

Research Article

Investigating the role of preservice teachers' digital transformation awareness in shaping their information literacy skills

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This study investigates the relationship between preservice teachers' digital transformation awareness and their 21st-century information literacy skills. A cross-sectional survey design was employed with 378 preservice teachers at a Turkish state university. Data were collected through a Personal Information Form, the Digital Transformation Awareness in Education Scale, and the 21st Century Information Literacy Skills Scale. Analyses included descriptive statistics, *t*-tests, ANOVA, correlation, and hierarchical regression analyses. The findings revealed that preservice teachers possessed moderate levels of digital transformation awareness and high levels of information literacy skills. No significant differences were found in digital transformation awareness or information literacy skills in terms of gender. However, significant differences were observed across year of study and technology-assisted instructional experience, with upper-year students and those with more frequent and technology-assisted instructional experience demonstrating higher levels of both skills. Daily internet usage significantly predicted digital transformation awareness but not information literacy skills. Hierarchical regression analysis indicated that digital transformation awareness, year of study, and frequency of technology-assisted instructional experience together explained 28% of the variance in information literacy skills, with digital transformation awareness being the strongest predictor. These results suggest that enhancing preservice teachers' awareness of digital transformation in education may play a key role in fostering their information literacy skills, which are critical for effective teaching in digitally rich learning environments.

Keywords: Digital transformation awareness; Digital literacy; Information literacy skills; Preservice teachers

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1. Introduction

The rapid development of digital technologies has made it possible to access any information from anywhere at any time, resulting in a vast accumulation of data. However, the abundance of information requires not only access but also an understanding and effective use of that information (Botturi & Beretta, 2022). In this context, information literacy skills [ILS] have become critical for success in today's complex world, especially in education.

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Information literacy skills represent a broad and multidimensional construct that encompasses various forms of literacy, including digital, visual, media, academic, information processing, news, data organization, and data management (Society of College National and University Libraries [SCONUL], 2011). Beyond these technical dimensions, ILS also include essential 21st-century competencies such as critical thinking (Grafstein, 2017), problem solving (Ananiadou & Claro, 2009), communication (Dadakhonov, 2024), lifelong learning (Feng & Jih-Lian, 2016), and learning to learn (Anthonysamy et al., 2020). In today's information-rich environment, especially with the rapid proliferation of online content, younger generations must not only access information but also develop the ability to filter, evaluate, and use it effectively (Trixa & Kaspar, 2024). Within this framework, digital literacy—one of the core components of ILS—refers to the ability to access, evaluate, store, and utilize information through the critical and ethical use of information and communication technologies (Chartered Institute of Library and Information Professionals [CILIP], 2018). The increasing complexity and diversity of digital information resources in the modern world have necessitated a shift in educational systems to align more closely with these skills (Eisenberg, 2008). In response, many countries—including Türkiye, Finland, Singapore, the United Kingdom, and Canada—have placed growing emphasis on digital literacy and information literacy within their national curricula, acknowledging them as foundational to 21st-century learning (Ministry of National Education [MoNE], 2024; OECD, 2021; Polizzi, 2020). These curricular approaches aim to cultivate students' abilities to critically engage with information while integrating digital technologies into subject-based learning through cross-disciplinary strategies. Consequently, teachers' competencies in ILS, their awareness of digital transformation, and their effective use of digital tools are key to the successful implementation of these curricula in classroom settings.

Digital transformation in education refers to the integration of digital technologies into teaching and learning processes to enhance educational practices, improve learning outcomes, and increase efficiency (Mhlanga, 2024; Thai et al., 2021). In education, digital transformation is not limited to the adoption of technologies but also includes fostering the necessary skills and awareness to effectively utilize these technologies for teaching and learning. The ILS and digital transformation awareness [DTA] of teachers are also crucial for the integration of digital technologies in the educational process. Teachers need to use digital technologies in the teaching process, keeping up with the rapid development of technologies in different areas of knowledge, to ensure digital transformation in education (Schleicher, 2016). In addition, some studies have shown that the use of digital technology in the classroom has a positive effect on conceptual learning and retention (Alkhabra et al., 2023; Ginting et al. 2024; Wu, 2024), attitudes, student motivation and class participation (e.g., Bhoje, 2015; Lin et al., 2017). Barron et al. (2001) reported that digital technology encourages critical thinking, improves communication skills and provides opportunities for students to explore, learn and motivate themselves. On the other hand, the ILS and DTA deficiencies of teachers may negatively affect their ability to transfer these skills to students in the classroom environment (Durodolu, 2018). In this context, in our era of rapid information and technology development, teachers who organize learning environments need to have high levels of ILS and DTA. It is especially important for preservice teachers to have these skills to guide their students in their future careers and help them manage information access (Nieto-Isidro et al., 2023; Trixa & Kaspar, 2024).

1.1. Importance of Information Literacy and Digital Transformation Skills in Education

Information literacy is concerned with information in all its forms, not only in print but also in digital content, data, images, and spoken words. Information literacy is related to and intersects with other literacies, including academic literacy, digital literacy, and media literacy (CILIP, 2018). SCONUL (2011) stated that ILS requires an awareness of the ethics of using, managing, synthesizing, and creating information, as well as information literacy skills for effective use. The CILIP information literacy model includes eight skills that a person should have to become

information literate. They include the need or requirement for information, the availability of resources, how to retrieve information, how to calculate the result(s), how to apply the results to work, accountability and integrity in the use of information, how to share the results, and how to address the results (CILIP, 2018).

