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Impact Of Digital Literacy on Teachers' Professional Development in Universities: The Mediating Role of Internet Self-Efficacy

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ABSTRACT

Purpose. Digital transformation in higher education has emphasized upon the importance of digital literacy for teachers' professional development by intermingling the need for Internet self-efficacy. This study investigates the impact of digital literacy and Internet self-efficacy on teachers' professional development of university teachers. **Methodology**. Based on the theory of connectivism, a questionnaire survey method was adopted. A total of 534 valid questionnaires were collected from five universities in Jiangsu, China through purposive sampling. The proposed research model was validated using structural equation modeling. **Results**. The results indicate that digital literacy and Internet self-efficacy have a notable positive impact on teachers' professional development, with Internet self-efficacy acting as a mediator in the relationship between digital literacy and professional development. **Implications for theory and practice.** This study deepens the understanding of the learning theory of connectivism in the context of teachers' professional development. The findings provide crucial insights into how digital literacy and Internet self-efficacy can be integrated into teachers' professional development to enhance its efficiency.

Introduction

Since the advent of the 21st century, digital technology has notably influenced various fields and accelerated processes across industries in society (Akour & Alenezi, 2022; Rodrigues, 2020). Studies highlight that the transformation driven by digital technology and the multiple demands of the labor market have profoundly impacted educational management practices and philosophies, fostering the digital transformation of education (Bicalho et al., 2022; Palacios-Rodríguez et al., 2023). Digital literacy is increasingly

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recognized as a critical tool for enhancing educational quality and social development (Nguyen & Habók, 2023; Sharma & Satpathy, 2022). UNESCO has advocated for the innovative application of ICT to promote teachers' professional development globally. The proposal of this framework also urges a re-evaluation of teachers' professional development from a new perspective in the context of digital age.

In recent years, considering digital transformation in higher education, numerous studies have emphasized the importance of teachers' professional development, including the integration of ICT to enhance professional development efficacy for university teachers (Alemu, 2015; Alenezi et al., 2023; Guillén-Gámez et al., 2023; Nagy & Dringó-Horváth, 2024; Son & Amparado, 2018). However, previous studies have indicated that inadequate digital literacy, insufficient technical training and a lack of IT support hinder teachers from effectively integrating digital technology into their professional development (Popova et al., 2021; Zimmer & Matthews, 2022). Previous studies have often focused on technological tools and their potential, rather than on the necessary training to incorporate them didactically into teaching, research and learning processes. This phenomenon leads to numerous obstacles to promoting the professional development of teachers through digital literacy.

In the context of China, particularly, studies on the digital literacy and professional development of teachers have primarily focused on developmental pathways, national and regional experiences and policy interpretations at the macro level (Guo & Chen, 2019). Such studies have not yet discussed the pathway to viewing teachers as the primary agents in professional development. (Khalid et al., 2015; Popova et al., 2021). In response, the Chinese Ministry of Education launched the Education Digitalization Strategy Action Plan in 2022, setting high standards for enhancing the digital literacy of teachers. As the integration of digital technology with education deepens, university teachers, in particular, must adapt to the rapid development of digital technology and seek new avenues for growth (Gao et al., 2024).

Digital literacy can be defined as the ability to understand digital tools and use appropriate digital concepts and knowledge to actively engage in meaningful and valuable activities (Ng, 2012). Digital literacy encompasses a range of essential skills for modern society, including critically evaluating online information, using digital tools for communication and collaboration and responsibly using digital platforms. Educators can acquire the necessary skills to use digital tools, innovate with digital technologies, engage in digital communities and apply critical digital practices to meet evolving developmental needs by incorporating digital literacy into teachers' professional development programmes (Guillén-Gámez et al., 2023).

Internet self-efficacy refers to the perception of an individual's ability to use the Internet (Torkzadeh & Van Dyke, 2002). Cognition and emotion are formed when engaging in Internet use events, which subsequently influence their behaviour (Torkzadeh & Van Dyke, 2002). In contemporary educational settings, the Internet self-efficacy of teachers refers to their confidence in completing tasks using Internet technology. Studies have shown that Internet self-efficacy enhances the confidence of teachers in their professional development, providing a positive influence (Kao et al., 2011; Othman & Masum, 2017). Therefore, Internet self-efficacy is also regarded as a key factor affecting teachers' professional development.

