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Research Article

The influence of learning experience and social-cognitive factors on teachers' digital instructional practice

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Teachers' digital instructional practices are central to system-level digital transformation; however, the developmental mechanisms linking teachers' earlier learning experiences to classroom practice remain insufficiently specified. Grounded in Social Cognitive Career Theory, this study examined how teachers' pre-service digital learning experiences and social-cognitive factors influence digital instructional practices through key pathways of influence. The study utilized data from the 2024 Teaching and Learning International Survey, published in October 2025, which included responses from 6,222 teachers across 374 schools in Korea. After confirming the validity and reliability of the research variables, structural equation modeling was conducted using AMOS software to verify the hypotheses and analyze the significance of indirect effects. Results indicated that teachers' pre-service digital learning experiences significantly predicted digital instructional practices through the social-cognitive factors of teaching efficacy and perceived professional learning needs. Furthermore, the study found that the Social Cognitive Career Theory framework—comprising social learning experience, self-efficacy, and cognitive interest—is well suited to identifying teachers' digital professional characteristics. Notably, increases in digital teaching efficacy developed during in-service teaching positions were strongly associated with improvements in digital instructional practices. In conclusion, this study underscores the need for systematic support measures to empower pre-service teachers in developing digital competence. Additionally, it proposes support strategies, such as informal learning, to enable in-service teachers to autonomously enhance their digital teaching efficacy when they perceive a need.

Keywords: Digital instructional practice; Digital learning experience; Digital teaching efficacy; Professional learning needs; Social cognitive career theory

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1. Introduction

The digital transformation in education refers to the integration of digital technology into all aspects of teaching, learning, and institutional management. This was particularly accelerated by the COVID-19 pandemic, which reshaped the educational system worldwide. Digital transformation in education entails more than introducing devices into the classroom. A common thread across studies is that digital transformation is a process of restructuring the entire educational ecosystem, encompassing curriculum, teaching and learning methods, assessment, administration and governance, and school culture (Farias-Gaytan et al., 2023; Wang et al., 2024).

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Digital technologies are evaluated as means to enhance learner engagement and motivation, self-regulated learning, collaboration, and creativity; to provide learning opportunities that transcend the constraints of time and space; and to ensure educational continuity even in times of crisis (Timotheou et al., 2023). In this sense, digital transformation offers new learning opportunities in the education system and has the potential to reshape educational goals and content (Oliveira & de Souza, 2022; Wang et al., 2024). Building on this view, digital transformation is increasingly described as a long-term, systemic process in which schools redesign instructional routines and organizational arrangements so that digital tools serve pedagogical purposes rather than merely digitizing existing practices.

Despite these potentials, digital transformation in practice presents multiple challenges. At the core of these challenges, many institutions pursue "digitalization" by merely migrating existing activities to digital media, rather than truly transforming them (Farias-Gaytan et al., 2023). While equipment distribution, platform adoption, and online content development are central to policy and research, curriculum restructuring, assessment changes, organizational culture and governance restructuring, and teacher roles tend to lag behind (Bui & Nguyen, 2023; Farias-Gaytan et al., 2023). Moreover, transformation is difficult to evaluate through short-term, easily quantifiable indicators, because its educational value depends on deeper, qualitative shifts such as teachers' pedagogical decision-making and students' learning experiences (Oliveira & de Souza, 2022). As a result, while strategic documents and visions may be impressive, the leadership, accountability structures, incentive systems, and collaboration mechanisms that support implementation are absent, creating a strategy-to-implementation gap (Bui & Nguyen, 2023).

This distinction also implies a measurement challenge. Indicators such as device availability or platform adoption capture inputs and exposure, but they do not necessarily reflect changes in instructional quality or teachers' pedagogical decision-making (Timotheou et al., 2023; Oliveira & de Souza, 2022). Accordingly, the educational value of transformation depends less on the presence of technology itself and more on how teachers and schools integrate digital tools into curriculum enactment, assessment, and classroom interaction (Oliveira & de Souza, 2022; Wang et al., 2024). Thus, to narrow the strategy-to-implementation gap, research needs to explain the human and professional mechanisms through which policies and resources translate into sustained classroom practice.

In this regard, teachers stand at the intersection of these possibilities and challenges, serving as translators, transforming digital strategy documents into classroom activities and interactions, and as mediators, reinterpreting the direction and meaning of technology adoption from an educational perspective (Bui & Nguyen, 2023). Various studies highlight teachers' digital teaching competence as a key driver of digital transformation. Teachers' competence is not simply the skill of handling specific software, but rather closer to the professional practical knowledge that determines which technology to use, when, and how, for which educational purpose (Timotheou et al., 2023). Therefore, to turn digital transformation into educational innovation, the key question should not be "How much technology has been introduced?" but rather "What expertise can teachers have to lead this change?" Digital transformation cannot be pursued by bypassing teachers; it can succeed only when the education system is transformed in ways that center on teachers.