Technological developments in the 21st century have led to radical changes in the field of education, and these changes have had a profound impact on learning environments (Huang & Yang, 2016). An important component of ensuring change and development is creating digital learning environments by integrating learning processes with technology (Ellis & Goodyear, 2016). ILS is defined as a key competence for the 21st century and is increasingly being integrated into curricula (Botturi & Beretta, 2022). The integration of digital technologies into the educational process has radically changed the way information is accessed and used, and it requires both teachers and students to adapt to this new structure.

The digital transformation in education is built on an understanding that considers the individual characteristics of students, is compatible with social and professional relationships, equips teachers with digital competencies, and provides students with the cognitive, social, and affective skills required in the 21st century (Oliveira & De Souza, 2022). This process is supported by innovations such as artificial intelligence, data management, robotics, cloud computing and sustainable technologies and is different from traditional educational approaches (González-Pérez & Ramírez-Montoya, 2022).

Digital transformation has the potential to restructure education systems, and teachers' digital skills play a critical role in this transformation process (Hammons, 2020). To realize digital transformation, teachers must attain competence in accessing, managing, and critically evaluating information—a point emphasized by Fernández- Otoya et al. (2024), whose systematic review of WOS-indexed studies demonstrates persistent needs for formal training programs that empower teachers in information literacy strategies. Studies suggest that the integration of digital technologies into teaching processes depends on teachers' competences in using these technologies effectively and creatively (Antonietti et al., 2022). Teachers' digital transformation competence is a set of knowledge, skills, and attitudes necessary for effectively integrating ICT in teaching practice across technological, informational, multimedia, communicative, collaborative, and ethical dimensions (Basilotta- Gomez- Pablos et al., 2022). Research has indicated that teachers' digital competences have a direct effect on classroom practices and student achievement (Birgin et al., 2020; Claro et al., 2024).

In the digital transformation process, not only teachers' ability to use digital tools but also their ability to critically evaluate and ethically use the information obtained through these tools are highly important (Spiteri & Chang Rundgren, 2020). During the integration of digital technologies into educational processes, teachers are responsible for questioning the accuracy and reliability of the information provided by these technologies. ILS, one of the most important components of digital transformation in education, stands out as a critical competence for teachers to adapt to this new era. Deja et al. (2021) suggested that teachers with ILS could carry out digital transformation processes more effectively and provide these skills to their students more efficiently.

It is important to develop teachers' information literacy skills and digital transformation awareness to support authentic digital integration in education. Studies have shown that many preservice teachers regard themselves as only moderately prepared—or even underprepared—for navigating the digital demands of today's classrooms (Aleksieva, 2025; Ilhami et al., 2021). Moreover, research with experienced or in-service teachers indicates that structured professional development in digital pedagogy can significantly increase both their DTA and ILS levels (Getenet et al., 2024; Hizam et al., 2021). Therefore, instilling these competencies early in teachers' careers is crucial for facilitating the smooth integration of digital technologies into educational processes and for strengthening the foundations of digital transformation in education.

1.2. Previous Research Results on the ILS and DTA of Preservice Teachers

Many studies in literature have focused on the ILS and digital transformation skills of preservice teachers. Some studies have shown that the ILS levels of preservice teachers are sufficient (e.g., Bates et al., 2017; De Vera & Valencerina, 2022; Lim, 2023; Peled, 2021), whereas others have shown that their ILS levels are low and insufficient (e.g., Lucas et al., 2021; Shannon et al., 2019; Yan, 2024). Recent research has also shown that DTA levels can vary significantly based on demographic factors such as gender and instructional modality, with female preservice teachers and those in hybrid learning environments demonstrating stronger digital competence and engagement (Getenet et al., 2024). Supporting this, Alnasib (2023) found that a substantial proportion of preservice teachers rated themselves as highly competent in digital skills, yet many acknowledged only moderate readiness for digital teaching integration. Similarly, Khanal et al. (2020) documented high levels of digital awareness among mathematics teachers, reflecting the global trend toward integrating digital competencies in teacher education. Furthermore, Ho (2024) emphasized that DTA significantly impacts students' satisfaction and their intention to engage in online learning, while experimental interventions—such as Yurdakal (2024) — demonstrated that structured digital learning experiences significantly improved preservice teachers' DTA in educational contexts.

