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Research

Investigation of Digital Competencies and Artificial Intelligence Literacy of Special Education Students

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Abstract:

This study investigated the digital competence and artificial intelligence (AI) literacy levels of special education students at various universities, examining differences by gender and grade level. A quantitative, descriptive, and correlational design was employed with a sample of 234 voluntary participants studying in special education departments. Data were collected using the "Digital Competence Perception Scale for Pre-service Teachers" and the "Artificial Intelligence Literacy Scale." Results indicated that students exhibited high levels of both digital competence and AI literacy. Male students scored significantly higher in overall digital competence, whereas gender differences in AI literacy were minimal. Regarding grade level, notable differences emerged in the sub-dimensions of digital competence, and higher-grade students demonstrated greater AI literacy and self-efficacy. Regression analysis showed that digital competence significantly predicted AI literacy, explaining 39% of its variance. These findings highlight the interconnection between digital skills and AI literacy among future special education teachers. Therefore, it is recommended that teacher education programs integrate digital competence and AI literacy modules into their curricula. Future studies should adopt mixed or qualitative methods to explore participants' experiences more deeply and validate the quantitative outcomes.

Keywords: Special education, Pre-service teachers, Artificial intelligence literacy, Digital competence

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INTRODUCTION

With the spread of digitalization across all sectors of society, radical transformations are occurring in the educational ecosystem. Information and communication technologies, which are central to these transformations, profoundly affect and reshape not only teaching processes but also the characteristics of learners. The opportunities offered by technology-oriented innovations contribute to the construction of inclusive, accessible and participatory learning environments that support the cognitive, sensory and motor skills of individuals with learning disabilities, especially in connection with special education (Bozkurt, 2017; Drigas & Ioannidou, 2012; Shettar et al., 2021).

Digital competencies is a multidimensional concept that encompasses individuals' ability to use digital technologies effectively, safely, critically, and responsibly. The Digital Competence Framework (DigComp) developed by the European Commission classifies these competencies into five main areas: information and data literacy, communication and collaboration, digital content production, security, and problem solving. Digital competence is not only limited to technical knowledge but also includes social and cognitive skills such as ethical behavior in digital environments, critical thinking, and digital citizenship (Carretero et al., 2017; Essuman et al., 2025). In the context of education, digital competencies enable prospective teachers and students to use technology effectively in learning and teaching processes. Today, the digitalization of learning environments requires individuals to be able to use digital tools effectively in education (Tondeur et al., 2017). For the students of the Department of Special Education, digital competencies have special importance in terms of both developing their professional competencies and providing effective support to the learning processes of individuals with special needs. These students are expected to have the skills to use digital technologies effectively related to special education, develop adaptive digital materials, work with assistive technologies, and integrate digital solutions into individualized instructional practices (Al-Awidi & Aldhafeeri, 2017).

With the rapid introduction of artificial intelligence-based technologies to the education agenda, the concept of “artificial intelligence literacy” has been included in the discussions on digital transformation in education. This concept is defined as a broad area of competence that includes individuals' ability to recognize algorithmic systems, critically evaluate these systems, and use productive technologies with ethical responsibility (Chiu et al., 2024). The acquisition of these competencies by students and teachers is seen as a prerequisite for the safe and effective implementation of data-driven and individualized teaching practices (Stolpe & Hallström, 2024). According to the findings of a study conducted by Uğraş and colleagues (2025) on teachers, ChatGPT plays important roles in providing instant feedback, including personalized content recommendations, encouraging creativity, fostering real-world connections, and increasing student motivation. Furthermore, ChatGPT's features have accelerated the educational process and provided teachers with greater flexibility in planning and promoting student equity. When used

correctly, AI applications can not only improve learning experiences but also lead to more creative, rich, and flexible teaching methods, helping to achieve the ambitious sustainability goals of education (Ipek et al., 2023; Uğraş et al., 2024). Despite the high potential benefits of using artificial intelligence-based applications in special education, there are limited concrete examples in practice (Hopcan et al., 2023). In addition, ethical concerns in data-based decision-making processes and the inadequate management of data security and privacy issues lead stakeholders to develop reservations towards these technologies (Kharbat et al., 2021). This study aims to examine the digital competencies and artificial intelligence literacy of special education students studying at different universities across various factors.

Digital competence is no longer limited to computer use but encompasses comprehensive areas such as data security, digital ethics, and productivity (Long & Magerko, 2020). Competence in the use of artificial intelligence is an important extension of digital competence today. Education systems should integrate these two competence areas into the curriculum, supported by teacher training, digital infrastructure investments, and awareness campaigns (Sector, 2021; Vuorikari et al., 2016).

