

Research on science teacher education students' digital competence and scientific literacy perceptions

Dilara Ünlü ^a , Gülcan Öztürk ^{a*} , Hasene Esra Yıldırım ^a 

^a Balıkesir University, Türkiye.

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Highlights

- Participants' both digital competence and scientific literacy perceptions were at high levels
- The perceptions differed according to various variables
- There was a significant correlation between digital competence and scientific literacy perceptions

Abstract

This study aimed to identify science teacher education students' digital competence and scientific literacy perceptions, and to examine whether these perceptions differ according to various variables (gender, type of high school attended, age, year of university education, possession of a personal computer, having internet access, and daily internet usage time). The study also examined relationship between science teacher education students' digital competence and scientific literacy perceptions. The study was conducted with participation of 140 science teacher education students studying at a university in the west of Türkiye. The sample was selected using criterion sampling and convenience sampling methods. Data were collected using the Digital Competence Perception Scale, Scientific Literacy Perceptions Scale and a personal information form. Descriptive statistics were calculated and t-test and one-way analysis of variance for independent samples, and correlation analysis was performed to analyze data. The research results indicated that science teacher education students' both digital competence and scientific literacy perceptions were at high levels. It was found that there were no significant differences in digital competence and scientific literacy perceptions according to gender and type of high school attended. It was concluded that scientific literacy perceptions indicated significant difference according to year of university education, and digital competence perceptions demonstrated significant differences according to age, possession of a personal computer and having internet access, and daily internet usage time. The study also revealed that there was a statistically significant, moderate and positive correlation between science teacher education students' digital competence and scientific literacy perceptions.

Article Info: Research Article

Keywords: *Digital competence perception, science teacher education students, scientific literacy perception*

1. Introduction

The rapid developments in the field of science and technology make it necessary for individuals and societies to keep pace with these advancements. In this context, the concept of digital competence, which includes processes of accessing, evaluating, storing, producing, and sharing information through digital technologies (Köksal & Canlı, 2024), and the concept of scientific literacy, defined as capacity to understand and consciously use new knowledge and technological innovations (Özdemir, 2010), are gaining importance. Addressing these two competences together in current educational settings enables individuals to both effectively utilize skills required by digital age and participate in scientific processes

* Corresponding author. Balıkesir University, Türkiye.
e-mail addresses: unludilara99@gmail.com, ozturkg@balikesir.edu.tr, epoyraz@balikesir.edu.tr

(Coşkunserçe & Aydoğdu, 2022; Öztürk, 2021). Therefore, examining teacher education students' digital competence and scientific literacy perceptions can provide valuable insights about quality of future teaching and learning processes.

1.1. Digital Competence

Digital competence is a multidimensional concept that stands out among 21st century skills and is recognized by the European Commission as one of eight essential lifelong learning competences (Bozkurt et al., 2021; Özden & Örgen-Yaşar, 2024; Redecker, 2017). Digital competence involves the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society (Vuorikari et al., 2022). Digital competence encompasses not only technical skills but also processes of accessing, evaluating, storing, producing, and sharing information through digital technologies (Köksal & Canlı, 2024). Karakuş et al. (2022) emphasize that digital competence is a holistic framework encompassing dimensions such as media and communication, information technology, and learning and teaching processes.

Various frameworks were developed at international level to define scope and standards of digital competence. One of the most comprehensive of these frameworks is the Digital Competence Framework (DigComp) established by the European Commission (Afacan-Adanır & Gülbahar, 2022; Aşıcı & Temel, 2023). The DigComp framework consists of five main dimensions: (1) *Information and data literacy*, (2) *Communication and collaboration*, (3) *Digital content creation*, (4) *Safety*, and (5) *Problem-solving* (Vuorikari et al., 2022). (1) *Information and data literacy* dimension involves articulating information needs, locating and retrieving data to evaluate the suitability of the source and its content, as well as managing, storing and organising digital content, data and information. This competence dimension consists of the following sub-competences: browsing, searching and filtering digital content; evaluating data, information and digital content; and managing data, information and digital content. (2) *Communication and collaboration* dimension involve interacting and collaborating through digital technologies while being aware of cultural and generational diversity, participating in society through public and private digital services, and managing an individual's digital presence, identity and reputation. The communication and collaboration dimension comprises six sub-competences: interacting through digital technologies, sharing information and content through digital technologies, engaging in citizenship through digital technologies, collaborating through digital technologies, netiquette, and managing digital identity. (3) *Digital content creation* dimension refers to the skills of creating and editing digital content, integrating and re-elaborating information and content into an existing body of knowledge, understanding how copyright and licences apply, and giving understandable instructions to a computer system. Its sub-competences are developing digital content, integrating and re-elaborating digital content, copyright and licences, and programming. (4) *Safety* dimension requires protecting personal data and privacy, protecting physical and psychological health, being aware of digital technologies for social well-being and social inclusion, and being aware of the environmental impact of digital technologies and their use. The sub-competences of this dimension are protecting devices, protecting personal data and privacy, protecting health and well-being, and protecting the environment. (5) *Problem solving* dimension involves identifying needs and problems, resolving conceptual problems and problem situations in digital environments, using digital tools to innovate processes and products, and keeping up to date with the digital evolution. The sub-competences of the problem-solving dimension are solving technical problems, identifying needs and technological responses, creatively using digital technologies, and identifying digital competence gaps (Vuorikari et al., 2022).

Another important framework developed to assess educators' digital competences is the Digital Competence Framework for Educators (DigCompEdu). Developed by Redecker (2017) and adapted into Turkish by Toker et al. (2021), this framework addresses educators' digital competences across six dimensions: (1) *Professional engagement*, (2) *Digital resources*, (3) *Teaching and learning*, (4) *Assessment*, (5) *Empowering learners*, and (6) *Facilitating learners' digital competence*. (1) *Professional engagement* dimension involves using digital technologies for communication, collaboration and professional development. This dimension consists of four sub-competences: organisational

communication, professional collaboration, reflective practice, and digital continuous professional development. (2) *Digital resources* dimension involve sourcing, creating and sharing digital resources. This dimension consists of three sub-competences: selecting digital resources, creating and modifying digital resources, and managing, protecting and sharing digital resources. (3) *Teaching and learning* dimension involve managing and orchestrating the use of digital technologies in teaching and learning. This dimension consists of four sub-competences: teaching, guidance, collaborative learning, and self-regulated learning. (4) *Assessment* dimension involves using digital technologies and strategies to enhance evaluation. This dimension consists of three sub-competences: assessment strategies, analysing evidence, and feedback and planning. (5) *Empowering learners* dimension involves using digital technologies to enhance inclusion, personalisation and learners' active engagement. This dimension consists of three sub-competences: accessibility and inclusion, differentiation and personalisation, and actively engaging learners. (6) *Facilitating learners' digital competence* dimension involves enabling them to creatively and responsibly use digital technologies for information, communication, content creation, wellbeing and problem-solving. This dimension consists of five sub-competences: information and media literacy; digital communication and collaboration; digital content creation; responsible use; and digital problem-solving (Redecker, 2017). This framework classifies educators' digital competence levels into six categories: (1) Newcomer, (2) Explorer, (3) Integrator, (4) Expert, (5) Leader, and (6) Pioneer (Redecker, 2017).