In addition, several studies have examined teachers' and preservice teachers' digital competencies and their use of ICT in the classroom (e.g., Pozas & Letzel, 2023; Tondeur et al., 2018; Tzafilkou et al., 2023). For instance, Torres-Hernández and Gallego-Arrufat (2022) conducted a systematic review of digital competence studies and emphasized the need for structured assessment indicators, particularly in the areas of digital security and ethics, within teacher education programs. Similarly, Merjovaara et al. (2024) found that preservice teachers with more positive attitudes toward digital technology also demonstrated higher self-perceived digital competence, especially in technological knowledge and pedagogical content knowledge. Basilotta-Gómez-Pablos et al. (2022) conducted a systematic review study in Web of Science and Scopus to identify, analyze, and classify articles published between 2000 and 2021 on the digital literacy of teachers in the university context. The results revealed that teachers have low or medium levels of digital literacy, along with deficiencies in key areas such as evaluating teaching practices. Bond et al. (2018) investigated the effects of digital transformation in higher education on the awareness and use of digital media among students and lecturers at German universities, showing that both groups had limited engagement with digital technology. Similarly, Tekleselase (2021) found that while teachers and students in higher education recognize the importance of digital technologies for academic performance, especially among high-achieving students, their actual digital skill levels remain relatively limited. Zakharov et al. (2021) also explored the ILS and digital competencies of preservice teachers in the context of educational digital transformation and found that most preservice teachers exhibit moderate ICT literacy in using digital tools in the classroom.

1.3. Rationale for the Study

The motivation for this study stems from the increasing importance of both information literacy skills and digital transformation awareness in the evolving landscape of education. As digital technologies become more integral to teaching and learning processes, educators are required not only to possess technical skills but also to effectively manage and apply information in innovative and pedagogically sound ways. Understanding the relationship between preservice teachers' ILS and DTA is critical for equipping future educators with the competencies needed to navigate these digital environments. These skills determine not only how teachers use existing technologies but also how they handle and manage the information provided by these technologies (Yurdakal, 2024; Zakharov et al., 2021). Previous studies have identified various factors influencing information literacy and digital competence, such as gender (e.g., Cabezas-González, 2021; Guillén-Gámez et al., 2021; Lucas et al., 2021; Zhao et al., 2021), year of study (e.g., Aharony & Gazit, 2019; Yang et al., 2022), frequency of technology use (e.g., Birgin et al., 2020; Yang et al.,

2022), internet usage (Ata & Yıldırım, 2019), perceived support for ICT (e.g., Aharony & Gazit, 2019; Eryansyah, 2020) and beliefs toward digital transformation (Eryansyah, 2020). While some studies have focused on ILS and digital transformation skills separately, no studies have examined the interplay between these two essential skills, particularly in the context of teacher education. Therefore, there is a need for a study that examines the ILS and DTA levels of preservice teachers and focuses on the relationships among them. In this context, the answers to the following questions are examined:

RQ 1) What are the ILS and DTA levels of preservice teachers?

RQ 2) Do the ILS and DTA levels of preservice teachers differ significantly in terms of gender, year of study, daily internet usage, and technology-assisted instruction (TAI) experience?

RQ 3) Do gender, year of study, daily internet usage, TAI experience and level of DTA predict the ILS levels of preservice teachers?

2. Method

2.1. Research Design

This study employed a quantitative, cross-sectional survey design to investigate the current levels of preservice teachers' Information Literacy Skills and their Digital Transformation Awareness. The cross-sectional nature of the design allowed for the collection of data at a single point in time, thereby providing a snapshot of participants' competencies and perceptions during the study period.

2.2. Participants

This study used a quantitative cross-sectional survey design to investigate the ILS and DTA levels of preservice teachers. The participants were selected via convenience sampling. The participants were 378 preservice teachers enrolled in different study programs at the Faculty of Education of a public university in Western Türkiye. As shown in Table 1, 75.5% of the participants were female, and 24.5% were male, ranging in age from 17--26 years. In terms of the year of study of preservice teachers, 20.1% of them were freshmen, 23.0% were sophomores, 41.8% were juniors, and 15.1% were seniors. With respect to their study programs, 13.5% were in elementary mathematics education, 4.8% in elementary science education, 11.9% in special education, 22.8% in preschool education, 9% in elementary education, 6.6% in Turkish education, 11.1% in social science education, and 20.4% in psychological counseling and guidance.

All first-year preservice teachers attended a 3-hour information technology course each week. The course covers basic computer knowledge and skills with an emphasis on introductory hardware and common operating systems. In more advanced classes, preservice teachers experience computer-assisted instruction in many subjects and actively use computers and communication technologies to complete many tasks, assignments and research projects.

Table 1

Demographic characteristics of the participants

<i>Gender</i>	<i>n</i>	<i>%</i>	<i>Study Program</i>	<i>n</i>	<i>%</i>
Female	287	75.5	Elementary mathematics education	51	13.5
Male	93	24.5	Elementary science education	18	4.8
<i>Year of Study</i>			Special Education	45	11.9
Freshmen	76	20.1	Preschool Education	86	22.8
Sophomore	87	23.0	Elementary school education	34	9
Junior	158	41.8	Turkish education	25	6.6
Senior	57	15.1	Social science education	42	11.1
			Psychological Counseling and Guidance	77	20.4

2.3. Data Collection

In this study, data were collected via a “Personal Information Form”, the “Digital Transformation Awareness Scale in Education”, and the “21st Century Information Literacy Skills Scale”.

2.3.1. Personal information form

This form was organized by the researchers and included questions to collect data about the demographic information of the participants, such as gender, study program, and year of study. This form also includes questions about daily internet usage (1= less than 4 hours, 2 = 4-6 hours, 3 = more than 6 hours) and the TAI experiences for lessons or assignments (1= rarely, 4 = very often).