This key concept is also reflected in Korean society. Recent national strategies for digital transformation in education have placed particular emphasis on teachers as the driving force of transformation. Beginning with the Comprehensive Plan for Digital Talent Development in 2022 (Government of the Republic of Korea, 2022), which aims to cultivate one million digital talents, policies have been implemented since 2023, including the Digital-Based Education Innovation Plan (Ministry of Education, 2023a), the EdTech Promotion Plan (Ministry of Education, 2023b), and the Digital-Based Education Innovation Capacity Building Support Plan (Ministry of Education, 2024) to strengthen teacher capabilities. Most recently, the AI for All policy (Ministry of Education, 2025) has further underscored the expectation that all teachers will be able to integrate AI and digital

tools into their practice. The policy discourse on digital transformation in Korea has intersected with growing concerns about digital distraction and students' digital well-being. This tension illustrates that digital transformation is not a unidirectional expansion of technology use; rather, it requires schools to negotiate when, how, and for what purposes digital tools should be integrated.

Nevertheless, empirical evidence remains fragmented regarding how teachers develop and sustain digital instructional practices over the career continuum. Existing studies often examine isolated factors (e.g., training participation, technology acceptance, or self-efficacy) without clarifying how learning experiences become internal resources that shape practice. In Korea, this question is especially salient because policy expectations for digital and AI-integrated teaching are rising rapidly.

In response to these global and national changes, it is necessary to examine whether digital education policies are being implemented in ways that systematically support teacher professionalism across the career continuum, from pre-service preparation to in-service development. Social Cognitive Career Theory [SCCT] offers a suitable framework for this purpose, as it theorizes that contextual learning experiences shape self-efficacy and need-related perceptions, which in turn influence behavioral enactment and performance outcomes (Lent & Brown, 2019; Lent et al., 1994). Accordingly, this study aims to develop and test a structural pathway model explaining teachers' digital instructional practices. Specifically, it examines whether teachers' pre-service and in-service digital learning experiences predict digital teaching efficacy and perceived professional learning needs, and whether these social-cognitive factors subsequently explain variation in digital instructional practices. Given Korea's highly selective teacher recruitment system and the structurally differentiated teacher education tracks by school level, the study further treats teacher education and school environments as contextual conditions that may shape these relationships. Overall, the findings are expected to provide evidence for designing teacher professional learning policies that better connect pre-service preparation with in-service development in the era of digital and AI transformation.

2. Literature Review

2.1. Pre-Service Experience on Digital Instructional Practices

Amid the accelerating digital transformation in education, teachers' digital competence has become essential. Consequently, Korean teacher education policies and pre-service teacher education increasingly emphasize digital competence as a core element of teacher professionalism. Substantial public funds have been allocated to developing teachers' digital competence and creating adequate digital teaching and learning environments (Park et al., 2024). From a lifecycle perspective, the most effective way to enhance the competence of in-service teachers is to improve their readiness during the early stages of their professional trajectory, particularly during pre-service preparation.

This emphasis on early-stage preparation is not merely a matter of efficiency but also of mechanism. Pre-service teacher education constitutes one of the few institutionalized periods in which prospective teachers can repeatedly engage in structured opportunities to learn, practice lesson design and enactment, and receive feedback before their routines become stabilized by school demands and time constraints (McGarr & McDonagh, 2021). In addition, evidence from recent work suggests that the gap between general digital familiarity and pedagogically meaningful technology use is likely to narrow when pre-service teachers engage in guided, practice-based integration tasks rather than isolated tool training (Dolezal et al., 2025). Therefore, examining pre-service learning experiences as a foundational source of later digital competence is essential for understanding variation in teachers' digital instructional practices.

Recognizing this, the Ministry of Education of Korea recently announced "AI for All: AI Talent Development Plan for All" (Ministry of Education, 2025), which identifies the expansion of universal AI education and the strengthening of pre-service teachers' AI education capabilities as key initiatives. This is significant because it acknowledges at the national policy level that in-

service training alone has limitations in improving the quality of digital-based teaching and learning, and that systematic capacity building during pre-service teacher training is essential. Importantly, this policy direction implies a shift in what counts as "teacher readiness" in the digital era: readiness increasingly encompasses the ability to design instruction, assessment, and feedback processes that leverage digital tools for specific pedagogical purposes, rather than merely operating technologies in general. This reinforces the need for empirical evidence linking the quality and form of pre-service digital learning experiences to teachers' subsequent instructional enactment.

The Korean government trains elementary and secondary school teachers through separate degree programs, each featuring a structured curriculum that includes core teaching courses, a major, and practical training. Initial teacher education is regarded as a key policy lever for enhancing teacher professionalism, and to this end, the government periodically conducts evaluations and competence assessments of teacher training institutions. Park et al. (2024) describe how Korean teacher education institutions are embedded in a broader national system that links teacher selection, university curricula, practicum placements, and school appointments. Thus, these institutional arrangements indicate that Korean pre-service teacher education operates as a relatively standardized, structured context in which pre-service teachers acquire core teaching competence. At the same time, the structural separation between elementary and secondary teacher education suggests that opportunities to develop digital instructional competence may not be uniform across tracks. Differences in curriculum organization, practicum contexts, and institutional priorities can lead to varying levels of exposure to digital pedagogy and practice-based integration (Choi & Paik, 2021; Park et al., 2024). This makes the Korean context particularly relevant for examining how pre-service learning experiences operate as a contextual "starting point" for teachers' later digital instructional practices.