However, the literature identified a significant shortcoming in that present digital competence frameworks had mainly been developed for elementary, middle and secondary school teachers, and there was no consensus on nature of higher education instructors' digital competences. In response to this need, Tondeur et al. (2023) developed the Higher Education Digital Competence Framework (HeDiCom). The HeDiCom framework addressed higher education instructors' digital competences across four main dimensions: (1) *Empowering students for digital society*, (2) *Teaching practices*, (3) *Digital literacy*, and (4) *Professional development*. (1) *Empowering students for a digital society* dimension involve developing and implementing learning activities for students' digital literacy, guiding students in their use of the Internet and social media, and ensuring that students are familiar with new digital developments in their future profession. (2) *Teaching practices* dimension involves designing, implementing, facilitating, monitoring, evaluating and modifying digital learning. (3) *Digital literacy* dimension involves effectively implementing (Information and communication technologies [ICT]) in teaching practice, locating and evaluating digital information and resources, critically engaging with Internet and social media use, and formulating and solving problems using ICT, having information/media/data literacy, basic digital skills, and computational thinking. (4) *Professional development* dimension involves identifying and actively developing areas of personal professional development, working with colleagues to develop a vision for digital innovation, experimenting with and reflecting on innovative digital practice, and collaborating with colleagues and students in the design and evaluation of innovative digital practice (Tondeur et al., 2023). This framework aimed to establish clearer expectations regarding teachers' digital competences in higher education context, guide integration of digital technologies into teaching practices, and ultimately enhance quality of students' digital competences (Tondeur et al., 2023).

The digital competence concept was commonly considered together with digital literacy in the literature, and these two concepts were used synonymously in several studies (Köksal & Canlı, 2024; Yılmaz-Özden, 2023). However, digital competence went beyond ability to use technological tools, and it was a more complex structure encompassing multidimensional knowledge, skills, and attitudes such as communication, collaboration, problem-solving, creating digital content, and adhering to ethical and security guidelines in these processes (Afacan-Adanır & Gülbahar, 2022). In studies examining teachers' digital competence, for example, Köksal and Canlı (2024), involving 149 teachers in their study, found that teachers' digital competence perceptions were at integrative level across entire scale. Fidan and Cura-Yeleğen (2022), involving 158 teachers in their study, investigated how teachers' digital competence levels varied according to gender, years of experience, teaching subject, Web 2.0 tools usage status, and internet usage time. Researchers found that female teachers' digital competences were significantly higher than those of male teachers, that teachers with fewer years of experience (0–5 years) had significantly higher digital

competences than more experienced teachers, and that vocational training teachers' digital competences were lower than those of teachers of other teaching subjects.

Köksal and Canlı (2024) found no significant difference in teachers' digital competences based on gender. In a study focusing specifically on tourism academicians, Doğan (2023) determined that academicians' digital competences were at integrative level and that digital competence level decreased as age and professional experience increased. Yılmaz and Toker (2022), in their study investigating the COVID-19 pandemic's effect on teachers' digital competences, concluded that teachers' digital competences improved significantly during the pandemic. Saygıner and Laçın (2024), in their experimental study on special education teachers, demonstrated that technology supported instructional activities significantly increased teachers' digital competence levels. The group's digital competences were at beginner level before the activities, and it increased to integrative and expert levels following the activities.

There were also studies in the literature that examined education faculty students' digital competences. Özden and Öрге-Yaşar (2024), involving 2,170 education faculty students in their study, found that education faculty students' digital competences were at intermediate level. Similarly, Kaya and Uyangör (2022), involving 681 education faculty students in their research, concluded that education faculty students' digital competences were at intermediate level. Özden and Öрге-Yaşar (2024) found that male education faculty students' digital competences were significantly lower than female education faculty students'. Özkan-Kanat (2023) found that there was no significant difference in pre-service Turkish language teachers' digital competences based on gender. In terms of year of university education, it was found that education faculty students in higher year groups had higher digital competences than those in lower year groups. Furthermore, when examining sub-dimensions of education faculty students' digital competences, these studies found that the lowest scores were in digital content development dimension. Although education faculty students considered themselves as competent in data literacy and communication dimensions (Özden & Öрге-Yaşar, 2024; Özkan-Kanat, 2023). All these studies emphasized essential value of digital competence in today's education system. Digital competence was widely accepted as a standard for advanced academic understanding in 21st century according to Martínez-Bravo et al. (2022). Therefore, equipping education faculty students, teachers who will lead future, with digital competence plays a vital role in both their personal development and their ability to prepare their students for demands of modern era.

1.2. Scientific Literacy

Scientific literacy is a fundamental concept that refers to individuals' ability to understand and interpret scientific knowledge and to apply this knowledge effectively in everyday life (Ministry of National Education [MoNE], 2018). The terms "science literacy" and "scientific literacy" are frequently used interchangeably in the literature (Çolak, 2014). Scientific literacy is a multidimensional construct that encompasses inquiry and research, critical thinking, decision-making skills, and problem-solving, which supports lifelong learning (Kavak et al., 2006), and that involves not only mastery of scientific terminology but also ability to interpret information within social, economic and environmental contexts. A scientifically literate individual is someone who can evaluate events occurring in their surroundings from a scientific perspective, think critically, generate solutions to problems based on scientific processes, and relate what they have learned to daily life in this context (Başar & Elyıldırım, 2022; Can & Çelik, 2020; Tunç-Şahin & Say, 2010). The concept of scientific literacy has acquired many different definitions and dimensions in historical process and has demonstrated continuous development as a dynamic structure (Keskin & Çam, 2019).

The growing impact of developments in science and technology at both societal and individual levels has made training scientifically literate individuals one of fundamental objectives of education systems (MoNE, 2018; Turgut, 2007). In this regard, primary aim of science education is not merely for students to memorize scientific knowledge, but to enable them to develop scientific process skills and thereby acquire competences to think critically, solve problems and apply knowledge they have acquired to their daily activities (Salcı & Aydın, 2021; Şahin et al., 2014).