2.3.2. Digital transformation awareness scale in education

The DTA scale was developed by Yurdakal (2023). The DTA scale consists of a total of 50 items with a 5-point Likert scale and has three subfactors, including concept-oriented transformation (33 items), education-oriented transformation (9 items), and individual-oriented transformation (8 items). Concept-oriented transformation includes conceptual transformations such as digital tools, mobile learning, e-books, the metaverse, and digital reading/writing (e.g., “The metaverse can positively contribute to an individual's socialization.” and “Mobile learning provides spatial flexibility.”). Education-oriented transformation addresses the use and impact of digital technologies in educational processes (e.g., “It is important to develop digital literacy skills starting from primary school” and “Social networks can be effectively used in educational processes.”). Individual-oriented transformation focuses on generational differences, digital adaptation, and individuals' relationships with technology (e.g., “Generation Z adapts to digital transformation more easily than does Generation X” and “The number of individuals belonging to the Alpha generation is steadily increasing”).

The DTA scale consists of 47 positive items and 3 negative items. The factor loadings of the DTA scale ranged from .34 to .81 and accounted for 45.19% of the total variance. The total DTA scale scores ranged from 50 to 150. High scores on the scale indicate higher levels of DTA. Yurdakal (2023) reported that the Cronbach alpha coefficients of the overall DTA scale and its subfactors were 0.957 (total DTA scale), 0.954 (first factor), 0.843 (second factor), and 0.793 (third factor). In this study, the Cronbach's α coefficient of the overall scale and subfactors ranged from 0.84 to 0.93.

2.3.3. 21st century information literacy skills scale

The ILS scale was developed by Kalaycı and Eşgi (2024). The ILS scale consists of 12 five-point Likert-type items and has two subfactors: “ability to use information and legal elements” (7 items) and “accessing information and sharing information” (5 items). The ability to use information and legal elements focuses on an individual's ability to access, use, and evaluate information effectively while also considering the legal and ethical implications of information usage (e.g., “I evaluate different ideas together for the same information” and “I pay attention to legal aspects when accessing information”). The access and sharing information dimension emphasize the ability to access relevant information and share it responsibly (e.g., “I use secure internet addresses when accessing information sources” and “When I cannot find the information I need, I ask others for help”). The factor loadings of the scales ranged from .56 to .69 and accounted for a total variance of 46.95%. The ILS scale scores ranged from 12 to 60. Kalaycı and Eşgi (2024) reported that the Cronbach's α coefficients of the total scale and subfactors were 0.94 (total scale), 0.77 (first factor), and 0.74 (second factor), respectively. In this study, the Cronbach's α coefficient of the ILS scale and subfactors ranged from 0.82 to 0.90.

2.3.4. Procedure

The data collection process was conducted face-to-face at the Faculty of Education. The researchers distributed the surveys to participants during their regular class hours to ensure voluntary and

efficient participation. Each participant was given 20 minutes to complete the surveys, with the researchers available to clarify any questions. The participants were assured of the anonymity and confidentiality of their responses, and ethical approval was obtained before initiating the study. Before starting the survey, the participants were informed about the study's purpose, their voluntary participation, and the confidentiality of their responses.

2.4. Data Analysis

In this study, the DTA and ILS scale items were scored from 1 “strongly disagree” to 5 “strongly agree”. The negative items on the DTA scale were reverse scored. Higher scores on the scales indicate higher levels of preservice teachers’ DTA and ILS. To interpret the mean scores of the scales, the possible score ranges were divided into three equal intervals representing low, moderate, and high levels. For the DTA scale, which ranges from 33 to 165, scores between 33–87 were considered low, 88–121 moderate, and 122–165 high. For the ILS scale, with a range of 12 to 60, scores between 12–27 were classified as low, 28–43 as moderate, and 44–60 as high. This classification method was based on the formula: (maximum score – minimum score) / 3. The data were analyzed via the Statistical Procedures for Social Sciences 22.0 package program. The normality assumption, linearity, and extreme values were evaluated before the data analysis. Outlier data scores were removed from the analysis. The skewness and kurtosis values of the scales ranged from -1 to +1. Standardized z scores for the detection of outliers ranged from -3 to +3. These results indicated that the data were distributed normally. Descriptive statistics, t-tests for independent samples, ANOVA, correlation analysis and hierarchical regression analysis techniques were used to analyze the data.

3. Results

3.1. Results on the Levels of DTA and ILS of the Preservice Teachers

The results of the descriptive statistics on the levels of DTA and ILS of the preservice teachers are presented in Table 2.