Nevertheless, contrary to the widespread perception that pre-service teachers are a generation familiar with digital environments, recent studies have repeatedly demonstrated that digital familiarity does not automatically translate into professional digital competence. While pre-service teachers, often referred to as digital natives, may be adept at utilizing digital technologies in their daily lives (Karakuş & Kılıç, 2022), this does not immediately translate into professional teaching practices such as digitally-based lesson design, learning material creation, learner-tailored feedback, and learning analytics (Dolezal et al., 2025; McGarr & McDonagh, 2021; Zhang et al., 2023). Choi and Paik (2021) noted that the curricula of teacher training institutions remain heavily subject- and theory-centered, and that competence-based curricula, including digital competence, future competence, and convergence education, are not yet well established.

This distinction is critical because "professional digital competence" implies a capacity to make instructional decisions such as selecting, adapting, and orchestrating digital resources in alignment with content, learners, and assessment goals, rather than simply using devices or applications. Accordingly, pre-service digital learning experiences should be conceptualized not only as course attendance but also as the extent to which pre-service teachers engage in practice-oriented instructional design tasks, enactment opportunities such as microteaching or practicum-based experimentation, and reflective feedback cycles that help translate tools into pedagogical routines (McGarr & McDonagh, 2021; Park, 2023). This framing clarifies why the form and quality of pre-service experiences are expected to matter for subsequent digital instructional practice.

Although pre-service teachers are generally familiar with digital environments, their readiness to design and implement digitally based teaching and learning does not emerge automatically and requires separate, systematic support. Accordingly, reforming teacher education curricula to reflect the requisite competencies in the digital transformation era remains a persistent concern. Despite national policies that define digital competence as a fundamental teacher competence, structural limitations—such as insufficient field-based digital practices and weak school–university linkages—continue to hinder the development of pre-service teachers' readiness. From an international comparative perspective, the TALIS 2008 analysis showed that, although Korean

teachers exhibit high professionalism, the quality of the professional development system is relatively weak and the connection between policy and practice is limited (Kim et al., 2011). This highlights the need for a coherent competence development structure that spans initial teacher education, in-service training, and school-based practices.

Other empirical studies further demonstrate that experiences during initial teacher education fundamentally shape teachers' later capacity to implement digital instruction. Park (2023) found that, although pre-service teachers' attitudes toward digital technologies were generally positive, their competence in critical thinking, technological application, and digitally mediated interaction remained underdeveloped and were strongly associated with opportunities for structured practice, guided exploration, and reflective engagement with technology. Similarly, Chee and Hong (2023) reported that pre-service teachers perceived AI as complex or mainly burdensome because they lacked systematic opportunities to try, fail, revise, and reflect on AI use in instructional contexts. A study employing the Expectancy-Value-Cost framework also showed that pre-service teachers who engaged in meaningful AI-related instructional design tasks—and thereby experienced its pedagogical value in concrete ways—demonstrated a substantially higher willingness to implement AI (Choi & Sohn, 2025).

Overall, prior studies converge on a consistent conclusion that pre-service teachers' general digital familiarity does not automatically translate into professional digital competence. In contrast, practice-based and pedagogically meaningful learning opportunities during initial teacher education are strongly associated with later readiness for digitally supported teaching. Synthesizing this evidence, pre-service digital learning experiences can be treated as a foundational background condition that differentiates teachers' subsequent development trajectories. Accordingly, this study proposes the following hypotheses.

H1: Pre-service digital learning experience is positively associated with teachers' digital instructional practice.

H2: Pre-service digital learning experience is positively associated with digital teaching efficacy.

2.2. Influence Pathways of Digital Practices with Social Cognitive Career Theory Perspective

Teachers' digital teaching and learning practices encompass not only the frequency of technology use in class but also the ways in which teachers design technology-enhanced lessons, create digital materials, provide formative feedback, and evaluate learning. To understand why some teachers actively integrate digital tools while others do not, it is necessary to consider both individual characteristics and social conditions, which aligns with the core assumptions of SCCT.

SCCT explains how people translate contextual conditions and learning opportunities into goal-directed behaviors through social-cognitive mechanisms. In particular, SCCT posits that learning experiences provide information that shapes domain-specific self-efficacy, which then influences how individuals initiate, persist in, and perform behaviors in a given domain (Lent & Brown, 2019; Lent et al., 1994). This perspective is helpful in the context of digital transformation because it clarifies how teachers' prior learning opportunities become internal resources that support or constrain the enactment of digital instructional practices.

In this study, teachers' pre-service digital learning experiences are treated as contextual learning inputs, digital teaching efficacy is conceptualized as domain-specific self-efficacy, and perceived professional learning needs are treated as a proximal appraisal that reflects remaining capability gaps and motivation for further competence development. Teachers' digital instructional practices are defined as the performance-related behavioral outcome in which these learning and belief structures are enacted in classrooms. Based on this mapping, the following review first focuses on the individual-level antecedents that prior studies have most consistently linked to teachers' technology-related instructional behaviors, and then considers the environmental conditions that shape and condition these individual mechanisms.

First, individual teacher characteristics, such as digital competence, self-efficacy, and interest, have been identified as influencing factors of digital practice. Several studies have shown that

teachers' digital competence strongly influences digital instructional practices (Abu Hanifah et al., 2023; Lucas et al., 2021).