Digital Literacy in Special Education

In today's information age, digital literacy is defined as the ability of individuals not only to use technological tools, but also to critically evaluate, produce, and safely share digital content (Marín & Castaneda, 2023). Gilster (1997) defined digital literacy as the ability to "access, evaluate and use information effectively in a digital environment,". The acceptance of digital literacy as a basic competency in the educational context makes it necessary to reconsider this concept in terms of teacher training processes and especially in the field of special education (Forsling, 2023). Special education is a field that focuses on individual differences and includes customized teaching processes according to different learning needs. In this context, effective and creative use of digital technologies makes significant contributions to the learning processes of individuals with special needs. However, making effective use of the opportunities offered by technology requires not only technical skills but also the ability to criticize digital content and use it in a pedagogical context. At this point, digital literacy stands out as one of the basic competencies that special education teachers and candidates should acquire (Ng, 2012).

Research shows that digital literacy in special education provides cognitive, social and communicative gains in the learning processes of individuals with special needs. In particular, digital technologies such as augmented reality (AR), virtual reality (VR), speech recognition systems, and audio-visual aided materials make learning accessible and motivating for students with different disabilities such as autism spectrum disorder, learning disabilities, and intellectual disabilities (Bourgonjon et al., 2014; Alper & Raharinirina, 2006). This makes it imperative for teachers not only to be familiar with the tools, but also to be competent in individualizing, adapting, and using digital content

according to the pedagogical context. However, research has revealed that pre-service special education teachers' digital literacy levels are not sufficient, and that they have difficulty in using digital tools effectively in pedagogical contexts. A study conducted in Turkey stated that pre-service special education teachers have positive attitudes towards digital technologies, but their competence in using these technologies for effective and individualized instruction, is low (Kurt & Ayas, 2021). This situation reveals that digital literacy skills should be emphasized more in teacher training programs in harmony with special education.

When it comes to special education, digital literacy should include not only the use of information and communication technologies, but also awareness of digital citizenship, security, respect for copyright, and digital ethics. Acting with ethical responsibility in digital environments is an essential part of effective digital literacy for pre-service teachers. This includes respecting the privacy rights of students with special needs and guaranteeing their emotional safety when using technology. These ethical considerations are not optional; they are a fundamental component of a teacher's digital competence, as noted by Ribble (2011). In addition to theoretical knowledge, practical training is of great importance in developing digital literacy skills. In particular, pre-service teachers' gaining experience in preparing digital learning materials, developing digital content suitable for individualized education programs (IEPs), and applying technological tools in the field supports these competencies in becoming permanent. International studies emphasize that pre-service teachers' opportunities to directly experience technology are decisive for their digital competencies and literacy levels (Tondeur et al., 2012).

The factors affecting the acquisition of digital competence in special education students exhibit a multidimensional structure consisting of cognitive, motor, and socio-emotional factors. Woodward and Cuban (2001) state that limited professional development delays the utilization of technology in teacher practice. Cagıltay et al. (2019) report that lack of infrastructure and internet connectivity problems complicate integration efforts. In their analysis of the teacher technology acceptance model, Nam et al. (2013) reveal that perceived ease of use plays a critical role in developing positive attitudes. Drigas and Ioannidou (2012) state that teachers' lack of technological pedagogical content knowledge hinders the integration process. Bozdağ (2017) emphasizes that intercultural differences constitute important variables in technology acceptance. Ünal (2013) shows that integration initiatives become unsustainable if teacher self-efficacy perception is low. Gülnar (2025) states that the complexity of user interfaces increases the cognitive load, and this negatively affects student motivation. Alnahdi (2014) argues that adopting universal design principles reduces barriers by increasing accessibility. In this context, when barriers and facilitators are considered together, the development of digital competence requires coordinated technological, pedagogical, and institutional strategies.

Artificial Intelligence Literacy and Its Importance for Special Education

The concept of artificial intelligence literacy is defined as a holistic competence area that includes the capacity of individuals to comprehend the basic principles of artificial intelligence systems, to make critical evaluations on the outputs of these systems, and to assume ethical responsibility during their use (Chiu et al., 2024). It can be said that the cognitive, technical, social, and ethical sub-dimensions of AI literacy complement each other (Stolpe & Hallström, 2024). The cognitive dimension of the concept explains the level of users' comprehension of algorithmic processes. The technical dimension describes their ability to understand model architectures and use tools effectively. The social dimension covers the ability to interpret the social impacts of artificial intelligence. The ethical dimension requires responsible usage behaviors in line with the principles of privacy, bias and accountability (Yao & Wang, 2024).

Educational research lays emphasis on the significance of embedding AI literacy into interdisciplinary learning designs (Yim, 2024). In terms of general education, AI is widely applied through adaptive learning systems that provide customized feedback, analytics dashboards that offer data-driven guidance, and assessment tools based on natural language processing (Chen et al., 2022; Takona, 2024). These applications create individualized learning paths by adapting content according to students' learning speed. In the field of special education, artificial intelligence offers interventions tailored to the individual needs of students through interactive learning environments, eye-tracking-based attention monitoring systems, and alternative communication solutions supported by natural language processing (Hopcan et al., 2023; Kara, 2025). For example, audio and visual parameters are dynamically adjusted for students with sensory sensitivity. These adaptations organize the learning materials in a way that reduces the student's cognitive load. Research shows that AI-supported applications increase students' academic achievement and motivation (Barua et al., 2022). However, in relation to special education, systems need to be designed in accordance with accessibility standards. User interfaces are required to take into account cognitive and motor skill differences. Teachers need technical support in the process of selecting and implementing AI-based tools (Waterfield et al., 2024).