Table 2

Descriptive statistics results for DTA and ILS scores

<i>Variable</i>	<i>n</i>	<i>Min.</i>	<i>Max.</i>	<i>M</i>	<i>SD</i>	<i>Skewness</i>	<i>Kurtosis</i>
DTA Scale	378	76	143	114.02	14.95	-.138	-.609
Education oriented transformation	378	9	27	20.47	4.12	-.211	-.482
Individual oriented transformation	378	8	24	17.84	3.07	-.223	.041
Concept oriented transformation	378	46	105	75.70	10.08	-.124	-.396
ILS Scale	378	29	60	47.98	5.56	-.163	.638
Accessing information and sharing information	378	10	25	20.35	2.77	-.439	.544
Ability to use information and legal elements	378	17	35	27.63	3.48	-.076	-.202

As shown in Table 2, the level of preservice teachers’ DTA in education is moderate ($M = 114.02$, $SD = 14.95$). The awareness of preservice teachers in terms of the “education-oriented transformation” ($M = 20.47$), “individual-oriented transformation” ($M = 17.84$), and “concept-oriented transformation” ($M = 75.70$) subfactors was moderate. The results in Table 2 indicate that the 21st century ILS level of preservice teachers is high ($M = 47.98$, $SD = 5.56$). Similarly, the preservice teachers’ skills related to “accessing information and sharing information” ($M = 20.47$) and “ability to use information and legal elements” ($M = 75.70$) subfactors are at a relatively high level.

3.2. Results regarding the DTA and ILS of Preservice Teachers in terms of Gender

The results of the level of DTA and ILS of the preservice teachers in terms of gender are presented in Table 3. The results in Table 3 show that there was no significant difference in the preservice teachers' DTA [$t_{(376)} = 1.048, p > .05$] or ILS [$t_{(376)} = 1.803, p > .05$] according to gender. In other words, the DTA and ILS levels of the male and female preservice teachers did not significantly differ.

Table 3

Independent samples t test results by gender

Variable	N	M	SD	df	t	p
DTA Scale						
Female	285	114.48	14.83	376	1.048	.295
Male	93	112.61	15.33			
ILS Scale						
Female	285	48.28	5.37	376	1.803	.072
Male	93	47.08	6.05			

3.3. Results regarding the DTA Level of Preservice Teachers according to Year of Study, Daily Internet Usage, and TAI Experience

As shown in Table 4, there was a significant difference between the DTA of preservice teachers in terms of their year of study [$F_{(3-374)} = 7.48, p < .001$]. Tukey's HSD post hoc analysis revealed that juniors and seniors had significantly higher levels of DTA than freshmen did.

Table 4

Results of ANOVA for the DTA level of preservice teachers by year of study, daily internet usage, TAI experience

Variable	n	M	SD	df	F	p	Difference
Year of study							
(1) Freshmen	76	108.11	14.89	3	7.48	<.001	3 > 1
(2) Sophomore	87	112.56	14.34				4 > 1
(3) Junior	158	115.88	14.30				
(4) Senior	57	118.96	15.29				
Daily internet usage							
(A) Less than 4 hours	122	110.85	15.91	2	5.32	.005	C > A
(B) 4-6 hours	162	114.66	13.50				
(C) More than 6 hours	93	117.34	15.24				
TAI experience							
(A) Rarely	20	104.60	17.67	3	5.41	.001	C > A
(B) Sometimes	98	112.06	14.03				D > A
(C) Often	177	114.28	14.61				D > B
(D) Very often	83	118.04	14.90				

There was a significant difference between the DTA levels of preservice teachers in terms of daily internet usage [$F_{(2-375)} = 5.32, p < .01$], as presented in Table 4. Tukey's HSD post hoc analysis revealed that preservice teachers who spent more than 6 hours on the internet had a significantly higher level of DTA than those who spent less than 4 hours on the internet.

The results in Table 4 show that there was a significant difference in the DTA level of preservice teachers in terms of their TAI experience [$F_{(3-374)} = 5.41, p < .01$]. Tukey's HSD post hoc analysis revealed that preservice teachers who had more TAI experience had significantly higher levels of DTA than those who had rarely or sometimes experienced them. Furthermore, preservice teachers who sometimes or often experienced them had significantly higher levels of DTA than those who rarely experienced them.

3.4. Results regarding the ILS Level of Preservice Teachers according to Year of Study, Daily Internet Usage, and TAI Experience

As shown in Table 5, there was a significant difference between the ILS levels of preservice teachers in terms of their year of study [$F_{(3-374)} = 10.21, p < .001$]. Tukey's HSD post hoc analysis revealed that sophomores, juniors and seniors had significantly higher levels of ILS than freshmen did, and sophomores also had significantly higher levels of ILS than freshmen did.

Table 5

Results of ANOVA for the ILS level of preservice teachers by year of study, daily internet usage, and TAI experience

Variable	n	M	SD	df	F	p	Difference
Year of study							
(1) Freshmen	76	45.42	5.40	3-374	10.21	<.001	2 > 1
(2) Sophomore	87	47.64	5.59				3 > 1
(3) Junior	158	48.55	5.15				4 > 1
(4) Senior	57	50.36	5.56				4 > 2
Daily internet usage							
(A) Less than 4 hours	122	47.30	5.71	2-374	1.43	.241	n.s
(B) 4-6 hours	162	48.35	5.24				
(C) More than 6 hours	93	48.31	5.85				
TAI experience							
(A) Rarely	20	41.95	5.64	3-374	18.80	<.001	B > A
(B) Sometimes	98	46.61	5.12				C > A, D > A
(C) Often	177	48.15	5.28				D > B
(D) Very often	83	50.69	5.03				D > C

The results in Table 5 show that there was no significant difference in the ILS levels of preservice teachers in terms of daily internet usage [$F_{(2-374)} = 1.43, p > .05$]. However, there was a significant difference in the ILS levels of preservice teachers in terms of their TAI experience [$F_{(3-374)} = 18.80, p < .01$]. Tukey's HSD post hoc analysis revealed that preservice teachers who had more TAI experience had significantly higher ILS levels than those who had rarely, sometimes, or often experienced TAI. Furthermore, the ILS levels of preservice teachers who had sometimes, or often experienced TAI were significantly higher than those of those who had rarely experienced it.