Prior et al. (2016) have found a significant positive correlation between the digital literacy of teachers and Internet self-efficacy, both of which are important factors influencing teachers' professional development. These factors will affect the ability of teachers to effectively integrate technology into learning, teaching and academic research (Gomez et al., 2021; Timotheou et al., 2022). Therefore, providing a digital learning environment that can stimulate the initiative of teachers for their long-term development has become crucial.

The current study is based on the learning theory of connectivism, which is a learning theory focused on network construction and continuous knowledge innovation in a remarkable measure. This theory emphasizes active learning through connection, interaction and collaboration in digital learning environments (Dziubaniuk et al., 2023). Looney (2020) studied teachers' professional development using the concept of connectivism as the conceptual framework and found that teachers must enhance their use of digital technology and strengthen collaboration with others to achieve continuous professional development. Anderson and Dron (2011) revealed that the core of connectivism learning is the creation of nodes, the establishment of connections and continuous interaction. In the digital context, as learners, teachers create connections between new and old knowledge nodes and acquire and generate rich knowledge content by forming learning communities based on their own connections.

Thus, this study aimed to examine the impact of digital literacy and Internet self-efficacy on teachers' professional development in universities. Adhering to the theory of connectivism, this study highlights the factors that influence teachers' professional development in the digital context and provides insight for teacher educators in terms of teacher training. It also explores the relationships between digital literacy, Internet self-efficacy and teachers' professional development amongst university teachers in Jiangsu, China. The rationale behind this study is that Jiangsu is a notable representative province of digital education and development in higher education in China. However, relevant studies indicate that a comprehensive teacher development support system has not yet been established within the Jiangsu, China in recent years (Huang et al., 2020). This research gap is primarily impacting the teachers' digital talents despite the digital transformation of higher education in China. This study, therefore, aimed to fill this gap, by elucidating the factors influencing teachers' professional development and their impact on the process of teachers' digital literacy.

Literature review and hypothesis development

Digital Literacy and Teachers' professional development

Digital literacy is a critical factor in teachers' professional development, which includes skills, knowledge, creativity and attitudes regarding digital media (Røkenes & Krumsvik, 2014). The digital literacy possessed by university teachers not only helps implement and integrate ICT in teaching practices but also provides a solid foundation for their professional development (Tondeur et al., 2023). The advent of the digital age has catalyzed remarkable shifts in university teachers' professional development approaches (Anis, 2024; Harris & Hofer, 2011). Over the past few decades, society has undergone remarkable changes. Information and communication technology (ICT) has not only

played a crucial role in improving quality of life but has also created new opportunities for teachers' professional development. ICT provides new spaces for online interaction, reflection and collaboration amongst teachers (Philipsen et al., 2019).

The digital transformation of the abilities of university teachers is essential for enhancing educational quality. After investigating the online learning activities of teachers, it was highlighted the role of digital technology in transforming teacher learning and implementing professional development activities (Minea-Pic, 2020). In a qualitative study concerning teachers' professional development, Fernández-Batanero et al. (2020) have mentioned that digital literacy plays a role by helping teachers successfully explore the effectiveness and possibilities of their development, thereby facilitating meaningful learning. The teaching challenges, opportunities and integration introduced by digital technology in higher education are undoubtedly inevitable trends in future education and teachers' professional development (Pischetola, 2021). Thus, this study hypothesizes the following:

H1: *Digital literacy of university teachers has a significant positive impact on teachers' professional development.*

Digital Literacy and Internet Self-Efficacy

Littlejohn et al. (2012) suggests that learners should possess strong digital and learning literacies within the context of connectivism and networking. Other studies indicate that teachers' professional development is not only dependent on the use of digital tools but is also influenced by various factors such as teacher initiative, self-efficacy and social interaction in the Internet-supported new environment (Akour & Alenezi, 2022; Buabeng-Andoh, 2012; Smith & Sivo, 2011). Information acquisition, processing and application are largely built upon the networked environment of the digital age (Dziubaniuk et al., 2023). In this process, higher digital literacy can substantially enhance the Internet self-efficacy of learners and maximize the effectiveness of teachers' professional development.