The theoretical foundations of AI literacy include students' competencies to understand, critically evaluate, and responsibly use AI systems; and these competencies take on even more complex dimensions in the field of special education. The literacy framework proposed by Chiu et al. (2024) addresses technical, moral, legal, and sociocultural dimensions as a whole. Stolpe and Hallström (2024) identify six structural components of AI literacy in technology education in relation to pedagogical goals and discuss their transferability to special education settings. AI literacy in special education is critical for students' participation in the future workforce and their right to be included in social life. In their research, Garg and Sharma (2020) reveal that AI-based interactions increase peer interaction. Barua et al (2022) state that personalized artificial intelligence tools

improve autonomous learning behaviors in children with neurodevelopmental disorders. Alkan (2024) argues that professional development programs should be redesigned by examining the factors determining the intention of special education teachers to use artificial intelligence tools. Johnson et al. (2023) explain that generative artificial intelligence expands students' creative expression areas by providing autonomous content production in special education classrooms. Yao and Wang (2024) show that digital literacy, self-efficacy, and perceived ease of use significantly determine attitudes towards artificial intelligence in their study on pre-service special education teachers. These studies reveal that special education students are more likely to take part as active citizens in the digital world thanks to their AI literacy. As a result, it is emphasized that literacy plays a key role in sustainable economic participation and social justice.

Integrating Digital and Artificial Intelligence Literacy into Teacher Education Programs

Training programs play a crucial role in developing AI literacy. Wallace and Georgina (2014) highlight that technology training modules for special education teachers increase pedagogical innovation when they include literacy components. Nazik Akcayir et al. (2020) in their research examining teacher attitudes, stated that the frequency of professional development programs directly affects the use of digital tools. Şen and Akbay (2023) reported that artificial intelligence workshops facilitated the experience sharing of pre-service teachers. Anderson (2019) states that applied AR/VR workshops trigger active learning approaches in teachers. Pinski (2024) states that in-house mentor systems ensure continuity and accelerate teacher adaptation. The findings in the related literature show that the structural revision of teacher training programs, along with other branches, is important for the institutional sustainability of artificial intelligence literacy in special education.

Within the framework of technology integration of pre-service teachers, the SAMR Model stands out in planning of teaching activities with the steps of Substitution, Augmentation, Modification, and Redefinition of technology. TPACK, on the other hand, defines Technological, Pedagogical, and Content Knowledge as three intersecting dimensions and is a model revealing that teachers can provide technology integration with the balance between these components (Aubakirova et al., 2024; Ay, Karadağ & Acat, 2015). Ünal (2013) shows that pre-service teachers' TPACK efficacy levels are significantly related to their technology integration self-efficacy. Kaya and Yılayaz (2013) state that teacher education programs are enriched with application-based courses that include TPACK components. Bozdağ (2017) points out that the adaptation of different frameworks in the international context varies due to cultural and institutional variables. Therefore, models such as SAMR and TPACK provide a systematic lens on technology integration in special education and make it possible to develop sustainable innovation strategies.

Statement of the Problem

Today, digital technologies are radically transforming educational environments and reshaping many areas from teaching processes to assessment methods. Especially in the field of special education, the use of digital tools plays a critical role in developing individualized teaching practices and ensuring the effective participation of individuals with special needs in learning processes (Drigas & Rodi, 2013). This transformation requires not only the technical use of digital tools but also the development of pre-service teachers' competencies to use these technologies effectively, ethically, and critically for pedagogical purposes. Thus, the level of digital competencies of prospective special education teachers directly affects their future teaching quality (Yenmez & Gökçe, 2019). Artificial intelligence technologies are becoming increasingly visible in education. Adaptive learning systems, applications that provide automatic feedback, artificial intelligence-based communication tools, and diagnostic assessment software developed for individuals with special needs require teachers to have both technological knowledge and AI literacy (Chiu et al., 2024).

Special education is one of the disciplines that can benefit the most from technology in terms of individualization, flexibility, and differentiated instruction (Alkan, 2024). However, the transformation of this potential into practice depends on pre-service teachers' strong digital competencies and artificial intelligence literacy. It is of great importance not only to use digital tools and artificial intelligence-based systems but also to evaluate them critically, use them within the framework of ethical principles, and apply them by considering the rights of individuals with special needs. Therefore, examining the competencies of special education students in these areas is a serious necessity both academically and practically.