3.5. Results of Hierarchical Regression Analysis of the Variables Predicting Preservice Teachers' ILS

To identify the relationships between the dependent and independent variables, a Pearson correlation analysis was conducted. The findings revealed a significant correlation between the ILS and DTA, year of study and TAI experience. As shown in Table 6, there was a moderately significant positive correlation between year of study and ILS [$r = .271, p < .01$] and between TAI experience and ILS [$r = .350, p < .01$]. There was also a significant moderate correlation between the ILS and DTA [$r = .433, p < .01$].

Hierarchical regression analysis was employed to identify the variables that predict preservice teachers' ILS. The VIF values ranged between 1.024 and 1.121, and the tolerance statistics were all above 0.1, indicating that there was no multicollinearity between the independent variables in the regression model. The Durbin-Watson statistic was 1.53, indicating that there were no independent errors caused by the residuals (Field, 2013).

The results of the hierarchical regression analysis are presented in Table 7. In the first step, a model (Model-1) was developed to determine the effects of independent variables such as gender, year of study, daily time spent on the internet, and frequency of TAI experience on ILS. In the second step, the awareness score related to digital transformation in education was added to these variables, resulting in the creation of Model 2.

Table 6
Pearson correlation test results

Variable	1)	2)	3)	4)	5)	6)
1) Gender	1	.024	-.139**	-.056	-.054	-.093
2) Year of Study		1	.098	.260**	.237**	.271**
3) Daily internet usage			1	.120*	.165**	.072
4) TAI experience				1	.196**	.350**
5) DTA					1	.433**
6) ILS						1

Notes: ILS = Information literacy skills, TAI = Technology-assisted instruction, DTA = Digital transformation awareness
* $p < .05$ ** $p < .01$

Table 7
Results of hierarchical regression

	B	Beta	t	p	R	R ²	ΔR^2
Step 1					.405	.164	.164
Constant	38.622		21.008	.000			
Gender	-1.030	-.080	-1.663	.097			
Year of study	0.280	0.196	3.971	.000			
Daily internet usage	0.053	0.007	.147	.883			
TAI experience	1.995	0.294	5.944	.000			
Step 2					.528	.279	.115
Constant	26.445		11.366	.000			
Gender	-.874	-.068	-1.518	.130			
Year of study	.724	.127	2.726	.007			
Daily internet usage	-0.281	-.038	-.839	.402			
TAI experience	1.683	.248	5.349	.000			
DTA scale	.133	.357	7.712	.000			

According to Table 7, both models developed in the hierarchical regression analysis were found to be statistically significant. In the first stage, gender, year of study, daily internet usage, and TAI experience explained approximately 16% of the variance in ILS. While gender and daily internet use had no significant effect on ILS, years of study and TAI experience were found to significantly increase preservice teachers' ILS.

In the second stage, when preservice teachers' DTA in education was added to the model, the explained variance increased by 11.5%, and this increase was significant. The hierarchical regression analysis results indicated that gender, year of study, daily internet usage, TAI experience, and DTA together explained 28% of the variance in preservice teachers' ILS. In this second model, the variable with the highest impact on ILS was DTA in education ($\beta = .357$), followed by TAI experience ($\beta = .248$) and year of study ($\beta = .127$). Gender and daily internet use were found to have no significant effect on preservice teachers' ILS.

4. Discussion

This study investigated the levels of preservice teachers' information literacy skills and digital transformation awareness, as well as the relationship between these constructs. The findings revealed that preservice teachers demonstrated a moderate level of DTA, which is consistent with emerging international evidence. For instance, Aleksieva (2025) reported that many preservice teachers perceive themselves as inadequately prepared for the digital age, despite having been exposed to various digital tools during their training. Similarly, Ilhami et al. (2021), in a large-scale study focusing on science education candidates, found moderate levels of digital literacy and

readiness for online learning, with notable deficiencies in areas such as digital content creation. Complementing these findings, several other studies have also emphasized that the digital competence of both in-service and preservice teachers tends to be limited or moderate (e.g., Basilotta-Gómez-Pablos et al., 2022; Zakharov et al., 2021). For example, Basilotta-Gómez-Pablos et al. (2022) identified significant gaps in university educators' digital competencies, particularly regarding the evaluation of teaching practices, while Zakharov et al. (2021) reported that most preservice teachers exhibited only moderate levels of ICT literacy and faced challenges when integrating digital tools into instructional activities. Collectively, these findings underscore the need for more comprehensive and pedagogically grounded approaches to digital competence development within teacher education programs.