Thus, a positive attitude of teachers towards Internet use and practical skills are important measurable components of digital literacy. As new technologies diversify, Internet self-efficacy is manifested as the perception of an individual's self-agency and confidence when using the Internet. Previous studies have indicated a notable positive relationship between digital literacy and the Internet self-efficacy of teachers (Coklar & Tatli, 2020; Prior et al., 2016). Teachers with strong digital literacy have high levels of perseverance and resilience in solving problems in digital environments and are willing to accept new tasks and challenges. Therefore, Internet self-efficacy will be improved (Aslan, 2020; Knutsson et al., 2012; Mayantao & Tantiado, 2024; Senemoğlu, 2007). Thus, this study hypothesizes the following:

H2: *Digital literacy of university teachers has a significant positive impact on Internet self-efficacy.*

Internet Self-Efficacy and Teachers' professional development

In digital interconnected learning spaces, as learners, teachers must obtain valuable and targeted Internet self-efficacy with initiative and confidence in Internet use by using high levels of digital literacy and make informed decisions and actions consistent with

educational trends to promote teachers' professional development (Prestridge et al., 2021; Sammour et al., 2008). In the era of educational reform, the mastery and application of Internet technology by teachers to develop Internet self-efficacy are critical factors in promoting their professional development (Herro & Quigley, 2016). Studies have shown that teachers with high levels of Internet self-efficacy often exhibit high motivation and a positive attitude towards professional development. These teachers are less likely to fear or doubt information acquisition. Therefore, they can fully integrate the Internet into their teaching activities (Akman, 2016). Kao and Tsai (2009)studied the relationship between Internet self-efficacy and teachers' professional development amongst 421 teachers and found that Internet self-efficacy is an important predictor of teachers' professional development. Therefore, this study hypothesizes the following:

H3: *Internet self-efficacy of university teachers has a significant positive impact on teachers' professional development.*

Mediating Role of Internet Self-Efficacy Between Digital Literacy and Teachers' professional development

Previous studies have shown that high digital literacy is associated with rich online experiences and high Internet self-efficacy (Rains, 2008). Teachers with high Internet self-efficacy are proactive in learning new skills and knowledge, acquiring additional knowledge reserves and promoting their professional development (Darling-Hammond et al., 2017). In the context of digital educational reform, as the main subjects of higher education activities, university teachers are particularly influenced by internal factors during their professional growth. Internet self-efficacy can stimulate belief in completing certain behaviours, ultimately achieving personal growth goals (Gokbel, 2020; Hajovsky et al., 2020).

Some studies have indicated that whilst ability and the external environment determine the behavioral tendencies of an individual, cognitive factors can mediate the relationship between environmental factors and behaviour (Bandura, 2002; Mei, 2019). In this study, as the virtual environment for cultivating and applying digital literacy, the Internet corresponds to environmental conditions, whilst teachers' professional development corresponds to behavioral variables. As a cognitive factor, Internet self-efficacy plays a mediating role between the two parties. Additionally, Tang and Tseng (2013) indicate a correlation between digital literacy and Internet self-efficacy. Fan et al. (2023) found that Internet self-efficacy reflects the belief and expectation of individuals in enhancing digital literacy during goal achievement, gradually promoting the updating and optimization of knowledge and competency structures of teachers based on digital literacy, thus making it a key focus in teachers' professional development (Garzon & Garzon, 2023; Godsk & Nielsen, 2024). Therefore, this study hypothesizes the following:

H4: *Internet self-efficacy mediates the relationship between digital literacy and teachers' professional development.*

Figure 1 illustrates the relationships between the constricts of the study and their hypothesized relationship;