Another crucial factor is self-efficacy. Ayanwale et al. (2022) found that confidence in teaching AI most strongly influences the intention to introduce it. In other words, domain-specific self-efficacy is a key factor of digital instructional practices. Abu Hanifah et al. (2023) identified technology self-efficacy as an important correlate of teachers' use of digital technology. Similarly, Antonietti et al. (2022) reported that stronger digital competence beliefs were positively associated with key technology-acceptance perceptions and intentions. The literature consistently indicates that stronger efficacy-related beliefs and more positive professional appraisals are associated with more active technology-related instructional enactment. Based on this synthesis, the present study posits that digital teaching efficacy is a central proximal predictor of digital instructional practice.

H3: Digital teaching efficacy is positively associated with teachers' digital instructional practice.

The literature also supports the idea that teachers' motivational appraisals—such as perceived usefulness, perceived relevance, and interest—are closely tied to technology-based teaching practices. Granström and Oppi (2025) demonstrated the significant effect of perceived usefulness on intention of use. In a similar vein, Spiteri and Chang Rundgren (2020) found that positive attitudes toward technology are a key factor in actual classroom use, and showed that perceptions of AI usefulness significantly influenced teachers' readiness to use and willingness to adopt AI.

Taken together, these findings highlight the relevance of SCCT-related constructs for understanding teachers' digital instructional practices. SCCT is widely used to understand how teachers make career decisions, develop professionally, and persist in the profession, and it emphasizes the interplay among personal factors such as self-efficacy, contextual influences, and outcome expectations in shaping professional trajectories. Importantly for the present study, the SCCT model, as applied and synthesized in meta-analytic work, includes multiple sets of variables, including self-efficacy and interest related to choose goals (Sheu et al., 2010). Sheu et al. (2010) visualize the overlapping relationships among self-efficacy and interest, which provides a useful conceptual basis for specifying how efficacy-related beliefs and motivation-related appraisals jointly shape goal-directed behavior. In this regard, self-efficacy can be interpreted as a domain-specific belief that reduces stress and increases intentional effort and persistence, thereby providing direct and indirect pathways to actual practice (Abu Hanifah et al., 2023; Ayanwale et al., 2022; Lee & Shin, 2017). This is consistent with prior research on digital practice that positions self-efficacy as a central explanatory factor of teachers' technology-related instructional enactment.

In this study, professional learning needs for digital education are regarded as a domain-specific motivational–cognitive construct that is conceptually aligned with the SCCT mechanisms linking interest to goal-directed engagement. Specifically, teachers' learning needs can be understood as an appraisal that (a) signals the recognition of remaining competence gaps and (b) reflects the perceived value and relevance of developing those competencies for improving instruction. In this sense, perceived professional learning needs are closely connected to the SCCT logic that interests shape intentions and aspirations for action. Thus, in the present model, perceived professional learning needs capture a proximal motivational pathway through which teachers translate efficacy-related judgments into intentions to pursue further learning and to enact digital instructional practices.

H4: Digital teaching efficacy is positively associated with perceived professional learning needs for digital education.

H5: Perceived professional learning needs are positively associated with teachers' digital instructional practice.

At the same time, both SCCT and related ecological perspectives emphasize that the interaction between individual characteristics and contextual supports and barriers shapes teachers' instructional enactment. In SCCT terms, supports and barriers condition how learning opportunities are accessed, interpreted, and translated into sustained behavior (Sheu et al., 2010). Research on school culture—the immediate environment surrounding teachers—also highlights

that it is a superordinate factor in shaping teachers' knowledge, attitudes, and skills. Lucas et al. (2021) found that school support—including training experience, infrastructure, policies, and individual characteristics—jointly explains digital competence and implementation. Specifically, the presence of school-level digital policies and training opportunities correlates with higher levels of teachers' digital competence, leading to greater classroom use. Granström and Oppi (2025) also reported that policy support from principals and the Board of Education, as well as participation in AI-related training, significantly impacts AI use and readiness. These findings imply that teachers' digital instructional practices are not determined solely by individual characteristics but are also shaped by environmental and contextual factors (Dos Santos, 2023; Lucas et al., 2021).

This body of evidence suggests that teachers' digital instructional practices are shaped not only by individual characteristics but also by social and contextual factors (Granström & Oppi, 2025; Lucas et al., 2021). It requires explaining that teachers' digital instructional practice entails more than merely listing correlates; it specifies the mechanisms by which learning opportunities and contextual supports are internalized into self-efficacy and need-related appraisals, and then translated into enacted classroom behaviors. Such a mechanism-focused approach helps connect professional learning history to current instructional practice in a theoretically interpretable manner.