On the other hand, some recent studies suggest a shift toward higher digital competence among educators (e.g., Tomczyk, 2024; Valtonen et al., 2021). For instance, Tomczyk (2024) conducted a large-scale Delphi study across 33 countries and reported that pre-service teachers now demonstrate advanced capabilities in creating, retrieving, managing digital content, and integrating ICT pedagogically. This change may be attributed to the increasing integration of digital tools in teaching following the COVID-19 pandemic (Pokhrel & Chhetri, 2021), which required a rapid transition to emergency remote teaching. In fact, the experience gained in distance education environments is likely to have improved preservice teachers' digital transformation awareness (Sales et al., 2020). Therefore, enhancing preservice teachers' ability to effectively find, evaluate, create, and communicate information using digital tools can contribute to further development of their DTA levels.

The finding that preservice teachers exhibit high levels of information literacy skills (ILS) is consistent with recent international research highlighting their growing digital and informational fluency. For instance, Trixa and Kaspar (2024) reported that preservice teachers not only rely predominantly on digital media for information acquisition but also develop a strong sense of competence in teaching information assessment, especially when they employ diverse evaluation strategies. Similarly, Peciuliauskiene et al. (2022) demonstrated that information evaluation literacy has a significant positive impact on preservice teachers' ICT self-efficacy in teaching, underscoring the interconnection between ILS and technology-related confidence in educational contexts. Additionally, systematic reviews indicate that while preservice educators generally display elevated information and digital literacy, there remains a clear need for deeper integration of these competencies into pedagogical practices to enhance critical thinking and reflective use (Fernández-Otoya et al., 2024). These findings reinforce the outcomes of the current study and underscore the importance of teacher education programs continuing to strengthen both the technical and pedagogical dimensions of literacy development.

The results of this study indicated that gender did not significantly differ the level of DTA in education or the ILS of preservice teachers. Although this finding contradicts the results of some studies in different countries (e.g., Garcia-Martin & Garcia-Sanchez, 2017; Guillén-Gámez et al., 2021; Lucas et al., 2021; Zhao et al., 2021), this study confirms the findings of previous studies (e.g., Aharony & Gazit, 2019; Cabezas-González, 2021; Tondeur et al., 2018; Usluel, 2006; Yang et al., 2022) that gender, as a sociodemographic factor, does not significantly differ preservice teachers' level of digital competence and information literacy. The findings of this study indicate that gender does not play a significant role in the development of preservice teachers' information literacy skills or adaptation to digital transformation, as these aspects can be concerned more with educational background, encouragement by an institution and internal motivation. This further suggests that strategies aimed at improving ILS and digital literacy in teacher education programs can be adopted equally well by both genders.

The results of this study indicated that the level of DTA in education and the ILS of preservice teachers differ significantly according to the year of study. The DTA and ILS of junior and senior preservice teachers are significantly greater than those of first- and second-year preservice teachers. This result is consistent with previous findings that senior preservice teachers have

significantly greater information literacy (e.g., Nurzhanova et al., 2023) and digital literacy and competence (e.g., Birgin et al., 2020; Cabezas-González et al., 2021; Can et al., 2020). This result may be explained by the fact that during the teacher education process, preservice teachers provide more courses and activities that require the integration of technology-enhanced resources and applications into teaching, including accessing, using and evaluating information. In this respect, senior and junior preservice teachers had more opportunities to gain experience and develop these skills during their initial teacher education.

This study revealed that the DTA of preservice teachers differed significantly in terms of daily internet use, with those spending more than six hours per day scoring higher. This finding aligns with previous research indicating that digital literacy perceptions vary with internet use frequency (Bond et al., 2018; Garcia-Martin & Garcia-Sanchez, 2017). However, recent studies suggest that this relationship is not always straightforward. For instance, Yi (2024) found no significant correlation between the amounts of time spent online and preservice teachers' digital literacy levels. Similarly, no significant difference was found in this study regarding preservice teachers' ILS based on daily internet use. In contrast, studies have shown that preservice teachers who use the internet for academic or instructional purposes—such as lesson planning or educational research—demonstrate stronger information literacy and instructional decision-making competencies (Sawyer & Myers, 2024). These findings highlight the importance of considering not only the frequency but also the purpose and quality of online engagement in relation to digital and information literacy development among preservice teachers. Overall, these diverse findings emphasize the significance of more research into how preservice teachers use their time online; implying that the precise activities students engage in online may influence their literacy abilities.

In this study, there was a significant difference in the DTA and ILS of preservice teachers in favor of those who had more frequent TAI experiences. This result is consistent with the findings of previous studies (Eryansyah et al., 2020; Usluel, 2006; Zhao et al., 2021) reporting that the availability of digital resources, ICT training and increased use of technology in higher education led to increased ILS and digital literacy skills. Ukachi (2015) reported a strong positive correlation between the use of electronic resources and ILS. Previous studies in different countries (Aharony & Gazit, 2019; Birgin et al., 2020; Cabello et al., 2020; Tondeur et al., 2018; Yang et al., 2022; Valtonen et al., 2021) have shown that ICT training and computer-supported instruction experiences for preservice teachers significantly affect their digital literacy skills in the learning process and improve their teaching practices. In this context, preservice teachers who are aware of digital transformation in education are more likely to use technology-enhanced instructional practices in their coursework and assignments. In addition, preservice teachers can develop their skills in accessing, using, sharing, and storing information, thereby increasing their information literacy.