Current research on the use of AI-based applications in special education reveals that although the potential benefits are high, there is limited research in practice (Hopcan et al., 2023). Although, scales and assessment tools for measuring AI literacy have started to be developed, the validity-reliability evidence of these tools in connection with special education is not sufficiently reported (Wang et al., 2023). The need for tools that can validly and reliably measure the level of AI literacy of special education students continues. This problem area necessitates an in-depth investigation of the relationship between technology integration skills and artificial intelligence literacy, which clarifies the problem of this study. This study aims to reveal the extent to which pre-service special education teachers have the knowledge and skills required by the digital age. The findings will contribute to the development of concrete recommendations for the restructuring of teacher training programs. At the same time, this study aims to fill an important gap by realizing digital transformation in special education effectively and increasing pedagogical adaptation to technological developments.

The aim of this study is to examine the digital competencies and artificial intelligence literacy of special education students studying at different universities in relation to various variables. In this respect, the following questions were addressed in the study.

H1: What is the level of digital competencies and artificial intelligence literacy of special education students?

H2: Do the digital competencies and artificial intelligence literacies of special education students differ in relation to the gender variable?

H3: Do the digital competencies and artificial intelligence literacies of special education students differ in relation to grade level?

H4: Do special education students' digital competencies significantly predict their AI literacy?

METHOD

Research Design

This research is a descriptive and correlational study designed to examine the relationship between digital competencies, and artificial intelligence literacy of students studying in the special education department at the university. In this study, which is based on quantitative research methods, data were collected using a questionnaire technique, and these data were evaluated through descriptive and correlational analyses.

Sample

The sample of the study includes all students studying in special education departments of universities in Turkey. It consists of 234 university students who agreed to share their data through an online survey studying in the special education departments of several universities. Maximum variation sampling was used in sample selection. Creating a maximum diversity sample involves making a sample that is directly related to the research purpose and reflecting the diversity of individuals who may be parties to the problem being studied to the maximum extent (Miestamo et al., 2016). Of the participating students, 135 (57.3%) were female and 96 (42.7%) were male. Forty-eight (20.51%) of the participants were in the first grade, 64 (27.35%) in the second grade, 87 (37.18%) in the third grade, and 35 (14.96%) in the fourth grade.

Data Collection Tools and Data Collection

In this study, different measurement tools and a sociodemographic information form were used to analyze the connection between digital competence and artificial intelligence literacy of university students studying in the special education department. The study was conducted using an online survey form that included all these measurement tools and questions. The personal information form, which was created to determine the

sociodemographic characteristics of the participants, was designed to collect basic information such as age, gender, class, and department. This data make it possible to determine the general demographic profiles of the participants and analyze the results of the study according to these demographic variables.

The data collection process was meticulously planned and implemented. In the first stage, the data collection tools to be used for the research were prepared and a pilot application was carried out. Necessary corrections were made to the surveys in line with the feedback received as a result of the pilot application. When selecting the sample, it was ensured that the students were distributed across all departments of the special education faculties in universities. It was decided to implement the data collection tools online, and the survey links were sent to the participants via WhatsApp and e-mail. In addition, QR codes were created and distributed in university areas to provide quick access to the surveys. Participants were given a certain amount of time to complete the survey, and the surveys were completed entirely on a voluntary basis. Participants' responses were collected anonymously and their identities were kept confidential. The collected data were securely recorded in a digital environment and protected against unauthorized access. The security of the data is of critical importance for the validity and reliability of the research.

Artificial Intelligence Literacy Scale (AILS)

The artificial intelligence literacy scale is a psychometric tool that aims to measure the knowledge, skills, attitudes, and awareness levels of individuals about artificial intelligence (AI) technologies. Such scales have been developed especially for use in the fields of education, psychology and informatics. Studies conducted in this field in Turkey aim to evaluate individuals' awareness, knowledge levels, and usage competencies regarding artificial intelligence. The "Artificial Intelligence Literacy Scale" developed by Çelebi et al. (2023) is one of the important contributions in this field. The researchers conducted validity-reliability analyses to develop the scale and grouped it into four dimensions. These are (i) Awareness, (ii) Usage, (iii) Evaluation, and (iv) Ethics. In a study conducted by Eniş-Erdoğan & Ekşioğlu (2024), the construct validity of the AI Literacy Scale was tested. The Kaiser-Meyer-Olkin value was found to be 0.780, and the Bartlett test was significant. Exploratory factor analysis results showed that the scale had four dimensions and explained 82.87% of the total variance. The scale's goodness-of-fit values were calculated as RMSEA=0.078, NFI=0.944, TLI=0.952, CFI=0.967, IFI=0.967, and GFI=0.931. These values demonstrate that the Turkish version of the AI Literacy Scale is a valid and reliable tool for measuring participants' perceptions of AI literacy. In this research sample, the Cronbach's Alpha coefficient of artificial intelligence literacy and its subscales was calculated. As a result of the analyses conducted for this purpose, the reliability coefficients of the whole scale and its subscales ranged between 0.76 and 0.89.