An examination of literature indicated that scientific literacy had been addressed in various studies. These studies generally focused on science teacher education students (Can & Çelik, 2020; Özdemir, 2010; Suwono et al., 2022; Ünlü & Yıldırım, 2024), pre-service preschool teachers (Başar & Elyıldırım, 2022), middle school students (Salcı & Aydın, 2021), seventh grade students (Şahin et al., 2014), and sixth grade students (Keskin & Çam, 2018). The Science and Technology Literacy Scale (Özdemir, 2010; Şahin et al., 2014), an open-ended questionnaire (Ünlü & Yıldırım, 2024), the Scientific Literacy Perception Scale (Suwono et al., 2022), the Attitude Scale Toward Science Education (Başar & Elyıldırım, 2022), and the Universal Science Literacy Scale (Can & Çelik, 2020; Keskin & Çam, 2019; Salcı & Aydın, 2021) were utilized as data collection tools in these studies. An examination of results of studies on scientific literacy revealed that parents' science literacy levels influence student achievement (Şahin et al., 2014), misconceptions regarding science and technology (Özdemir, 2010), science teacher education students had high scientific literacy perceptions (Suwono et al., 2022), pre-service preschool teachers had high science literacy levels (Başar & Elyıldırım, 2022), middle school students had high universal science literacy levels (Salcı & Aydın, 2022), and science teacher education students had high universal science literacy levels across all dimensions (Can & Çelik, 2020). In addition, a significant difference was found between pre- and post-test scores in scientific literacy among experimental group where the REACT strategy was implemented (Keskin & Çam, 2019). Ünlü and Yıldırım (2024) investigated science teacher education students' opinions on scientific literacy and found that science teacher education students believed scientific literacy contributes to advancement of science, that scientific literacy fosters environmental awareness in individuals and, that use of technology and materials should be increased to develop students' scientific literacy. The researchers had offered various recommendations based on their results. Can and Çelik (2020) recommended use of qualitative research methods to identify factors that influence students' universal science literacy levels. Keskin and Çam (2019) noted that instructional programs should be updated to develop students' scientific literacy skills and that hands-on activities should be increased in science courses. Özdemir (2010) emphasized importance of incorporating activities aimed at understanding nature of science in science and technology courses, and Başar and Elyıldırım (2022) underlined the need to include science literacy in early childhood education programs. Suwono et al. (2022) stated that scales utilized to evaluate science teacher education students' scientific literacy perceptions should be more widespread. Salcı and Aydın (2022) proposed various activities to enhance students' universal science literacy, such as examining technological designs, visiting museums, storytelling about scientists' discoveries, following scientific journals and documentaries, and designing technological tools and equipment using their creativity. They noted that these activities play a significant role in raising students' scientific literacy levels.

1.3. The Importance of the Study

A review of the literature revealed that, although there were numerous studies examining education faculty students' digital competence across different subject areas (Turkish, primary education, preschool education, etc.) and in relation to various variables. Researches aimed at examining science teacher education students' digital competence perceptions were limited. Furthermore, there were studies in the literature aimed at investigating science teacher education students' scientific literacy perceptions. No study was found that addresses digital competence and scientific literacy perceptions together. However, contemporary science education requires the training of individuals who can both effectively utilize digital technologies and comprehend scientific knowledge. For this reason, jointly assessing science teacher education students' digital competence and scientific literacy perceptions is significant in terms of understanding current state of education faculties and making recommendations for improvement. In this context, it is anticipated that the current study will fill this gap in the literature and provide data that will serve as a guide for future research.

1.4. The Aim of the Study

This study aimed to identify science teacher education students' digital competence and scientific literacy perceptions, and to examine whether these perceptions differ according to various variables (gender, type of high school attended, age, year of university education, possession of a personal computer, having

internet access, and daily internet usage time). The study also examined correlation between science teacher education students' digital competence and scientific literacy perceptions.

To achieve this aim, answers were sought to questions set out below:

1. What were science teacher education students' digital competence and scientific literacy perceptions?
2. Did science teacher education students' digital competence and scientific literacy perceptions vary according to various variables (gender, type of high school attended, age, year of university education, possession of a personal computer, having internet access, and daily internet usage time)?
3. Was there a significant correlation between science teacher education students' digital competence and scientific literacy perceptions?
4. Did science teacher education students' scientific literacy perceptions significantly predict their digital competence?

2. Method

2.1. Research Model

In this study, a correlational research design, one of quantitative research methods, was employed. Correlational studies are those in which relationship between two or more variables is examined (Büyüköztürk et al., 2023). Independent variables in the study were gender, type of high school attended, age, year of university education, possession of a personal computer, having internet access, and daily internet usage time. Dependent variables were science teacher education students' digital competence and scientific literacy perceptions.

2.2. Sample

The sample for this study consisted of 140 science teacher education students studying at a university in the west of Türkiye during the autumn term of 2023-2024 academic year. Criteria sampling and convenience sampling methods were used in selection of the sample. Sampling criterion was defined as participants studying in science teacher education program. Criterion sampling method is based on including all cases that meet a predefined set of criteria within scope of research (Yıldırım & Şimşek, 2011). In convenience sampling, sample is selected in a manner suitable for available conditions, such as time, budget, and location (Canbazoglu-Bilici, 2019). Frequency and percentage distribution of participants according to variables was presented in Table 1:

Table 1.

Frequency and Percentage Distribution of Participants

Variables		Gender		Total (f)	Total (%)
		Female (f)	Male (f)		
Type of high school attended	Scientific high school	9	2	11	7.86
	Anatolian high school	93	20	113	80.71
	Anatolian imam hatip high school	15	1	16	11.43
Age	19 years old or younger	24	2	26	18.57
	20 years old	16	4	20	14.29
	21 years old	27	7	34	24.28
	22 years old or older	50	10	60	42.86
Year of university education	1 st year	19	2	21	15.00
	2 nd year	30	7	37	26.43
	3 rd year	16	10	26	18.57
	4 th year	52	4	56	40.00
Possession of a personal computer	Yes	100	20	120	85.71
	No	17	3	20	14.29
Having internet access	Yes	102	17	119	85.00
	No	15	6	21	15.00
Daily internet usage time	2 hours or less	15	5	20	14.29
	3-4 hours	56	12	68	48.57
	5-6 hours	29	1	30	21.43
	More than 6 hours	17	5	22	15.71
Total		117	23	140	100.00

When Table 1 was examined, 86.57% (N=117) of participants were female science teacher education students and 16.43% (N=23) were male science teacher education students. 18.57% (N=26) of participants were 19 years old or younger, 14.29% (N=20) of participants were aged 20, 24.28% (N=34) of participants were aged 21, and 42.86% (N=60) of participants were 22 years old or older. 15.00% (N=21) of participants were in the first year of university education, 26.43% (N=37) of participants were in the second year of university education, 18.57% (N=26) of participants were in the third year of university education and 40.00% (N=56) of participants were in the fourth year of university education. 7.86% (N=11) of participants attended a scientific high school, 80.71% (N=113) of participants attended an Anatolian high school, and 11.43% (N=16) of participants attended an Anatolian imam hatip high school. 85.71% (N=120) of participants possessed a personal computer and 85.00% (N=119) of participants had internet access. When daily internet usage time was examined, 14.29% (N=20) of participants spent 2 hours or less, 48.57% (N=68) of participants spent 3-4 hours, 21.43% (N=30) of participants spent 5-6 hours, and 15.71% (N=22) of participants spent more than 6 hours online per day.