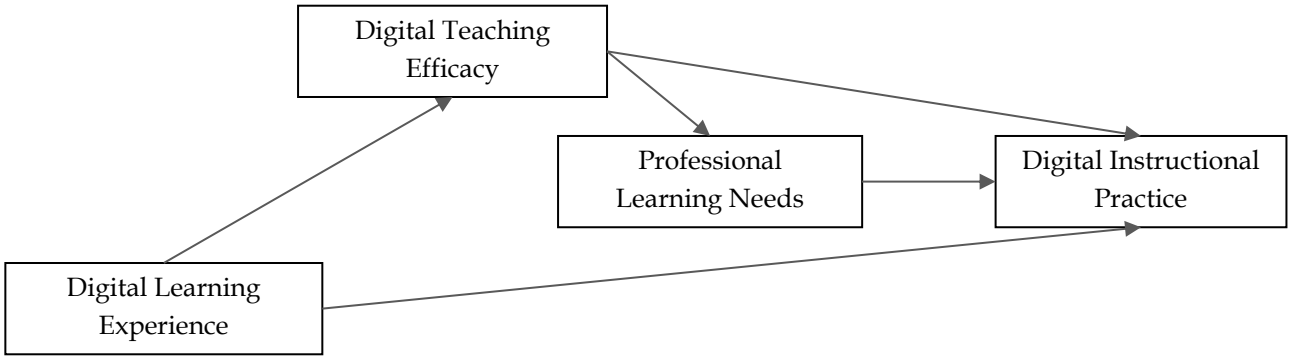
However, with respect to external factors, how teachers' prior experiences influence their digital instructional practices remains insufficiently explained, despite the pivotal role of the pre-service years. Within Korea's systematic pre-service teacher education curriculum described above, digital learning experiences can be understood as pathways that influence teachers' self-efficacy and subsequent practice. Prior studies on pre-service teacher training similarly suggest that learning experiences are foundational for in-service teachers' self-efficacy and instructional practice. Sheu et al. (2010) further argue that self-efficacy, a core construct in SCCT, mediates the relationship between contextual learning experiences and interest; in the present study, this interest-related mechanism is operationalized through perceived professional learning needs for digital education.

Accordingly, this study aligns the importance of pre-service experiences with SCCT's social-cognitive pathways by linking digital learning experiences during pre-service preparation to digital teaching efficacy and, subsequently, to teachers' perceived professional learning needs and enacted digital instructional practices.

H6: Pre-service digital learning experience is indirectly associated with digital instructional practice through a sequential pathway via digital teaching efficacy and perceived professional learning needs.

Drawing on this synthesis, this study proposes the hypothesized relationships among learning experiences, social-cognitive factors, and teachers' digital instructional practices, as illustrated in Figure 1.

Figure 1
Hypothesized SCCT influence pathways toward digital instructional practice



3. Method

3.1. Research Design

This study aimed to examine the relationships among pre-service teacher experience, teaching efficacy, and professional learning needs, and how these factors influence in-service teachers' digital instructional practices. To achieve this, reliability and validity were assessed, focusing on the six variables used as measurements. Subsequently, correlation analyses between these factors and digital instructional practices were conducted, along with descriptive statistics on skewness and kurtosis, to test the hypotheses underpinning the subsequent analyses. Finally, to evaluate the primary hypothesis based on the SCCT framework, path analysis using structural equation modeling [SEM] was performed, and the significance of indirect effects was assessed. SEM enables the simultaneous analysis of multiple paths and reciprocal influences among independent variables and the latent dependent variable, composed of numerous sub-factors, within a single model, thereby empirically demonstrating predictive validity (Tarka, 2018).

3.2. Participants

This study utilized data from the TALIS 2024, released by the Organization for Economic Co-operation and Development [OECD] in October 2025. TALIS is a large-scale survey of teacher perceptions conducted every five to six years, designed to facilitate international comparisons across countries.

TALIS 2024 employs a two-stage stratified probability sampling design: first, schools are randomly sampled, and then teachers within those schools are randomly selected. School sampling is conducted using explicit and implicit stratum variables established for each of the 54 participating countries. Schools are selected using a probability proportional to size [PPS] method based on a sampling frame constructed from the explicit stratum variables. From the sampled schools that confirmed participation, 20 teachers were randomly selected with equal probability from all teachers who met the population criteria.

Data validity was considered secured if both the participation rate of the sampled schools and the response rate of the sampled teachers exceeded 75%. This sampling approach was intended to produce relatively accurate estimates, providing comparable data with high validity and reliability. This survey was conducted from May to June 2024, yielding 6,222 responses from teachers at 374 elementary and middle schools across Korea. Participants ranged in age from 20s to 50s, with a level of formal education ranging from bachelor's to master's degrees. Most teachers obtained their teaching qualifications after 1990, when digital technology became widespread, and over 99.2% were employed full-time. A significant proportion (62.1%) had more than 10 years of work experience, and 92.8% taught classes of 15-34 students. Table 1 shows the characteristics of the participants.

3.3. Measures

The TALIS 2024 was administered to 280,000 teachers in 54 countries, yielding 278,383 data points. For this study, data from Korea were extracted separately using the SPSS 27.0 data selection function.

Among the numerous questions included in the data, this study focused on teachers' digital instructional practices. Questions related to digital technologies were first surveyed in the four TALIS studies conducted since 2008. These surveys included items on teachers' professional level, experience, and perceptions, to improve school effectiveness and explore effective teaching practices. The primary focus of this study is digital instructional practices, which comprised three specific items: "Use digital tools and resources when presenting information to students [DIP-Present]," "Use digital tools and resources when managing classes, such as grades and assignments [DIP-Manage]," and "Use digital tools and resources to assess student learning [DIP-Assess]." To confirm the consistency of these three items, a reliability analysis was conducted.