Prospective Teacher Digital Competence Perception Scale

The Prospective Teacher Digital Competence Perception Scale is a valid and reliable measurement tool developed by Karakuş, Sünbül, and Kılıç (2022) to measure the digital competence perceptions of prospective teachers. In this study published in the Bayburt Faculty of Education Journal, 347 prospective teachers studying at a state university in the 2020-2021 academic year were selected as participants. The scale, designed as a five-point Likert-type scale, consists of 26 items and three main dimensions: media-communication competencies, competencies in designing teaching in digital environments, and informatics competencies. As a result of exploratory and confirmatory factor analyses, it was found that the three-factor structure of the scale was statistically significant. While the total variance of the scale was represented as 56.798%, the Cronbach alpha reliability coefficients obtained for the sub-dimensions were 0.90, 0.90, and 0.88, respectively. These high reliability values show that the internal consistency and construct validity of the scale are strong. This scale, effective instrument for measuring the digital competence levels of prospective teachers, is valuable for use in educational research and digital pedagogical development processes.

Data Analysis

After the data collection phase of the study was completed, the data were processed and analyzed using the SPSS 27.0 program. The data analysis included applying various statistical methods to conduct the objectives of the study and test the hypotheses. First, the demographic characteristics and scale scores of the participants were summarized using descriptive statistics. Frequency and percentage values were calculated for categorical variables, and mean, standard deviation, minimum, and maximum values were calculated for numerical variables.

The internal consistency of the scales used was evaluated with Cronbach's Alpha coefficients. This analysis aims to determine the reliability and consistency of the scales. Skewness and kurtosis coefficients were calculated to check whether the data were normally distributed. The skewness and kurtosis values of the digital competence and artificial intelligence literacy scores, of the special education department students showed that the data had a normal distribution. In this context, Pearson correlation analysis was used to determine the relationship between digital competence and artificial intelligence literacy. This analysis helped to evaluate the linear relationship between two quantitative variables, as well as the direction (positive or negative) and strength of this relationship.

Regression analysis was applied to determine the effect of digital competencies on AI literacy. This analysis helped to determine the effect of independent variables (digital competence) on the dependent variable (AI literacy) and the magnitude of this effect. ANOVA and independent sample t-tests were used to determine whether there was a significant difference in dark personality traits, and burnout levels between demographic groups. The one-way ANOVA test was used to compare three or more groups in terms of a numerical variable. In case of significant ANOVA results, post hoc tests (e.g., Scheffe Test)

were applied to identify the groups between which differences existed. An independent sample t-test was used to compare two independent groups in terms of a numerical variable.

Compliance with Ethical Rules

Throughout the research process, the researcher adhered to all principles of scientific research and publication ethics. Participating students were informed of the data collection process through a consent form. Citations in the study were made in accordance with scientific rules and are included in the bibliography in accordance with APA style. Ethics committee approval was required for this study. Therefore, approval was obtained from the Scientific Research Ethics Committee of Hasan Kalyoncu University.

RESULTS

Descriptive findings regarding the scores obtained by special education department students from the digital competence and artificial intelligence literacy scale are presented in Table 1.

Table 1.

Descriptive Statistics on the Scores Obtained by Special Education Students from the Digital Competence and Artificial Intelligence Literacy Scale

	-n-	Min.	Max.	$\overline{X}$	*Sd*
Media Communication Competencies	234	1,00	5,00	4,48	0,69
Competencies for Designing Instruction in Digital Environments	234	1,00	5,00	4,23	0,77
Competences in Information Technology	234	1,00	5,00	4,13	0,86
General Digital Competence	234	1,00	5,00	4,28	0,71
Awareness	234	1,67	5,00	3,63	0,51
Use	234	1,00	5,00	3,62	0,61
Evaluation	234	1,00	5,00	4,21	0,79
Ethics	234	1,33	5,00	3,72	0,64
Artificial Intelligence Literacy	234	1,58	5,00	3,79	0,50

Table 1 shows descriptive statistics regarding the scores obtained by special education students from the digital competence and artificial intelligence literacy scale. According to the findings, it was determined that the scores of the digital competence scale and its subscales varied between 1.00 and 5.00. The mean scores were calculated as 4.48±0.69 in the Media Communication Competence subscale, 4.23±0.77 in the Digital Environments Instructional Design Competencies subscale, 4.13±0.86 in the Informatics Competencies subscale, and 4.28±0.71 in the entire scale, respectively. According to the mean values

obtained, the data indicate that the digital competences of special education students are at a very high level.

The study found that special education students have a high level of artificial intelligence literacy. The scores on the artificial intelligence literacy scale and its subscales ranged from 1.00 to 5.00, with average scores falling between 3.62 and 4.21. These high mean scores indicate a strong command of AI literacy among the students.

Table 2.