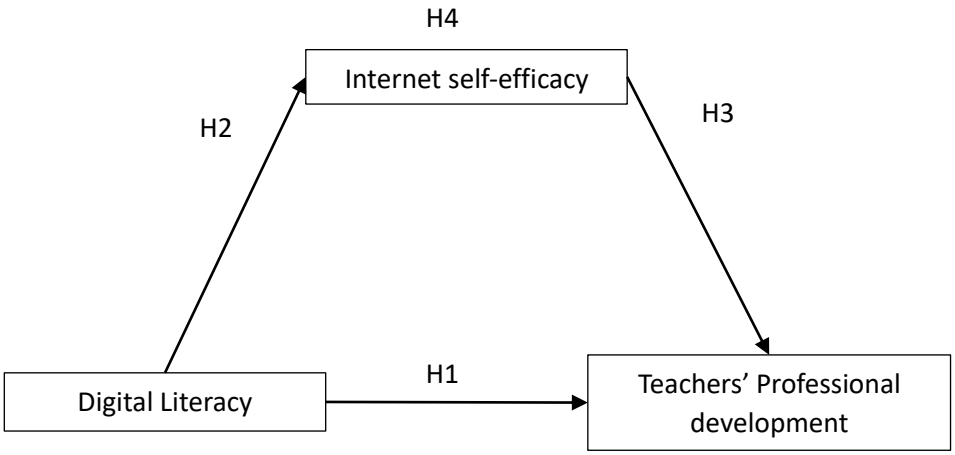

Figure 1: The hypothesized research model

Methodology

Research design

A questionnaire survey method was employed for data collection in this study. Teachers were asked to complete a questionnaire covering factors such as digital literacy, Internet self-efficacy and teachers' professional development. Firstly, a survey notification was sent to each participating school, followed by an email from school administrators to faculty members inviting them to participate. The email explained the purpose, procedures and content of the study, providing a link and QR code to access the questionnaire. Participants were then informed regarding the study and an informed consent was taken before proceeding.

Sampling

The sample of this study comprised teachers from Jiangsu universities. Jiangsu Province is located in eastern China. This province is at the forefront of educational reform in China due to its strong educational infrastructure and demand for educational innovation. Convenience sampling was adopted in this study. Five universities across Jiangsu Province were selected, and approximately 550 teaching and administrative staff participated in this survey. A total of 534 valid questionnaires were analyzed after excluding invalid responses to ensure a sufficient and representative sample size and minimize potential bias. Regarding demographic information, approximately 45% (N = 240) of the respondents were male, and 55% (N = 294) were female.

Data collection and research instrument

The data was collected through a questionnaire comprising three different scales, validated in previous studies, namely: Digital Literacy Scale, Internet Self-efficacy Scale, and Teachers' Professional Development Scale. The Digital Literacy Scale, developed by

Ng (2012), which originally had 17 items, including three dimensions: Digital Attitude (DL1), Digital Skills (DL2), Digital Cognition, and Digital Social Emotion. Based on the results of the pre-test analysis, this study merged two dimensions of Digital Cognition and Digital Social Emotion and renamed them as Digital Social Cognition (DL3). All item in this scale were measured using a 5-point Likert scale, with 1 being "strongly disagree" and 5 being "strongly agree". The Cronbach's Alpha coefficient value of this was 0.869, showing good reliability and validity.

The Internet Self-Efficacy Scale, developed by Eastin and LaRose (2006), had a total of 8 items, with Cronbach's Alpha value measuring 0.93, showing good reliability and validity. Originally, the scale used a 7-point Likert scale, with 1 being "strongly disagree" and 7 being "strongly agree". However, this study changed it to a 5-point Likert scale, adhering to the recommendations of Chen et al. (2015), who suggested a Likert 5-point scale was the most commonly used and is the best choice from the perspective of information processing.

Ther Teachers' Professional Development Scale, compiled by Chang and Fan (2022), was used in this study without any changes. The scale had three dimensions, with a total of 33 items, including 8 items on [teachers' professional knowledge, PD1], 10 items on [teachers' practical ability, PD2], and 15 items on [teachers' professional attitude PD3]. Each item was measured using a 5-point Likert scale, with 1 being "strongly disagree" and 5 being "strongly agree". The Cronbach's Alpha value of the scale was 0.970, and the scale showed good reliability and validity.

Data analysis

The data was analyzed using Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM) techniques through hypothesis testing. construct reliability and convergent validity, where CR > = 0.70, Average Variance Extracted (AVE) for CV > =0.50 and item factor loading > 0.70 Hair et al. (2017). Awang (2015) recommended that if the square root of the average extracted variance (AVE) of each facet is greater than the Pearson correlation coefficient of other facets, it indicates that the facet has facet discriminant validity. This study also used the bootstrapping method (Shrout & Bolger, 2002) to improve the accuracy of the estimated values of the mediation effect test, which is to calculate the confidence interval of various effects (Preacher & Hayes, 2008). The bootstrapping method uses repeated sampling to obtain the mean and 95% confidence interval of the mediation effect. If the 95% confidence interval of the mediation effect does not include 0, it means that the mediation effect reaches a significant level of $p < 0.05$ (Shrout & Bolger, 2002).

Results

Descriptive statistics

This study assessed the internal consistency of the formal measurement tools for digital literacy, Internet self-efficacy, and professional development. The overall Cronbach's Alpha for digital literacy is 0.930, with the subscales of digital attitude, digital skills, and digital social cognition showing Cronbach's Alphas of 0.913, 0.907, and 0.856, respectively. The Cronbach's Alpha for Internet self-efficacy, considered as a unidimensional scale, is 0.931. For teachers' professional development, the overall Cronbach's Alpha is 0.965, with

the subscales of professional knowledge, practical ability, and professional attitude having Cronbach's Alphas of 0.918, 0.936, and 0.963, respectively. Given that the overall Cronbach's Alpha values for each measurement tool exceed .800, the reliability of these measurement tools is deemed satisfactory. The results are presented in Table 1.