Table 1
Personal characteristics of the participants (N = 4136)

Characteristic	*N*	*%*
Age		
Under 29	837	13.5
30-39	1678	27.0
40-49	2192	35.3
50-59	1311	21.1
60 or above	186	3.0
Total	6204	100.0
Highest level of formal education		
ISCED Level 5	58	1.4
ISCED Level 6	2643	63.9
ISCED Level 7	1393	33.7
ISCED Level 8	42	1.0
Total	4136	100.0
First teaching qualification		
1970-1979	2	0.1
1980-1989	189	4.7
1990-1999	844	21.2
2000-2009	1363	34.2
2010-2019	1122	28.2
2020-2024	464	11.6
Total	3984	100.0
Employment status		
Full-time/more than 90%	4093	99.2
Part-time/90% or less	33	0.8
Total	4126	100.0
Years of work experience		
Less than or equal to 5 years	1265	20.6
6-10 years	1062	17.3
11-20 years	1969	32.0
Above 20 years	1851	30.1
Total	6147	100.0
Target class size		
Fewer than 15	207	5.2
15-24	1788	44.7
25-34	1925	48.1
35 or above	78	2.0
Total	3998	100.0

Cronbach's alpha was .70, meeting the acceptable standard. Nevertheless, since the data collected were analyzed using a four-point scale (ranging from "always" to "never or rarely"), it should be considered a limitation that the characteristics of the ordinal data may have been exaggerated.

Next, three variables were used as influencing factors of digital instructional practice: learning experience and preparedness in using digital tools and materials during formal teacher training [DL-Experience]; the needs for professional training in the skills required to utilize digital tools and materials [PL-Needs]; and teaching efficacy in supporting student learning through digital tools and materials [DT-Efficacy].

The data used in this study were obtained through a stepwise sampling method, which may result in non-independent observations and a high intraclass correlation coefficient (ICC). To address this, ICC for six variables was additionally assessed. The analysis yielded coefficients of .204 (single-measure) and .606 (mean-measure), which is below the acceptance threshold of .75 as

defined by Koo and Li (2016), indicating a moderate level of independence among the variables.

3.4. Data Analysis

As the primary analytical method for hypothesis testing, this study employed SEM using AMOS 27.0 software to analyze factors influencing teachers' digital instructional practices and to assess their statistical significance. Standardized path coefficients were derived through data analysis using standardized scores that reflect the weight values provided by TALIS 2024. To evaluate the goodness of fit of the structural equation model, the Comparative Fit Index [CFI], which is robust to large sample sizes, the Tucker-Lewis Index [TLI], and the Root Mean Square Error of Approximation [RMSEA] were applied, as these indices consider both model fit and parsimony. The criteria for acceptable model fit are TLI and CFI values of .90 or higher and RMSEA values of .06 or lower, with lower RMSEA values indicating better fit (Schermelleh-Engel et al., 2003). Additionally, bootstrapping was performed to verify mediation effects (Shrout & Bolger, 2002). Specifically, 5,000 bootstrap samples were generated via random sampling with replacement from the original data for parameter estimation (Preacher & Hayes, 2008), and a 95% confidence interval [CI] was used.

4. Results

4.1. Verification of Measurement Variables

Analysis of correlations among the presumed variables revealed that all relationships were statistically significant at the $p < .001$ level. Furthermore, the skewness and kurtosis values for all variables were below 3, confirming the assumption of normality.

Furthermore, confirmatory factor analysis [CFA] was conducted to verify the construct validity of the measurement instrument. For this purpose, three variables—Experience, Teaching Efficacy, and Needs—were designated as exogenous variables, while the three items of the digital instructional practice scale (Present, Manage, Assess) were designated as endogenous variables. The model fit of the measurement model, which included two latent variables, was statistically acceptable: CFI = .978, TLI = .958, and RMSEA = .053.

As shown in Table 2, descriptive statistics revealed considerable individual differences in digital learning experiences during pre-service teacher training (SD = 0.945). Among the influencing factors, awareness of the need for professional digital learning was relatively high (M = 3.142). In contrast, the practice level of digital media utilization in student assessment was relatively low (M = 2.170), and exhibited substantial individual variability (SD = 0.873).

Table 2
Correlation and descriptive statistics

Variable	*DL-Experience*	*DT-Efficacy*	*PL-Needs*	*DIP-Present*	*DIP-Manage*	*DIP-Assess*
DL-Experience	1					
DT-Efficacy	.119***	1				
PL-Needs	.271***	.127***	1			
DIP-Present	.111***	.312***	.095***	1		
DIP-Manage	.154***	.305***	.063***	.437***	1	
DIP-Assess	.166***	.334***	.068***	.340***	.535***	1
M	2.432	2.985	3.142	2.934	2.658	2.170
SD	0.945	0.773	0.777	0.802	0.860	0.873
Skewness	0.143	−0.100	−0.609	−0.230	−0.059	0.351
Kurtosis	−0.882	−1.011	−0.124	−0.675	−0.693	−0.568

Note. ***$p < .001$. Abbreviations: DL-Experience: pre-service digital learning experience; DT-Efficacy: digital teaching efficacy; PL-Needs: perceived professional learning needs for digital education; DIP-Present: use of digital tools/resources for presenting information; DIP-Manage: use of digital tools/resources for class management; DIP-Assess: use of digital tools/resources for student assessment.

4.2. Hypothesis Verification

To verify the hypotheses, a structural equation model was developed, as illustrated in Figure 2. This model, based on SCCT, explains how teachers' cognitive experiences lead to psychological growth and to the practical application of these experiences. The model demonstrated an acceptable fit, with CFI = .968, TLI = .904, and RMSEA = .036. As shown in Table 3, all five paths between the influencing factors were statistically significant.