2.3. Data Collection Tools

In this study, the “Scientific Literacy Perception Scale (SLPS)”, developed by Suwono et al. (2022) and adapted into Turkish by Çalık et al. (2024), was used to measure scientific literacy perceptions, and the “Digital Competence Perception Scale (DCPS)”, developed by Karakuş et al. (2022), was used to measure digital competence perceptions. In addition, a personal information form designed by the researchers was used to determine participants’ gender, type of high school attended, age, year of university education, possession of a personal computer, having internet access, and daily internet usage time.

SLPS consists of 41 items and eight factors, consistent with the original scale. The factors are Metacognitive (items 1-7), Nature and Function of Science (items 8-14), Science as Human Endeavour (items 15-19), Habits of Mind (items 20-24), Interest in Science (items 25-29), Teaching of Scientific Literacy (items 30-34), Sense of Moral and Social Responsibility (items 35-37), and Ethics in Science (items 38-41). Participants indicate their agreement level with scale items using a six-point likert scale: “(1) strongly disagree”, “(2) disagree”, “(3) somewhat disagree”, “(4) somewhat agree”, “(5) agree” and “(6) strongly agree”. No negative items were reported. The highest possible total score on the scale was 246, and the lowest was 41. A score closer to 246 indicates a high scientific literacy perception, and a score closer to 41 indicates a low scientific literacy perception. Cronbach’s alpha coefficients for all items in the scale and in

its factors range from 0.63 to 0.90 (Çalık et al., 2024). Using the data obtained from this study, Cronbach's alpha coefficients for items within the scale's factors ranged from 0.823 to 0.929, and Cronbach's alpha coefficient for all items was found to be 0.944.

DCPS comprises 26 items and three factors. The factors are Media Communication Competences (items 1-8), Designing Instruction in Digital Environments Competences (items 9-16), and Informatics Competences (items 17-26). Participants indicate their agreement level with the scale items on a five-point Likert scale: “(1) not at all suitable”, “(2) not suitable”, “(3) partially suitable”, “(4) suitable” and “(5) completely suitable”. No negative items were reported. The highest possible score on the scale was 130, and the lowest was 26. A score approaching 130 indicates a high digital competence perception, and a score approaching 26 indicates a low digital competence perception. Cronbach's alpha coefficients for all items in the scale and in its factors range between 0.88 and 0.90 (Karakuş et al. 2022). Using the data obtained from this study, Cronbach's alpha coefficients for items within the scale's factors ranged from 0.947 to 0.956, and Cronbach's alpha coefficient for all items was found to be 0.974.

2.4. Data Analysis

The data obtained from DCPS and SLPS were analyzed using statistical analysis software (IBM SPSS Statistics 27). Descriptive statistics were utilized to reveal distributions of scores on DCPS and SLPS. Skewness and kurtosis values of participants' scores on the scales were examined in order to determine whether non-parametric or parametric tests should be performed in data analysis, Table 2 provided skewness and kurtosis values for scores on DCPS and SLPS according to variables.

Table 2.

Skewness and Kurtosis Values for Scores on DCPS and SLPS

		DCPS		SLPS					
Variables		Skewness	SE	Kurtosis	SE	Skewness	SE	Kurtosis	SE
-	-	-0.243	0.205	-1.214	0.407	-0.290	0.205	0.107	0.407
Gender	Female	-0.170	0.224	-1.310	0.444	-0.292	0.224	0.346	0.444
	Male	-0.539	0.481	-0.925	0.935	-0.252	0.481	-0.825	0.935
Type of high school attended	Scientific high school	0.195	0.661	-1.064	1.279	0.108	0.661	1.287	1.279
	Anatolian high school	-0.307	0.227	-1.210	0.451	-0.399	0.227	0.291	0.451
	Anatolian imam hatip high school	0.056	0.564	-1.294	1.091	0.039	0.564	-1.156	1.091
Age	19 years old or younger	0.249	0.456	-0.377	0.887	0.340	0.456	0.068	0.887
	20 years old	0.068	0.512	-0.977	0.992	-0.173	0.512	0.290	0.992
	21 years old	-0.131	0.403	-1.613	0.788	-0.236	0.403	0.222	0.788
	22 years old or older	-0.676	0.309	-0.814	0.608	-0.527	0.309	0.446	0.608
Year of university education	1 st year	0.035	0.501	-0.885	0.972	0.188	0.501	0.207	0.972
	2 nd year	-0.058	0.388	-1.329	0.759	0.340	0.388	-0.501	0.759
	3 rd year	-0.124	0.456	-0.948	0.887	-0.268	0.456	-0.798	0.887
	4 th year	-0.552	0.319	1.205	0.628	-0.627	0.319	1.284	0.628
Possession of a personal computer	Yes	-0.374	0.221	-1.084	0.438	-0.324	0.221	0.186	0.438
	No	0.566	0.512	-0.757	0.992	-0.207	0.512	0.026	0.992
Having internet access	Yes	-0.298	0.222	-1.234	0.440	-0.323	0.222	0.244	0.440
	No	0.286	0.501	-1.034	0.972	-0.186	0.501	-0.336	0.972
Daily internet usage time	2 hours or less	-0.379	0.512	-1.358	0.992	-0.539	0.512	-0.667	0.992
	3-4 hours	-0.111	0.291	-1.339	0.574	-0.134	0.291	0.484	0.574
	5-6 hours	0.000	0.427	-0.554	0.833	-0.230	0.427	0.850	0.833
	More than 6 hours	-1.071	0.491	-0.254	0.953	-0.852	0.491	0.490	0.953

Note. DCPS: Digital Competence Perception Scale, SLPS: Scientific Literacy Perception Scale, SE: Standard Error

The skewness and kurtosis coefficients were examined to decide whether the data met assumption of a normal distribution. Table 2 revealed that skewness value was -0.243 and kurtosis value was -1.214 for scores on DCPS, skewness value was -0.290 and kurtosis value was 0.107 for scores on SLPS. According to Tabachnick and Fidell (2014), a value between -1.5 and +1.5, and according to George and Mallery (2021), a value between -2.0 and +2.0, indicates that the data have a normal distribution. Based on these criteria, it could be stated that scores for both scales had a normal distribution. Kurtosis value of scores on DCPS for 21 years old age group (kurtosis=-1.613) excluding independent variables (gender, type of high

school attended, age, year of university education, possession of a personal computer, having internet access, and daily internet usage time), skewness and kurtosis values were also within range of -1.5 to +1.5, as shown in Table 2. Additionally, histogram, stem and leaf, normal Q-Q plot, detrended normal Q-Q plot and boxplot diagrams were examined (Alpar, 2020). Accordingly, it was concluded that the data had a normal distribution with respect to independent variables, and it was decided to use parametric tests in analysis of the data. A t-test for independent samples was performed to reveal whether there were differences in mean scores on DCPS and SLPS according to gender, possession of a personal computer and having internet access. T-test is used to test for differences between mean scores of two independent groups with interval-scale measurements that have a normal distribution (Büyüköztürk, 2020). A one-way analysis of variance (ANOVA) for independent samples was used to examine whether there were differences in mean scores on DCPS and SLPS according to type of high school attended, age, year of university education, and daily internet usage time. ANOVA is used to test statistical significance of differences among more than two independent groups mean scores with interval-scale measurements that have a normal distribution (Büyüköztürk, 2020). Following ANOVA, in case of a significant difference emerge among mean scores, condition of homogeneity of variances was examined, and it was observed that this condition was met across all groups. Scheffe test was used as a post hoc test to determine between which two groups' differences occurred (Büyüköztürk, 2020). Relationship between scores on DCPS and SLPS, and direction and strength of relationship between these variables was determined using Pearson correlation coefficient. Pearson correlation coefficient varies from -1 to +1, and as coefficient approaches 0, relationship's strength decreases (Alpar, 2020).