Table 1

Reliability Test Result

Scale	Dimensions	*Cronbach's Alpha*	
Digital literacy	Digital attitude (D1)	0.913	
	Digital skills (D2)	0.907	0.930
	Digital social cognition (D3)	0.856	
Internet self-efficacy	Internet self-efficacy (S1)	0.931	0.931
Teachers'	Professional knowledge (PD1)	0.918	
Professional	Practical ability (PD2)	0.936	0.965
development	Professional attitude (PD3)	0.963	

Fornell and Larcker (1981) recommend the standardized factor loading (SFL) of the observed variable greater than 0.500, and the t-test should be significant; secondly, the squared multivariate correlation (SMC) should be greater than 0.500. The CR value of digital attitude is found 0.913 and the AVE valued at 0.600; the CR value of digital skills is 0.907 and the AVE is 0.619; the CR value of digital social cognition is .857 and the AVE is 0.600. The CR value of Internet self-efficacy is 0.931 and the AVE is 0.627. The CR value of professional knowledge is 0.918 and the AVE is 0.585; the CR value of practical ability is 0.936 and the AVE is 0.596; the CR value of professional attitude is 0.633 and the AVE is 0.963. The above values all met the standards of good convergent validity (Awang, 2015). This shows that the convergent validity of the models measured in this study is good. This convergence effect is shown in Table 2,

Table 2

Summary table of confirmatory factor analysis values

Dimension	Item code	SFL	SMC	CR	AVE
Digital Literacy	D1	0.767	0.588	0.913	0.600
(DL)	D2	0.776	0.602		
-Digital attitude	D3	0.789	0.623		
(D1-D7)	D4	0.802	0.643		
	D5	0.761	0.579		
	D6	0.764	0.584		
	D7	0.761	0.579		
-Digital skills	D8	0.787	0.619	0.907	0.619
(D8-D13)	D9	0.770	0.593		
	D10	0.795	0.632		
	D11	0.780	0.608		
	D12	0.796	0.634		
	D13	0.793	0.629		
-Digital social	D14	0.732	0.536	0.872	0.600
cognition	D15	0.783	0.613		
(D14-D17)	D16	0.787	0.619		
	D17	0.795	0.632		

Table 2(continued)

Summary table of confirmatory factor analysis values

Dimension	Item code	SFL	SMC	CR	AVE
Internet self-efficacy (ISE) (S1-S8)	S1	0.785	0.616	0.931	0.627
	S2	0.797	0.635		
	S3	0.798	0.637		
	S4	0.780	0.608		
	S5	0.790	0.624		
	S6	0.783	0.613		
	S7	0.801	0.642		
	S8	0.798	0.637		
Teachers' Professional Development (PD) -Professional knowledge (P1-P8)	P1	0.791	0.626	0.918	0.585
	P2	0.769	0.591		
	P3	0.764	0.584		
	P4	0.777	0.604		
	P5	0.733	0.537		
	P6	0.798	0.637		
	P7	0.718	0.516		
	P8	0.762	0.581		
-Practical ability (P9-P18)	P9	0.774	0.599	0.936	0.596
	P10	0.741	0.549		
	P11	0.776	0.602		
	P12	0.774	0.599		
	P13	0.754	0.569		
	P14	0.780	0.608		
	P15	0.789	0.623		
	P16	0.776	0.602		
	P17	0.770	0.593		
	P18	0.782	0.612		
-Professional Attitude (P19-P33)	P19	0.811	0.626	0.633	0.963
	P20	0.804	0.591		
	P21	0.800	0.584		
	P22	0.808	0.604		
	P23	0.820	0.537		
	P24	0.780	0.637		
	P25	0.791	0.516		
	P26	0.806	0.581		
	P27	0.782	0.599		
	P28	0.800	0.549		
	P29	0.790	0.602		
	P30	0.784	0.602		
	P31	0.779	0.569		
	P32	0.793	0.608		
	P33	0.782	0.623		

The results of the discriminant validity are shown in Table 3. The square root of the average variance extracted (AVE) on each dimension was 0.775, 0.787, 0.775, 0.792, 0.765, 0.772 and 0.981. Therefore, the scale shows that the data met the requirements and were statistically significant. Hence, the scale had good reliability and validity.