Figure 2
Structural equation research model

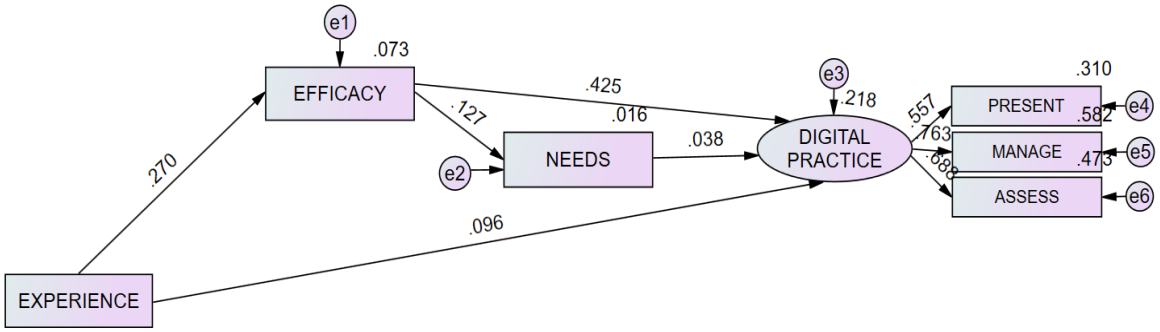


Table 3
Path significance and hypothesis verification

Path	*β*	*S.E.*	*C.R.*	*p*
DL-Experience → DT-Efficacy	0.270	0.012	21.811	<.001
DT-Efficacy → PL-Needs	0.127	0.016	8.136	<.001
DL-Experience → DI-Practice	0.096	0.010	5.352	<.001
DT-Efficacy → DI-Practice	0.425	0.012	19.984	<.001
PL-Needs → DI-Practice	0.038	0.010	2.232	.026

Note. Abbreviations: DL-Experience: pre-service digital learning experience; DT-Efficacy: digital teaching efficacy; PL-Needs: perceived professional learning needs for digital education; DI-Practice: digital instructional practice.

In particular, the impact of the digital learning experience during formal teacher training on digital teaching efficacy (β = 0.270) and the effect of teaching efficacy on digital instructional practice (β = 0.425) were relatively strong and significant at the .001 level or lower. The influence of the need for professional learning to enhance teachers' digital competence (β = 0.038) to digital instructional practice was statistically significant (p = .026) but relatively weak. In other words, teachers tend to connect their previous digital learning experiences to their digital instructional practices through digital teaching efficacy.

Table 4
Indirect effects of bootstrapping

Path	*β*	*SE*	*95% CI*
DL-Experience → DT-Efficacy → PL-Needs	0.029	0.003	0.024 – 0.035
DT-Efficacy → PL-Needs → DI-Practice	0.003	0.001	0.001 – 0.005
DL-Experience → DT-Efficacy → PL-Needs → DI-Practice	0.055	0.003	0.050 – 0.061

Note. Abbreviations: DL-Experience: pre-service digital learning experience; DT-Efficacy: digital teaching efficacy; PL-Needs: perceived professional learning needs for digital education; DI-Practice: digital instructional practice.

Furthermore, the bootstrap analysis verifying the indirect effect of the mediating factor reaffirmed its statistical significance, as shown in Table 4. All three path relationships exhibited statistically significant indirect effects, as the 95% CI calculated through bootstrapping did not include zero. Additionally, a comparison of the detailed bootstrap results showed that the indirect effect had the greatest influence when all four variables of the structural equation model were considered together (β = 0.055).

5. Discussion

This study examined how learning experiences and social-cognitive factors are associated with teachers' digital instructional practices through an SCCT-informed pathway model. Read together, the findings suggest that digital instructional practice is less a short-term response to training participation and more a developmental outcome shaped across the career continuum.

What stands out most is the formative role of pre-service preparation. The observed pattern indicates that pre-service digital learning remains uneven, yet it is precisely this early phase that appears to shape later classroom enactment. This supports a developmental interpretation of teacher digital competence: teachers do not automatically progress from access to technology to instructional integration. Rather, they appear to develop pedagogically meaningful use through repeated opportunities to design, enact, evaluate, and revise instruction with digital tools. This supports the previous research that argues digital competence is holistic and transversal and evolving, involving attitudes, self-efficacy and collaboration as well as technical and pedagogical knowledge (Falloon, 2020; Peters et al., 2022). In this sense, pre-service education is not simply a preparatory stage before professional life begins; it is a period in which core instructional habits and judgments are established. This interpretation is consistent with prior work showing that general digital familiarity does not readily transfer to professional teaching competence without practice-based integration opportunities (Dolezal et al., 2025; McGarr & McDonagh, 2021; Zhang et al., 2023), and with Korean evidence that pre-service teachers may experience digital teaching as difficult when structured pedagogical support is limited (Chee & Hong, 2023; Park, 2023).