2.5. Information of Ethical Approval for the Study

All rules specified in “Guidelines on Scientific Research and Publication Ethics for Higher Education Institutions” were followed in this study. None of actions mentioned in the second section of guidelines under heading “Actions Contrary to Scientific Research and Publication Ethics” were committed.

Name of ethical committee: Balıkesir University Science and Engineering Ethics Committee

Date of ethical approval decision: 10 February 2025

Ethical approval reference number: 19928322-108.01-487984

3. Results

Descriptive statistics were calculated for scores on DCPS and SLPS to answer the first research question, “What were science teacher education students' digital competence and scientific literacy perceptions?” Descriptive statistics for scores on DCPS and SLPS were presented in Table 3.

Table 3.

Descriptive Statistics for Scores on DCPS and SLPS

Scales	N	Min	Max	$\bar{x}$	S
DCPS	140	78	130	110.686	15.718
SLPS	140	134	246	194.757	21.730

Note. DCPS: Digital Competence Perception Scale, SLPS: Scientific Literacy Perception Scale, N: number of participants, $\bar{x}$: mean score, S: standard deviation

Table 3 revealed that mean score on SLPS was 194.757. The highest possible score on SLPS was 246, and the lowest was 41. Based on these scores, it could be concluded that science teacher education students had a high scientific literacy perception. Similarly, mean score on DCPS was 110.686. The highest possible score on DCPS was 130, and the lowest was 26. Based on these scores, it could be presumed that science teacher education students had a high digital competence perception.

An analysis of responses to DCPS items revealed that item with the lowest mean score ($\bar{x}=3.936$) was “19. I can take measures to eliminate negative aspects of digital tools.” It could be inferred based on this result, that science teacher education students had a low digital competence perception regarding taking measures to eliminate problems with digital tools. It was observed that item with the highest mean score ($\bar{x}=4.557$)

was “2. I can use social media applications (Facebook, Twitter, Instagram, etc.).” Accordingly, it could be stated that science teacher education students had a high digital competence perception regarding use of social media applications.

An analysis of participants’ responses to SLPS items revealed that item with the lowest mean score ($\bar{x}=4.307$) was “12. A person’s use of science and technology should always involve social problem solving.” Based on this result, it could be indicated that science teacher education students had a low scientific literacy perception that use of science and technology must necessarily serve to solve social problems. It was observed that item with the highest mean score ($\bar{x}=5.471$) was “15. Scientists must be honest in conducting and reporting their research.” Accordingly, it could be claimed that science teacher education students had a high scientific literacy perception regarding need for scientists to be honest when conducting and reporting their research.

The second research question was that “Did science teacher education students’ digital competence and scientific literacy perceptions vary according to various variables (gender, type of high school attended, age, year of university education, possession of a personal computer, having internet access, and daily internet usage time)?” To answer this question, firstly an independent samples t-test was utilized to find out how mean scores on DCPS and SLPS differed according to gender, possession of a personal computer, and having internet access. Table 4 demonstrated t-tests’ results.

Table 4.

T-Test’s Results for Mean Scores on DCPS and SLPS

Scales		DCPS							SLPS					
Variables		N	$\bar{x}$	S	sd	t	p	Cohen’s d	$\bar{x}$	S	sd	t	p	Cohen’s d
Gender	Female	117	110.581	15.334	138	0.177	.860	0.296	195.957	21.428	138	1.480	.141	0.338
	Male	23	111.217	17.909					188.652	22.707				
Possession of a personal computer	Yes	120	112.142	15.418	138	2.747	.007	0.664	195.675	21.853	138	1.226	.222	-0.040
	No	20	101.950	14.996					189.250	20.645				
Having internet access	Yes	119	112.252	15.103	138	2.880	.005	0.682	195.790	21.741	138	1.343	.182	0.318
	No	21	101.810	16.552					188.905	21.229				

Note. DCPS: Digital Competence Perception Scale, SLPS: Scientific Literacy Perception Scale, N: number of participants, $\bar{x}$: mean score, S: standard deviation, sd: degree of freedom, p: statistical significance value, Cohen’s d: effect size coefficient

Table 4 demonstrated that there was no significant difference in mean scores on DCPS according to gender, $t(138)=0.177$, $p>.05$. Based on this result, it could be concluded that gender had no effect on science teacher education students’ digital competence perceptions. Mean scores on DCPS revealed a significant difference according to possession of a personal computer [$t(138)=2.747$, $p<.01$, Cohen’s $d=0.664$] and having internet access [$t(138)=2.880$, $p<.01$, Cohen’s $d=0.682$]. According to Cohen’s d values, observed difference indicated a moderate effect (Cohen, 1988; Lenhard & Lenhard, 2017). Based on these results, it could be indicated that possession of a personal computer and having internet access had a moderate effect on science teacher education students’ digital competence perceptions.

Table 4 revealed that mean scores on SLPS did not demonstrate a significant difference according to gender [$t(138)=1.480$, $p>.05$], possession of a personal computer [$t(138)=1.226$, $p>.05$], having internet access [$t(138)=1.343$, $p>.05$]. Based on these results, it could be stated that gender, possession of a personal computer and having internet access had no effect on science teacher education students’ scientific literacy perceptions.

Secondly descriptive statistics for scores on DCPS and SLPS were calculated according to type of high school attended, age, year of university education, and daily internet usage time in order to answer the second research question (Table 5).

Table 5.

Descriptive Statistics of Scores on DCPS and SLPS

Scales		DCPS			SLPS	
Variables		N	$\bar{x}$	S	$\bar{x}$	S
Type of high school attended	Scientific high school	11	105.818	17.691	194.091	25.809
	Anatolian high school	11	111.195	15.814	195.779	21.446
	Anatolian imam hatip high school	16	110.438	13.928	188.000	20.989
	Total	14	110.686	15.718	194.757	21.730
Age	19 years old or younger	26	104.769	14.673	188.615	21.693
	20 years old	20	105.200	16.218	191.050	25.918
	21 years old	34	110.794	15.901	193.765	23.840
	22 years old or older	60	115.017	14.832	199.217	18.351
	Total	14	110.686	15.718	194.757	21.730
Year of university education	1 st year	21	105.714	15.881	191.238	22.605
	2 nd year	37	109.703	16.359	198.351	21.295
	3 rd year	26	107.462	15.593	180.846	23.581
	4 th year	56	114.696	14.683	200.161	17.982
	Total	14	110.686	15.718	194.757	21.730
Daily internet usage time	2 hours or less	20	114.450	14.947	192.850	24.782
	3-4 hours	68	108.118	16.509	194.368	21.682
	5-6 hours	30	107.900	13.126	191.767	17.224
	More than 6 hours	22	119.000	14.396	201.773	24.329
	Total	14	110.686	15.718	194.757	21.730

Note. DCPS: Digital Competence Perception Scale, SLPS: Scientific Literacy Perception Scale, N: number of participants, $\bar{x}$: mean score, S: standard deviation

Table 5 revealed that there were differences in mean scores on DCPS and SLPS according to type of high school attended, age, year of university education, and daily internet usage time. To test statistical significance of these differences, an ANOVA for independent samples was conducted (Table 6).