T-test Results of Digital Competence Scores of Special Education Teachers According to Gender Variable

	Gender	-n-	$\overline{X}$	*Sd*	t	P
Media Communication Competencies	Male	135	4,42	0,72	-1,62	0,11
	Female	96	4,57	0,64		
Competences in Designing Instruction in Digital Environments	Female	135	4,14	0,81	-2,22	0,03*
	Male	96	4,36	0,69		
Competences in Information Technology	Female	135	3,99	0,95	-3,04	0,00*
	Male	96	4,33	0,68		
General Digital Competence	Female	135	4,18	0,74	-2,58	0,01*
	Male	96	4,42	0,62		

*p<0.05

An analysis of digital competency scores among special education teachers revealed a significant relationship between gender and most aspects of digital competence, with one key exception. According to Table 2 ($p < .05$), there was a significant difference in scores for all digital competency subscales and the overall total score based on gender. However, for the media communication subscale, no significant difference was found ($p > .05$). This suggests that while gender may be a factor in other areas of digital skill, it does not appear to influence a teacher's proficiency in media communication. When the mean scores of the groups were examined, it was found that the digital competencies of male students were higher than their female peers.

Table 3.

T-test Results of Digital Competence Scores of Special Education Teachers According to Gender Variable

	Gender	-n-	$\overline{X}$	*Sd*	t	P
Awareness	Female	135	3,64	0,54	0,28	0,78
	Male	96	3,62	0,48		
Use	Female	135	3,58	0,66	-1,10	0,27
	Male	96	3,67	0,55		
Evaluation	Female	135	4,12	0,82	-2,11	0,04*

	Male	96	4,34	0,74		
Ethics	Female	135	3,73	0,66	0,46	0,65
	Male	96	3,69	0,61		
AI Literacy	Female	135	3,77	0,55	-0,94	0,35
	Male	96	3,83	0,43		

*p<0.05

According to Table 3, there was a significant relationship between gender and the scores on the evaluation subscale of the artificial intelligence literacy scale for special education teachers. This means that male and female teachers differed in their ability to critically evaluate AI systems. However, gender was not a significant factor for other aspects of AI literacy. On the other hand, there was no significant difference in the other subscales and total scores (p>0.05). When the mean scores of the groups were examined, it was seen that although the artificial intelligence literacy of male students appeared higher than their female peers, no significant difference was found between the scores of this sample in terms of gender.

Table 4.

ANOVA Test Results of Digital Competence Scores of Special Education Teachers According to Grade Level

	Grade	-n-	$\overline{X}$	*Sd*	F	P
Media Communication Competencies	1	48	4,45	0,46	1,10	0,35
	2	64	4,37	0,79		
	3	87	4,57	0,68		
	4	35	4,50	0,78		
Competences in Designing Instruction in Digital Environments	1	48	4,07	0,66	1,93	0,13
	2	64	4,16	0,78		
	3	87	4,37	0,70		
	4	35	4,24	0,99		
Competences in Information Technology	1	48	3,92	0,89	2,28	0,08
	2	64	4,04	0,88		
	3	87	4,29	0,74		
	4	35	4,22	1,02		
Digital Competencies General	1	48	4,14	0,62	1,97	0,12
	2	64	4,19	0,77		
	3	87	4,41	0,66		
	4	35	4,32	0,80		

In Table 4, the relationship between the scores obtained from the scale, used to determine the digital competencies of the special education teachers included in the study, and the class level was examined using an F test. The analysis revealed that the F values

calculated according to the class variable in the entire scale and its sub-scales of the digital competencies scale did not differ significantly (p>.05).

Table 5.

ANOVA Test Results of Artificial İntelligence Literacy Scores of Special Education Teachers According to Grade Level

	Grade	N	Mean	Std. Deviation	F	P
Awareness	1	48	3,47	0,44	2,67	0,05*
	2	64	3,59	0,46		
	3	87	3,70	0,55		
	4	35	3,73	0,55		
Use	1	48	3,44	0,44	2,36	0,07
	2	64	3,57	0,56		
	3	87	3,70	0,62		
	4	35	3,72	0,84		
Evaluation	1	48	3,94	0,65	2,91	0,04*
	2	64	4,17	0,85		
	3	87	4,32	0,78		
	4	35	4,36	0,83		
Ethics	1	48	3,57	0,45	3,35	0,02*
	2	64	3,67	0,64		
	3	87	3,73	0,62		
	4	35	4,00	0,82		
AI Literacy	1	48	3,61	0,37	4,24	0,01*
	2	64	3,75	0,51		
	3	87	3,86	0,48		
	4	35	3,95	0,61		

*p<0.05

Scores from the artificial intelligence literacy scale, when analyzed in relation to the grade level of the special education teachers, showed no significant difference on the usage subscale. This indicates that a teacher's grade level did not have a measurable effect on their ability to use AI tools, as shown in Table 5 (p > .05). On the other hand, there was a significant difference according to the grade level in the other subscales and total scores (p<0.05). According to the advanced analyses carried out with the Scheffe test, it was seen that the participants studying in the second, third and fourth grades had significantly higher artificial intelligence literacy compared to the students studying in the first grades.

