association between digital competence and cognitive skills among Iranian EFL teachers while also exploring their views on digital competence, effective digital teaching practices, and challenges related to technology integration. The quantitative results demonstrated a robust and statistically significant association between digital competence and cognitive skills, with cognitive skills emerging as a substantial predictor of teachers' digital capability. The qualitative findings complemented these results by demonstrating that teachers viewed digital competence as a broad construct integrating technological proficiency, pedagogical expertise, learner-centered instruction, professional adaptability, and ethical responsibility. Participants further identified communication, collaboration, multimedia integration, assessment literacy, and informed pedagogical decision-making as essential elements of effective technology-enhanced teaching. At the same time, the findings indicated that technology integration is shaped by multiple contextual factors, including limitations in technological infrastructure, unequal access to digital resources, learner-related challenges, ongoing professional development needs, assessment concerns, and ethical issues. Overall, the results indicate that successful technology

integration relies on both teachers' individual competencies and supportive institutional environments as well as adequate educational resources.

One of the principal contributions of this study is its demonstration that digital competence is closely associated with higher-order cognitive skills. By combining quantitative and qualitative findings, the results indicate that effective technology integration extends beyond technical knowledge and requires high-order cognitive skills including critical thinking, problem-solving, decision-making, and cognitive flexibility. These competencies enable teachers to evaluate digital resources, make informed instructional decisions, and adapt effectively to rapidly evolving educational environments. Accordingly, the findings provide valuable guidance for teacher education and educational policymaking. Teacher preparation and continuing professional learning initiatives should adopt a comprehensive approach that promotes not only technological proficiency but also the cognitive and reflective capacities required for effective technology integration. Likewise, educational institutions should provide reliable technological infrastructure, access to digital resources, and continuous technical and pedagogical support, while policymakers should recognize digital competence as a comprehensive professional capability that combines technological, pedagogical, cognitive, and ethical dimensions.

Several study limitations should be acknowledged when interpreting the findings. Reliance on convenience sampling and self-reported measures may limit the generalizability and accuracy of the findings, whereas the study's cross-sectional nature precludes causal conclusions. In addition, the qualitative findings were based on self-reported experiences rather than direct observations, and this investigation was conducted within the Iranian EFL context, which may reduce the transferability of these findings across other educational settings. Some subscales yielded comparatively low internal consistency coefficients, warranting caution when interpreting domain-specific associations. Future studies should therefore employ longitudinal and cross-cultural research designs to examine the developmental relationship between cognitive skills and digital competence across diverse educational contexts. Studies incorporating objective performance-based assessments, classroom observations, and intervention designs would provide a deeper insight into how cognitive skills contribute to teachers' effective use of digital technologies. Such research will further advance knowledge of technology-enhanced language teaching and support evidence-informed teacher education and professional learning programs.

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