Table 6.

ANOVA Results for Mean Scores on DCPS and SLPS

Scales	Variables	Source of Variance	Sum of Squares	sd	Mean of Squares	F	p	η^2	Significant difference
DCPS	Type of high school attended	Between groups	290.881	2	145.440	0.585	.558	0.008	-
		Within groups	34049.291	137	248.535				
		Total	34340.171	139					
	Age	Between groups	2637.814	3	879.271	3.772	.012	0.077	E-H
		Within groups	31702.358	136	233.106				
		Total	34340.171	139					
	Year of university education	Between groups	1725.855	3	575.285	2.399	.071	0.050	-
		Within groups	32614.316	136	239.811				
		Total	34340.171	139					
	Daily internet usage time	Between groups	2.485	3	828.488	3.537	.017	0.072	J-L, K-L
		Within groups	31.855	136	234.226				
		Total	34.340	139					
SLPS	Type of high school attended	Between groups	853.365	2	426.682	0.902	.408	0.013	-
		Within groups	64780.378	137	472.849				
		Total	65633.743	139					
	Age	Between groups	2482.338	3	827.446	1.782	.154	0.038	-
		Within groups	63151.405	136	464.349				
		Total	65633.743	139					
	Year of university education	Between groups	7404.563	3	2468.188	5.765	<.001	0.113	C-B, C-D
		Within groups	58229.180	136	428.156				
		Total	65633.743	139					
	Daily internet usage time	Between groups	1.434	3	478.051	1.013	.389	0.022	-
		Within groups	64.200	136	472.056				
		Total	65.634	139					

Note. DCPS: Digital Competence Perception Scale, SLPS: Scientific Literacy Perception Scale, sd: degree of freedom, p: statistical significance value, η^2 : Eta-squared effect size, A: 1st year, B: 2nd year, C: 3rd year, D: 4th year, E: 19 years old or younger, F: 20 years old, G: 21 years old, H: 22 years old or older, I: 2 hours or less, J: 3-4 hours, K: 5-6 hours, L: More than 6 hours

The ANOVA results in Table 6 revealed that there were no significant differences in mean scores on DCPS based on year of university education [$F(3,136)=2.399$, $p>.05$] and type of high school attended [$F(2,137)=0.585$, $p>.05$]. Based on these results, it could be indicated that year of university education and type of high school attended had no effect on science teacher education students' digital competence perceptions. Mean scores on DCPS demonstrated significant differences according to age [$F(3,136)=3.772$, $p<.05$, $\eta^2=0.077$] and daily internet usage time [$F(3,136)=3.537$, $p<.05$, $\eta^2=0.072$]. In terms of age ($\eta^2=0.077$) and daily internet usage time ($\eta^2=0.072$), effect sizes correspond to moderate effect sizes (Lenhard & Lenhard, 2017). According to Scheffe post hoc test's results, it could be stated that 19 years old or younger science teacher education students' mean scores on DCPS ($\bar{x}=104.769$) were significantly lower than 22 years old or older science teacher education students' ($\bar{x}=115.017$). Similarly, it could be indicated that science teacher education students' mean scores on DCPS with a daily internet usage time of more than 6 hours ($\bar{x}=119.000$) were significantly higher than science teacher education students with a daily internet usage time of 3-4 hours ($\bar{x}=108.118$) and 5-6 hours ($\bar{x}=107.900$).

The ANOVA results in Table 6 revealed that there were no significant differences in mean scores on SLPS based on age [$F(3,136)=1.782$, $p>.05$], type of high school attended [$F(2,137)=0.902$, $p>.05$] and daily internet usage time [$F(3,136)=1.013$, $p>.05$]. Based on these results, it could be stated that type of high school attended, age, and daily internet usage time had no effect on science teacher education students' scientific literacy perceptions. Mean scores on SLPS demonstrated a significant difference according to year of university education, $F(3,136)=5.765$, $p<.001$, $\eta^2=0.113$. In terms of year of university education, effect size ($\eta^2=0.113$) corresponds to a medium effect size (Lenhard & Lenhard, 2017). According to Scheffe post hoc test's results, it could be stated that science teacher education students' mean scores on SLPS studying third year ($\bar{x}=180.846$) were significantly lower than studying second year ($\bar{x}=198.351$) and fourth year ($\bar{x}=200.161$).

To answer the third research question, "Was there a significant correlation between science teacher education students' digital competence and scientific literacy perceptions?", Pearson correlation coefficient between scores on DCPS and SLPS was examined. Results obtained from correlation analysis were given in Table 7.

Table 7.

Correlation Analysis Results for Scores on DCPS and SLPS

Variables	N	p	R	R ²
Scores on DCPS * Scores on SLPS	140	<.001	0.621	0.386

Note. DCPS: Digital Competence Perception Scale, SLPS: Scientific Literacy Perception Scale, N: number of participants, p; statistical significance value, r: correlation coefficient

A Pearson correlation coefficient between 0.00-0.19 specifies a low relationship, between 0.20-0.39 states a weak relationship, and between 0.40-0.69 signifies a moderate relationship, between 0.70-0.89 shows a strong relationship, and between 0.90 and 1.00 indicates a very strong relationship (Alpar, 2020; Schober et al., 2018). Accordingly, Table 7 revealed there was a statistically significant, moderate and positive correlation between scores on DCPS and SLPS, $R=0.621$, $p<.001$. Considering determination coefficient ($R^2=0.386$), it could be interpreted that approximately 39% of variation in digital competence perceptions could be explained by scientific literacy perceptions, or that approximately 39% of variation in scientific literacy perceptions could be explained by digital competence perceptions.

To answer the fourth research question, "Did science teacher education students' perceptions of scientific literacy significantly predict their digital competence?", a simple linear regression analysis was conducted. The results obtained from the regression analysis were presented in Table 8.

Table 8.