Table 6.

Results of Simple Regression Analysis between Participants' Digital Competence and Artificial İntelligence Literacy

	β	-t-	P	R	R2	F	P
Regression	1,88	11,94	0,000	0,0117	0,39	150,67	P<0,05
Artificial Intelligence Literacy	0,45	12,28	0,000				

According to Table 6, digital competence is the independent variable and artificial intelligence literacy is the dependent variable. The digital competences of the participants explain the change in the dependent variable of artificial intelligence literacy significantly (F= 150.67, p<0.05). There is a significant and high-level relationship between digital competences and artificial intelligence literacy (β=0.45; p<0.05). In addition, digital competences account for 39% of artificial intelligence literacy. In this respect, if digital competences are at a high level, artificial intelligence literacy shows a positive trend.

DISCUSSION

This study describes the relationship between the digital competence levels and artificial intelligence literacy levels of students studying in the special education department, and reveals how these variables differ in terms of gender, grade level, and interaction factors. First, the digital competence levels and artificial intelligence literacy of special education students were examined in the study. The findings show that the digital competence levels of the students are quite high. The data reveal that the students exhibit strong performance in basic media communication competencies. This result indicates that the students' perceptions of their skills in designing instruction in digital environments are positive. The level of teacher candidates' use of information and communication technologies appears to be high in the field of informatics competencies. The performance in the field of data evaluation reflects the students' competencies in making inferences and providing feedback. The level of perception in the ethical dimension shows that there is a sense of responsibility in the use of artificial intelligence. These findings reveal that the students exhibit a positive profile in both digital competence and artificial intelligence literacy. The high averages in the study suggest that the students can quickly adapt to technology-integrated learning environments. This result is parallel to Ünal's (2013) study, which revealed the effect of technology integration self-efficacy perception on learning outcomes. Similarly, research by Spasopoulos and colleagues (2025) found that preservice teachers effectively use AI tools primarily for conceptual clarification, hypothesis generation, and self-regulated learning. Furthermore, these tools serve as cognitive partners in designing lesson plans, differentiating instruction, and simulating classroom scenarios. Teacher candidates' high levels of digital competence demonstrate their ability to effectively integrate technology into classroom practices in the future. This is particularly

important in fields where personalized learning environments are prominent, such as special education. Ferrari (2013) and Vuorikari et al. (2016) emphasize that digital competence is a fundamental prerequisite for the teaching profession. Krumsvik (2014) states that digital competence in special education is critical for personalized learning, communication supports (e.g., augmented and alternative communication), and adaptations for different disability groups.

The study examined the differences in digital competence and artificial intelligence literacy levels of special education department students according to gender and class variables. The findings show that there are significant differences in terms of gender in the general scores of digital competences. It was revealed that male students showed higher performance in digital competence scores compared to female students. This situation became evident in all sub-dimensions except for the media communication sub-dimension. It was determined that male students had an advantage especially in the sub-dimensions of designing instruction in digital environments and informatics competence. On the other hand, gender differences in artificial intelligence literacy levels were limited. It was determined that male students scored significantly higher than female students only in the evaluation sub-dimension. This finding supports the studies in the literature that reveal that the effect of gender on digital competence perception has a limited structure (Nam et al., 2013). Indeed, in a study conducted in Norway, Hatlevik et al. (2015) suggested that male students may have higher overall digital proficiency levels because they have greater exposure to and experience with digital tools. Similarly, Moreno-Guerrero et al. (2020) and Özkan (2024) noted that male students' higher self-confidence in technical skills positively impacts their digital proficiency levels. Similarly, studies show that while women possess sufficient knowledge in using technology and digital tools, they often have lower self-efficacy perceptions than men. This may stem from society's perception of technology as a male-dominated field (Cooper, 2006). Furthermore, access to technology, usage habits, and learning opportunities also create gender differences (Volman & van Eck, 2001). Therefore, the findings of this study support the existence of a gender-based dimension, not just a socioeconomic one. To address these disparities, it is crucial for education faculties to provide supportive learning environments and access to artificial intelligence applications, particularly for female students, to develop their digital competencies.

According to the class level analyses, no significant differences were observed in the sub-dimensions of digital competencies. This result suggests that the development of digital competencies based on class level progresses homogeneously. In terms of artificial intelligence literacy, the class level effect was observed to be more pronounced. The effect of the class variable was not found to be statistically significant in the awareness and usage sub-dimensions. Differences depending on the class level variable emerged in the evaluation and ethics dimensions and total artificial intelligence literacy. When further analyses were found, it was determined that students studying in lower grades received low scores, while these scores gradually increased in upper grades. This finding shows that

students' artificial intelligence perception and skills mature in the advancing grade levels. It points to the importance of supporting the development based on class level with the continuity of pedagogical practices and blended learning scenarios.