The results of this study revealed a positive and moderate correlation between preservice teachers' DTA in education and their ILS. This finding is consistent with growing evidence that highlights the interconnected nature of digital transformation awareness and information-related competencies. A recent systematic review emphasized that digital literacy is a foundational element enabling digital transformation, as it equips individuals with the ability to critically select, apply, and evaluate digital tools and information in complex environments (Arnaud et al., 2023). Similarly, Peculiauskiene et al. (2022) found that preservice teachers' competencies in information search and evaluation are significantly associated with their ICT self-efficacy. Moreover, studies have demonstrated moderate-to-strong associations between ILS and other related constructs, such as media literacy, positive attitudes toward ICT integration, and digital competence (Ramazani & Talebi, 2023). These findings support the argument that digital transformation awareness and information literacy are not isolated domains but rather mutually reinforcing capacities within the broader landscape of digital teaching readiness.

Finally, the results of the hierarchical regression analysis in this study revealed that gender and daily internet use had no significant effect on preservice teachers' ILS. Year of study, TAI experience, and DTA were found to be important predictors of preservice teachers' ILS, which

together explained 28% of the variance in ILS. First, the finding that gender and daily internet use did not significantly affect preservice teachers' ILS could imply that information literacy development in teacher education programs is less dependent on gender or general internet usage patterns and more influenced by other pedagogical and experiential factors. This finding challenges the assumption that digital literacy or internet proficiency—often generalized by increased daily use—translates directly to higher levels of information literacy.

The more significant predictors—year of study, technology-assisted instruction [TAI] experience, and digital transformation awareness—suggest a more targeted and context-specific approach to understanding how information literacy develops among preservice teachers. The importance of the year of study as a predictor aligns with the idea that information literacy is progressively acquired as students advance through their teacher training programs. This progression likely reflects their increasing exposure to research activities, educational technologies, and pedagogical methods that require higher levels of information processing and evaluation. Similarly, the importance of TAI experience underscores the role of hands-on, practical engagement with technology in fostering information literacy. This suggests that preservice teachers who are more frequently involved in integrating technology into their teaching practices become more adept at managing, evaluating, and applying information—a crucial skill set for modern educators. This aligns with constructivist theories of learning, which emphasize active learning experiences as key to the acquisition of complex cognitive skills. The finding that DTA is a significant predictor of ILS emphasizes the growing importance of digital transformation in education. As schools increasingly adopt digital tools and platforms, preservice teachers who are more aware of and adaptable to these shifts may find themselves better equipped to handle the vast array of information that these technologies provide. In essence, awareness of digital transformation is not just about using technology but also about understanding its implications for teaching, learning, and managing information effectively. This interpretation is supported by Farias-Gaytán et al. (2023), who highlight that digital transformation awareness plays a key role in empowering educators with the competencies needed to navigate complex digital learning environments and enhance information literacy in higher education.

In a comparative sense, the hierarchical regression model employed by Aharony and Gazit (2019) accounted for 52% of the variability in ILS, more specifically, by age, technology utilization, self-efficacy with computers, and perceived information overload. This model illustrates how crucial self-efficacy and technology play a role in developing information literacy. Their model could be expanded to include an even wider range of predictors, while this study concentrates on the year of study, TAI experience, and DTA, emphasizing the specific educational context in which preservice teachers' function. Similarly, Aharony and Gur (2017) ascertained 21% of the variance in ILS with the following predictors: curiosity, openness to experience, self-efficacy in computer usage, and deep learning strategies. Personal characteristics and cognitive engagement are also important aspects of information literacy that the authors underline in their research. The fact that this study accounts for 28% of the variance in ILS may indicate that the training of preservice teachers in information literacy is a complex process that is governed by actual experience and certain attitudes.

5. Conclusion, Limitations and Suggestions for Future Studies

The results of this study provide important insights into how preservice teachers' interactions with and awareness of digital technologies shape their information literacy skills. Moreover, increasing DTA in education is an effective strategy for improving ILS. Therefore, developing strategies for teacher education programs to increase awareness of digital transformation can help increase the information literacy skills of future teachers. Teacher education programs should include comprehensive training that not only focuses on technical skills but also emphasizes the pedagogical approaches needed to integrate technology into the classroom.

Importantly, some limitations of the current study should be noted. One of the limitations was that the current study was conducted only with preservice teachers. This study is also limited to examining the ILS and DTA of preservice teachers in terms of several variables. Thus, the ILS and DTA of preservice and in-service teachers can be examined in terms of different variables. The results of this study also open up avenues for future research, particularly in investigating the specific factors that influence the DTA of preservice teachers. Furthermore, as the instruments used rely solely on self-reported perceptions and do not include performance-based or observational data, the findings may reflect subjective judgments rather than objective skill levels. Investigating the impacts of different pedagogies, resources and experiences on preservice teachers' DTA can contribute to the development of effective educational strategies.

Conflicts of interest: The authors declare that they have no conflicts of interest.

Ethical approval: This study was conducted in accordance with the ethical standards of the institutional research committee and with the Helsinki Declaration and its later amendments or comparable ethical standards. Ethical approval was obtained from the Usak University Ethics Committee.

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