Table 3

Summary table of discriminant validity and correlation analysis of each dimension (n=534)

Item code	**correlation coefficient**						
	DL1	**DL2**	**DL3**	**ISE**	**PD1**	**PD2**	**PD3**
DL1	**0.775**						
DL2	0.550***	**0.787**					
DL3	0.508***	0.549***	**0.775**				
ISE	0.436***	0.454***	0.380***	**0.792**			
PD1	0.328***	0.359***	0.286***	0.347***	**0.765**		
PD2	0.310**	0.358***	0.302***	0.350***	0.573***	**0.772**	
PD3	0.377***	0.385***	0.333***	0.406***	0.567***	0.585***	**0.981**
M	3.432	3.429	3.488	3.335	3.540	3.568	3.422
SD	0.945	0.990	0.969	0.986	0.923	0.920	0.976

Note: *p < 0.05; **p < .01; ***p < 0.001;
DL1=Digital attitude; DL2=Digital skills; DL3=Digital social cognition; ISE=Internet self-efficacy; PD1=Professional knowledge; PD2= Practical ability; PD3= Professional attitude

Structural Equation Modelling

In the path analysis of the overall model, the relationships between digital literacy, Internet self-efficacy, and professional development were examined. As shown in Figure 2, the path coefficient of teachers' digital literacy on their professional development is 0.484 (t=6.861, p < 0.001), indicating that higher digital literacy significantly enhances professional development. This finding aligns with the studies by Pischetola (2021) and Fernández-Batanero et al. (2020), thus supporting Hypothesis 1. Additionally, the path coefficient of digital literacy on Internet self-efficacy is 0.602 (t=10.671, p<0.001), which confirms Hypothesis 2, suggesting that higher digital literacy leads to increased Internet self-efficacy. Furthermore, the coefficient of Internet self-efficacy on professional development is 0.213 (t= 3.555, p < 0.001), demonstrating that enhancing Internet self-efficacy positively impacts professional development, consistent with the claims of Kao and Tsai (2009). Therefore, Hypothesis 3 is also supported.

Based on these results, the relationships between the constructs in this study are both positive and significant. However, to gain deeper insights, exploring the mediating variables that influence teachers' professional development could provide more valuable information.

This study posits that in the context of the digital transformation of education, the relationship between teachers' digital literacy and professional development should be viewed through the lens of Internet self-efficacy to develop a more comprehensive professional development model. From Table 4 and Figure 2, it is evident that the indirect

effect of teachers' digital literacy on their professional development through Internet self-efficacy is 0.128, indicating that Internet self-efficacy serves as a partial mediator in this relationship.

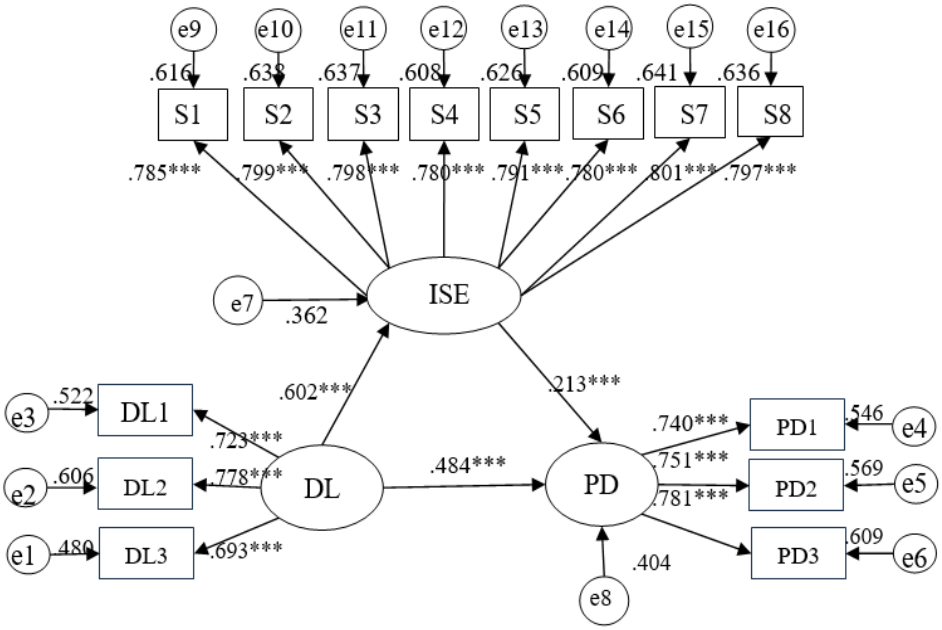

Figure 2: Professional Development Structure Model

Note: DL1=digital attitude; DL2=digital skills; DL3=digital social cognition; ISE (S1-S8) = Internet self-efficacy; PD1=Professional knowledge; PD2= Practical ability; PD3= Professional attitude.