The findings regarding the effect of special education students' digital competencies on their AI literacy show that digital competencies significantly explain AI literacy. As a result of the regression analysis, it was determined that digital competencies are an important predictor of AI literacy. Digital competencies explain 39% of AI literacy. This result reveals that students' technology use competencies are decisive on their ability to use AI tools interactively and critically. This finding supports the view of Chiu et al. (2024) that digital literacy is a fundamental building block within the framework of AI literacy. In addition, Çelebi et al. (2023) state that digital competencies are related to AI literacy indicators. These findings show that AI applications in education should be based on a digital competency infrastructure.

This study supports the TPACK theory's prediction that digital and pedagogical competencies play an important role in the development of AI literacy. This finding reveals that the integration of TPACK, SAMR, and TIM models into the context of special education strengthens the relationship between digital competencies and AI literacy. These findings expand Kaya and Yılayaz's (2013) studies on technology integration models in teacher education with the dimension of AI literacy. The findings expand Dönmez's (2022) proposal for an integration management model in Turkey on the axis of digital competence and AI literacy. In terms of application, this study emphasizes the need to enrich teacher candidates' professional development programs with AI-focused strategies. The results predict that digital competence training contents will have positive effects on learning outcomes when developed in parallel with AI literacy. In this context, it is recommended that SAMR and TPACK models be used together in the design of digital literacy programs in special education. Moreover, it becomes clear that education policies need to produce policies that integrate digital skills and artificial intelligence literacy.

In line with all these findings, the study also has some limitations. First of all, the fact that the sample was selected only from special education departments of certain universities in Turkey limits the general validity level. This situation indicates that the findings should be approached cautiously in generalizing them to different regional and cultural contexts. In addition, the fact that the data collection tool was self-reported questionnaires may have caused the emergence of a social desirability effect. This effect raises concerns that the participants may have overstated their actual competence levels. The fact that qualitative data collection methods were not used in the study causes the students' experiential perspectives to be lost. In conclusion, the findings should be interpreted with caution and these limitations should be eliminated in future studies.

LIMITATIONS AND RECOMONDATIONS

This study supports the TPACK theory's prediction that digital and pedagogical competencies play an important role in the development of AI literacy. This finding reveals that the integration of TPACK, SAMR, and TIM models into the context of special education strengthens the relationship between digital competencies and AI literacy. These findings expand Kaya and Yılayaz's (2013) studies on technology integration models in teacher education with the dimension of AI literacy. The findings expand Dönmez's (2022) proposal for an integration management model in Turkey on the axis of digital competence and AI literacy. In terms of application, this study emphasizes the need to enrich teacher candidates' professional development programs with AI-focused strategies. The results predict that digital competence training contents will have positive effects on learning outcomes when developed in parallel with AI literacy. In this context, it is recommended that SAMR and TPACK models be used together in the design of digital literacy programs in special education. Moreover, it becomes clear that education policies need to produce policies that integrate digital skills and artificial intelligence literacy.

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Educational institutions should update their teacher training programs by integrating digital competency training with AI literacy modules. At the school and university level, application workshops that include AI-based simulations and experiential learning activities should be organized. Infrastructure investments should be planned by matching

them with AI-supported solutions that are suitable for students' different learning needs. In addition, student progress should be monitored through digital learning analytics panels and feedback loops should be accelerated. Family and community engagement programs should be used to develop learning environments at home and outside of school in collaboration.

CONCLUSION

According to the research results, the digital competence levels and artificial intelligence literacy of special education department students are at a high level. According to the findings, it is seen that there are significant differences in the general scores of digital competences of special education department students in terms of gender. Male students have significantly higher average digital competence scores than female students. However, this difference is limited in terms of artificial intelligence. In terms of the class level analyses, while significant differences are seen in the sub-dimensions of digital competences, it is seen that the class level effect is more pronounced in terms of artificial intelligence literacy. Self-efficacy increases in higher classes. As a result of the regression analysis, it was determined that digital competences are an important predictor of artificial intelligence literacy.

The results of this study emphasize the necessity of integrating technology and artificial intelligence literacy models in the context of special education. When the research results and models based on the technology integration of teacher candidates are evaluated together, important data are provided. Digital and artificial intelligence-based content, suitable for special education student profiles, increases the inclusiveness of learning opportunities. In this context, a perspective is presented for teacher training institutions to integrate these two variables into their programs.

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Data Availability Declaration

While the primary datasets utilized in this study are not publicly accessible due to certain constraints, they are available to researchers upon a formal request. The authors have emphasized maintaining the integrity of the data and its analytical rigor. To access the datasets or seek further clarifications, kindly reach out to the corresponding author. Our aim

is to foster collaborative academic efforts while upholding the highest standards of research integrity.

Author Contributions

The sole author of this research, Mehrossâdat Vosough Matin was responsible for the conceptualization, methodology formulation, data collection, analysis, and interpretation.

Author(s)' statements on ethics and conflict of interest

Ethics statement: We hereby declare that research/publication ethics and citing principles have been considered in all the stages of the study. We take full responsibility for the content of the paper in case of dispute.

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