Within this developmental interpretation, SCCT provides a strong explanatory frame for how prior learning histories are translated into classroom action. The pathway structure observed in this study supports a mediated process rather than a purely direct-effect account, indicating that educational experiences are more meaningfully connected to practice when internalized through social-cognitive mechanisms. This interpretation aligns with Sheu et al. (2010), whose meta-analytic work showed that SCCT models incorporating indirect pathways tend to offer better explanatory fit than models restricted to direct paths from background factors to outcomes. In this view, learning experiences are not immediately determinative; they are processed through proximal mechanisms before being expressed in instructional behavior. This perspective also helps explain a recurring pattern in digital education research: everyday technology use alone does not guarantee pedagogically meaningful enactment (Dolezal et al., 2025; Karakuş & Kılıç, 2022; McGarr & McDonagh, 2021; Zhang et al., 2023). Read through SCCT, such a gap is expected, because experiences become professionally consequential when they are transformed into domain-relevant efficacy beliefs and motivation-related appraisals. This is consistent with Lent and Brown's (2019) argument that SCCT is well-suited to explaining professional development trajectories in school careers, including teaching.

The centrality of digital teaching efficacy in the present model further reinforces this mechanism-based account. Prior studies have consistently identified efficacy-related beliefs as key factors in teachers' technology-related implementation (Antonietti et al., 2022; Ayanwale et al., 2022; Spiteri & Chang Rundgren, 2020), and the current findings align with this literature. From an SCCT-informed perspective, the findings can be interpreted as suggesting that efficacy is central to classroom enactment because teachers' confidence influences how they plan, teach, reflect, and respond to instructional demands, especially when new or complex practices must be implemented in real classrooms (Almajnuni & Alwerthan, 2024; Mohafa et al., 2026). This interpretation also helps explain why perceived learning need alone may be insufficient for practice change: teachers may clearly recognize areas for development, yet implementation can remain limited when professional learning is not sufficiently contextualized, when teacher agency is constrained, or when structured support and resources are lacking (Badal, 2025; Dorji et al., 2025; Mekie & Gezahegn, 2023; Parry & Kumi, 2026). In this sense, the findings are compatible with research on professional learning that emphasizes the interaction between individual agency and sustained learning environments, including self-initiated reflection, participation in

professional development, and supportive conditions such as modelling, feedback, collaboration, and context-responsive training opportunities (Badal, 2025; Marsick & Watkins, 2015; Mohafa et al., 2026; Yang & Chang, 2024).

The discussion suggests that teachers' digital instructional practice is produced through an interconnected process linking formative pre-service experiences, social-cognitive development, and ongoing enactment in professional contexts. The study therefore contributes to the literature by empirically supporting a mechanism-based interpretation of digital instructional practice, in which early learning conditions, efficacy formation, and motivation-related appraisal are jointly implicated in teachers' classroom use of digital tools.

6. Conclusion

This study extended the SCCT for Korean teachers by structurally examining the mechanisms underlying the implementation of digital instructional practices. Specifically, the study tested hypotheses regarding the relationships among pre-service digital learning experience, digital teaching efficacy, perceived professional learning needs, and enacted digital instructional practice. The hypothesis-testing results showed that pre-service digital learning experience was positively associated with digital instructional practice both directly and indirectly through digital teaching efficacy. Digital teaching efficacy emerged as the strongest proximal predictor of digital instructional practice, while perceived professional learning needs showed a smaller but significant positive association with practice. Overall, the findings support a pathway model in which learning history, efficacy beliefs, and motivational appraisal are jointly related to classroom-level digital enactment.

In addition, this study considered the structural differentiation of Korean pre-service teacher education by school level and tested whether pathway strengths differed across school environments. Although path coefficients within each group were significant, between-group differences were not statistically significant in multi-group structural equation modeling. This result suggests that the core social-cognitive mechanism may operate similarly across the tested school-level groups within the Korean context, at least under the current model specification.

These findings, with the theoretical expansion of SCCT, provide several implications for teacher policy and professional development. First, they support a career-continuum approach to digital teacher development. Pre-service teacher education should include structured, practice-based opportunities for digital pedagogy, because early learning experiences are meaningfully linked to later classroom practice. Second, in-service systems should prioritize sustained support for digital teaching efficacy, given its central role in explaining digital instructional enactment. Third, professional learning structures that combine formal training with school-based collaboration and teacher-driven learning may help teachers translate perceived learning needs into practical instructional change. These implications should be interpreted as directional guidance rather than causal policy effects.

Despite these implications, several limitations should be noted. In particular, at the model level, the proposed SCCT-based framework was specified parsimoniously to test core pathways, thereby limiting its explanatory scope. Potentially relevant school- and system-level conditions were not fully modeled; therefore, the estimated relationships should be interpreted within the model's specified boundaries. At the data level, this study relies on cross-sectional, self-reported TALIS survey data. This study only partially considered the assumption of independence among the research variables, and the interpretation of the results was adjusted to mitigate distortion in the parameter estimates for ordinal data. Accordingly, the findings indicate structured associations rather than causal effects, and temporal ordering among constructs cannot be firmly established. In addition, because construct operationalization depends on available TALIS indicators, some concepts may not be fully captured in multidimensional terms.

Therefore, future research is required to expand SCCT-based model specifications that incorporate broader school- and system-level conditions to explain how contextual and

organizational factors shape pathways to digital instructional practice. It also requires longitudinal, multi-method designs to test temporal ordering more rigorously and to complement self-reported perceptions with evidence of enacted practice. Furthermore, because the present analysis focuses on Korea, future research requires comparative studies across countries and policy contexts. Collectively, these efforts can contribute to the field by clarifying the boundary conditions and cross-context robustness of the proposed relationships.

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Data availability: The data supporting the findings of this study are publicly available from the OECD Teaching and Learning International Survey (TALIS). The datasets are available on the OECD TALIS website.

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