Bootstrap analysis of mediating effect

A structural equation model was used to examine the mediating effect of Internet self-efficacy between digital literacy and professional development. A sample size of 2000 was used in AMOS, and the bias-corrected nonparametric percentile Bootstrap method was applied to test the direct, indirect, and total effects of the hypothesized model. The analysis revealed that the indirect effect of digital literacy through Internet self-efficacy was 0.128 ($p < 0.001$, 95% CI [0.058, 0.200]), with the confidence interval (CI) not including 0, confirming the significance of the indirect effect. Additionally, the direct effect was significant, with a direct effect size of 0.484 (95% CI [0.360, 0.617]), and the CI again did not include 0, indicating that the hypothesized model is a partial mediation model, as shown in Table 4. The total effect was 0.613 (95% CI [0.526, 0.699]), with the mediation effect accounting for 21% of the total effect. The verification of the partial mediation effect demonstrates that digital literacy enhances teachers' professional development through Internet self-efficacy, thus confirming Hypothesis 4.

Table 4

Bootstrap confidence interval test results (n=534)

Item	Path	Estimate	95% confidence interval	
			Lower limit	Upper limit
Direct effect	DL→PD	0.484	0.360	0.617
	DL→ISE	0.602	0.525	0.678
	ISE→PD	0.213	0.087	0.327
Indirect effect	DL→ISE→PD	0.128	0.058	0.200
Total effect	DL→PD	0.613	0.526	0.699

Note: DL= digital literacy; PD=Techers' Professional Development; ISE= Internet self-efficacy.

Discussion

Previous studies on digital literacy have focused on students related issues or self-learning and development using digital literacy. However, teacher-centered issued faced by teachers in the teaching of digital literacy have been ignored (Zimmer & Matthews, 2022). The current study attempt to examine how digital literacy contributes to teachers' professional development and internet self-efficacy. making use of quantitative techniques, this research confirms that digital literacy positively influences teachers' professional development, supporting the hypotheses that digital literacy has a direct effect on Internet self-efficacy and professional development. The direct effect of digital literacy on teachers' professional development is its primary mode of influence. This finding aligns with Agustini et al. (2020), who noted that teachers could enhance their professional levels through digital literacy across the following four competencies: teaching, personal, social and professional. The results indicate that, based on connectivism theory, positive interpretations of digital literacy, through the cultivation and enhancement of digital attitudes, skills and knowledge, can substantially improve the professional development of teachers. Thus, enhancing digital literacy is an essential resource and method for supporting teachers' professional development.

This study also confirms that digital literacy contributes to improving Internet self-efficacy. Teachers with high digital attitudes, skills and knowledge can integrate digital technology and are likely to adopt positive and proactive attitudes towards Internet use, thereby stimulating personal development momentum. This conclusion aligns with the findings of Garzon and Garzon (2023) and (Coklar & Tatli, 2020). The results show a significant positive mediation relationship between teachers' digital literacy and Internet self-efficacy.

The study also confirms that Internet self-efficacy has a significant positive impact on teachers' professional development. This finding indicates that teachers with high Internet self-efficacy possess a belief in success, a proactive attitude and motivation for their professional development. This conclusion is consistent with the research findings of Wu and Wang (2015) and Kahraman and Yilmaz (2018). These studies indicate that Internet self-efficacy is an important predictor of teachers' professional development because it enables teachers to acquire the latest trends and best practices in education by using

considerable amounts of knowledge and resources available online. Other researchers have reported that teachers with high Internet self-efficacy may exhibit remarkable flexibility, adaptability and innovation in response to the demands and environments of digital transformation in education (Ye et al., 2022). They are also likely to adopt innovative approaches to complete teaching, learning, research and management tasks, pursuing continuous professional development.