Regression Analysis of DCPS Scores According to SLPS Scores

Predictor Variable	<i>B</i>	<i>SE B</i>	β	<i>t</i>	<i>p</i>	<i>R</i> ²	ΔR^2	95% CI for <i>B</i>	
								<i>LL</i>	<i>UL</i>
Constant	23.157	9.454	-	2.449	.016	-	-	4.463	41.851
SLPS Scores	0.449	0.048	0.621	9.315	<.001	0.386	0.382	0.354	0.545

Note. DCPS: Digital Competence Perception Scale, SLPS: Scientific Literacy Perception Scale, CI=confidence interval; LL=lower limit; UL=upper limit, $F(1, 138)=86.771$, $p<.001$

According to Table 8, science teacher education students' perceptions of scientific literacy significantly predicted their digital competence, $R^2=0.386$, $F(1, 138)=86.771$, $p<.001$. The variances belonging to the independent variable (SLPS Scores) predicting the DCPS scores were 39% and the regression equation (mathematical model) for predicting DCPS scores was $DCPS \text{ score}=23.157+0.449 \times SLPS \text{ Score}$.

4. Conclusion, Discussion and Recommendations

This study aimed to determine science teacher education students' digital competence and scientific literacy perceptions, to examine these perceptions in relation to various variables (gender, type of high school attended, age, year of university education, possession of a personal computer, having internet access, and daily internet usage time), and to identify relationship between these two variables. In this section, the study's results were discussed by comparing them with results of studies in the literature.

The study's first key result indicated that science teacher education students had high digital competence and scientific literacy perceptions. This suggests that science teacher education students consider themselves competent in these two important contemporary skill areas. High digital competence perceptions could be explained by that science teacher education students belong to generation described as "digital natives" (Prensky, 2001) and make intensive use of technology in their daily lives. Similarly, a likely reason for this high scientific competence perceptions could be that science teacher education programs by their nature include courses designed to develop scientific literacy skills. In the literature, while Keskin and Yazar (2015) found that teachers in different subjects possessed digital competence at an acceptable level, Vosough-Matin (2025) determined that pre-service special education teachers had a very high digital competence level. These results suggest that teachers of different teaching subjects may have similar digital competence perceptions. On the other hand, Köksal and Canlı (2024) identified teachers' digital competences across all teaching subjects as being at an integrative level and emphasized that teachers should use digital technologies in teaching processes and should develop their ability to determine which tools are more appropriate for which subjects and situations, and to design effective instruction with these tools. Similarly, Kaman (2025) found that pre-service primary school teachers' digital competences were at high levels, while Özden and Örgen-Yaşar (2024) and Kaya and Uyangör (2022) found that education faculty students' digital competences were at intermediate levels. It was thought that discrepancies in these results, which partially align with this study's results, may stem from differences in structure of assessment tools used or from sample groups' demographic and professional characteristics.

When considering gender, this study found no significant differences in either scientific literacy perceptions, or digital competence perceptions. A review of the literature revealed that results regarding digital competence varied considerably according to gender. While this study's results align with studies of Köksal and Canlı (2024) and Doğan (2023), there were also numerous studies in the literature that identify significant differences across various sample groups and contexts, contrary to this result (Aktaş et al., 2025; Fidan & Cura-Yeleğen, 2022; Hiçyorulmaz et al., 2024; Kaman, 2025; Keskin & Yazar, 2015; Özden & Örgen-Yaşar, 2024; Özkan-Kanat, 2023). Among studies reporting results in favor of female participants across various dimensions of digital competence, Fidan and Cura-Yeleğen (2022) found that

female participants had higher digital competence level. Similarly, Kaman (2025) and Özden and Örgen-Yaşar (2024) identified significant differences in favor of female education faculty students. Furthermore, Hiçyorulmaz et al. (2024) found that among university students, and Özkan-Kanat (2023) found that among education faculty students, there were significant differences in favor of female participants only in certain subdimensions of digital competence. There were also studies in the literature that obtained results in favor of male participants. Keskin and Yazar (2015) and Aktaş et al. (2025) found that male teachers and education faculty students had higher digital competence levels. Aktaş et al. (2025), who examined subdimensions of digital competence, found that male education faculty students scored higher in security, data literacy, digital content creation, problem-solving, collaboration and communication sub-dimensions; whereas female participants scored higher only in ethics sub-dimension. Similarly, Vosough-Matin (2025) also identified a significant difference in favor of male education faculty students. Kaya and Uyangör (2022) reported a significant difference in favor of male participants in self-efficacy sub-dimension of digital competence. These conflicting results in literature highlight multi-dimensional and context-sensitive nature of subject. These differences may stem from variations in age range of sample groups, years of experience, cultural context, technology usage habits during period of research, and sub-dimensions of measurement tools. In particular, technology usage has permeated every aspect of life for both genders in recent years may have led to digital divide disappearing in certain contexts. As original study in which SLPS was developed (Suwono et al., 2022) and adaptation study into Turkish (Çalık et al., 2024) did not include a comparison regarding gender, there was no study with which current result could be directly compared. This situation indicates that effect of gender on scientific literacy perceptions has not been sufficiently investigated in the literature. Can and Çelik (2020) found that female science teacher education students had higher universal science literacy level compared to their male counterparts. Accordingly, it could be argued that research is needed to assess effect of gender on scientific literacy.

A significant difference was found in science teacher education students' digital competence perceptions while no significant difference was observed in their scientific literacy perceptions in terms of possession of a personal computer and having internet access. As digital competence is a functional construct encompassing an individual's abilities to work with digital tools, solve problems, access information, and produce content in digital environments, it is more directly influenced by hardware and access conditions. Indeed, studies examining education faculty students' digital competence demonstrated that access to digital tools, frequency of use, and interaction with technology had a significant impact on digital competence (Fidan & Cura-Yeleğen, 2022; Hiçyorulmaz et al., 2024). The literature emphasizes that scientific literacy is shaped more by individuals' learning experiences, scientific process skills and interactions within context of science education, rather than being directly related to having technological equipment (Kavak et al., 2006; Turgut, 2007).

With regard to year of university education, no significant difference was found in science teacher education students' digital competence perceptions, whereas it was found that there was a significant difference in their scientific literacy perceptions. Absence of significant differences in digital competence perceptions according to year of university education could be interpreted in line with researches indicating that digital competence changes in terms of its qualitative characteristics across different year groups. Galimullina et al. (2022) noted that while education faculty students' digital competence was more concentrated on technological dimension in lower year groups, pedagogical and professional dimensions come to fore in higher year groups. Özden and Örgen-Yaşar (2024), Kaman (2025) and Özkan-Kanat (2023) also found significant differences in favor of higher year groups in their studies. That no significant difference in digital competence perceptions emerged according to year of university education in this study may be due to the scale used not clearly differentiating according to year of university education or the scale focusing more on general digital competence. In the context of scientific literacy perceptions, the study's results indicate that scientific literacy perceptions among science teacher education students studying third year were significantly lower than science teacher education students studying second and fourth year. This situation could be attributed to contribution made to development of scientific literacy by courses such as subject knowledge, specialized teaching methods and teaching practice, which were concentrated in final years of teacher training. The literature, which demonstrates that scientific literacy is a construct strengthened by

knowledge accumulation, pedagogical experience and teaching practice (Kavak et al., 2006; Turgut, 2007), supports this result.