This study further explores the mediating mechanism between digital literacy and professional development. The results show that high digital literacy can notably strengthen Internet self-efficacy, and high Internet self-efficacy contributes to teachers' professional development. This finding is consistent with the research of Mohalik (2020), Reisoğlu (2021), Rains (2008) and Fan et al. (2023), demonstrating that in the context of digital educational transformation, the influence of Internet self-efficacy on professional development cannot be ignored.

This study also found that Internet self-efficacy plays a partial mediating role in the relationship between digital literacy and teachers' professional development, consistent with the findings of Kim and Glassman (2013) and Gokbel (2020). These studies indicate that Internet self-efficacy is a direct or indirect factor in the willingness and ability to harness the potential of information technology. This finding is due to the willingness of individuals with high Internet self-efficacy to explore, seize opportunities and attempt to use rapidly evolving Internet applications to solve problems. Therefore, Internet self-efficacy mediates the relationship between ICT use and professional development. Teachers with high Internet self-efficacy have positive views of their development potential. Internet self-efficacy is also considered a necessary pathway in teachers' professional development.

Last, but not the least, the model validation in the study confirmed that teachers develop a proactive cognitive attitude in digital environments when they have a positive and high level of Internet self-efficacy, which, in turn, promotes their professional development. This is consistent with Cavus and Ercag (2014) and Yasan Ak (2020), who also revealed that sources of improving Internet self-efficacy can be derived from offering Internet-based professional development programmes that increases confidence in technology integration. For example, online professional development courses focusing on self-regulated learning skills can be implemented, or effective and reliable tools can be developed to assess the abilities of teachers in various online tasks promptly.

Conclusion

This study explores the relationships between digital literacy, Internet self-efficacy and professional development amongst university teachers in Jiangsu Province, China. The research confirms that digital literacy not only directly influences professional development but also affects it through Internet self-efficacy.

Based on the findings, the following recommendations are proposed. Firstly, cultivating the positive digital attitudes of teachers is crucial, enhancing their openness, enthusiasm and inclusiveness towards emerging digital technologies. Strengthening the digital awareness of teachers is also essential because they should be encouraged to view digital technology not merely as a tool but as a transformative force that can profoundly

influence their development philosophies, methods and practices. Secondly, comprehensive digital skills training should be provided to teachers. Training programmes should cover a wide range of digital tools and platforms, including productivity software, educational applications, multimedia resources, online collaboration tools and learning management systems. Thirdly, studies should focus on developing the digital social cognition of educators, which includes cultivating critical thinking skills and using digital information technologies safely, legally and ethically. Such a development will enable teachers to integrate these skills into their professional development practices, promoting collaboration, creativity and critical inquiry.

Targeted training programmes emphasizing credibility, creativity, technical knowledge and information retrieval skills should be implemented based on the results. Therefore, this study recommends the use of Web 2.0 technologies to create interactive online learning environments for professional development programmes. These environments should be designed in combination with the practical learning and work experiences of teachers, offering informal blended training courses that include goal setting, time management, peer collaboration and feedback mechanisms to support teacher development. Additionally, collaboration with educators and technology experts should be strengthened to design user-friendly, accessible tools that address specific problems teachers encounter in practice.

Furthermore, a timely assessment of the use of online platforms by teachers, digital content creation and technology-related learning needs should be conducted. Formative and summative assessment strategies should also be implemented to evaluate online information sources, enhance instructional design creativity and improve technical abilities and information retrieval skills, ultimately reinforcing learning outcomes.

Limitations and future research directions

This study has several limitations, leading to the following four suggestions for future research: Firstly, sampling conditions were set to increase the sample representativeness in this study. A total of 534 valid questionnaires were collected for analysis by selecting five universities in Jiangsu Province, China. Suggestions indicate that future research can expand the sample size or conduct comparative analyses across different regions to understand the variations. Alternatively, future studies can focus on the specific needs of particular teacher groups; for example, the effect of digital literacy amongst teachers working in underdeveloped areas on their professional development, providing those with targeted interventions and support strategies. Secondly, a cross-sectional design was adopted in this study. To some extent, this design limits the capability to establish causal relationships between variables. The longitudinal or experimental designs can be adopted in the future to provide robust evidence of causality.

Thirdly, Internet self-efficacy is confirmed as a mediating variable between digital literacy and teachers' professional development. Other potential moderating factors that may influence the relationship between digital literacy, Internet self-efficacy and professional development can be investigated in the future; for example, investigating the effects of social expectations, school culture, resources or leadership support on the integration of digital skills into the teaching practices, learning and research of teachers could be valuable.

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