While a significant difference was found in digital competence perceptions with regard to age, no significant difference was found in scientific literacy perceptions. There were studies that aligned with result of a significant difference in digital competence perception, as well as studies that contradict this in the literature. Doğan (2023) and Köksal and Canlı (2024) found that there was no statistically significant difference in digital competence perceptions across different age groups. Özden and Öрге-Yaşar (2024) concluded that older university students had higher digital competence perceptions. This could suggest that age alone was not a determining variable in digital competence perceptions. These discrepancies in the literature may stem from differences in sample groups (academicians, teachers, pre-service teachers, education faculty students) and context. Specifically, regarding science teacher education students, maturity that come with age, experience and motivation to learn stand out as factors positively influencing digital competence perception. Indeed, Yılmaz and Toker's (2022) study, which demonstrated that teachers' digital competence improved during the pandemic, indicated that necessity and experience could enhance these skills. In a study conducted by Çebi and Reisoğlu (2019), a 51-hour instructional program designed within the DigComp framework to develop education faculty students' digital competence was implemented, and their knowledge and skills were observed. Following implementation of instructional program, it was determined that education faculty students' digital competence perceptions had improved significantly across all dimensions (Çebi & Reisoğlu, 2019). This indicates that systematic and practical instructional programs are an effective tool for developing digital competence, regardless of age, subject area or prior experience. Consequently, high digital competence perceptions observed in 22 years old or older group in this study may reflect not only these participants' life experiences but also practical courses they undertook in higher years of their teacher education program and experiences of teaching practice. Oikarinen et al. (2026) emphasize that school community plays a critical role in developing teachers' digital competences. According to Oikarinen et al. (2026), it is necessary to develop digital mentoring and counselling programs that provide continuous support to teachers, to create peer learning environments based on collaboration among teachers, and to ensure that time, equipment and resources required for these processes are made accessible. Furthermore, regular monitoring and evaluation of teachers' digital development, alongside school leadership actively providing guidance and encouragement throughout this process, is significantly important. In this context, when effectiveness of instructional programs highlighted in Çebi and Reisoğlu's (2019) study is combined with school based systematic support models proposed by Oikarinen et al. (2026), it may be possible to develop teachers' digital competences in a holistic and sustainable manner both pre-service and in-service. Studies examining variables influencing scientific literacy in the literature also contained results supporting that scientific literacy was not an age sensitive construct (Salcı & Aydın, 2022). Similarly, in a study analysing research on scientific literacy within Türkiye, it was noted that age did not emerge as a significant determinant in scientific literacy (Kılınçaslan & Dökme, 2022). Absence of age-related differences in scientific literacy perception could suggest that scientific literacy is a construct independent of age, shaped more by learning experiences within the context of education programs and pedagogical processes related to science education.

No significant difference was found in science teacher education students' digital competence and scientific literacy perceptions in terms of type of high school attended. This result could be interpreted that type of high school attended did not have a decisive influence on science teacher education students' digital competence and scientific literacy perceptions. No study was found in the literature that directly examined effect of type of high school attended on digital competence and scientific literacy perceptions. However, it was emphasized that scientific literacy was shaped more by subject knowledge, pedagogical competences, scientific process skills and experiences related to science education that science teacher education students acquire during university education, rather than by their previous school types (Kılınçaslan & Dökme, 2022). Similarly, results suggested that education faculty students' universal science literacy levels were not influenced by past educational variables such as type of high school attended but rather developed through learning processes within university education (Salcı & Aydın,

2022). This result suggested that university education largely eliminated differences stemming from previous educational levels and was shaped by individual efforts.

Significant differences were found in digital competence perceptions in terms of daily internet usage time, whereas no significant differences were found in scientific literacy perceptions. The literature supported these results. Studies demonstrated that digital competence was closely related to experience in technology use, frequency of interaction with digital tools, and time spent in online environments (Hiçyorulmaz et al., 2024). In this context, the result that science teacher education students with a daily internet usage time of more than 6 hours reported significantly higher digital competence perceptions compared to those with daily internet usage time of 3-4 hours and 5-6 hours suggests that time spent in digital environments contributes to development of digital competence. Scientific literacy was more closely related to theoretical knowledge, scientific process skills and pedagogical experience within the context of science education, rather than being directly linked to time spent in digital environments (Kılınçaslan & Dökme, 2022).

The study's one of the most significant results was identification of a statistically significant, moderate and positive correlation ($r=0.621$) between science teacher education students' digital competence and scientific literacy perceptions. That approximately 38% of variation in digital competence perceptions was explained by scientific literacy perceptions, or that approximately 38% of variation in scientific literacy perceptions was explained by digital competence perceptions, may suggest that these two concepts were complementary and mutually reinforcing. Furthermore, according to the results of the regression analysis, science teacher education students' perceptions of scientific literacy significantly predicted their digital competence. A scientifically literate individual is expected to apply skills such as accessing information, questioning, analysing and problem-solving in digital environments in a similar way. Digital competence provides necessary means to make these processes more effective and efficient. The study's result aligned with Çittir et al.'s (2025) result, that digital competence significantly predicted "information and technology literacy" dimension of 21st century skills, which encompass scientific literacy. This situation highlights that these two areas cannot be considered independently in pre-service teachers' education, but rather they must be addressed as a holistic whole. Approaches such as collaboration, authentic learning and reflective thinking, emphasized in model proposed by Røkenes and Krumsvik (2014), could be considered pedagogical strategies that would develop both digital competence and scientific literacy. Filiz and Kurt's (2022) flipped course study with pre-service teachers demonstrated the tangible effects of pedagogical strategies in the context of teacher education. It revealed that it led to significant improvements in digital competences and levels of innovativeness. As noted by Tondeur et al. (2023) within the HeDiCom framework, it is essential for faculty members to model this integrated structure and incorporate it into their lessons for pre-service teachers' professional development. When considering science teacher education students specifically, importance of concrete practices aimed at developing this integrated structure becomes even more evident. Abouelenein et al. (2024) revealed that integration of virtual chemistry laboratories into teacher education programs contributed to scientific literacy by enhancing both science teacher education students' digital competences and scientific application skills. Problem-solving, data analysis, model development, and content creation activities conducted in such virtual environments support pre-service teachers' ability to use digital tools for pedagogical purposes while also strengthening their scientific process skills (Abouelenein et al., 2024). Moderate relationship between digital competence and scientific literacy perceptions identified in this study was particularly valuable in demonstrating that this relationship could be concretized through discipline-specific digital applications.

In conclusion, this study found that science teacher education students' digital competence and scientific literacy perceptions were at high levels, that these perceptions did not differ according to gender and type of high school attended, that digital competence perceptions varied according to age, possession of a personal computer, having internet access and daily internet usage time, and that scientific literacy perceptions varied according to year of university education. Most importantly, result of a moderate and significant relationship between digital competence and scientific literacy perceptions indicates that contemporary teacher education programs must address these two areas through an integrated approach.

This study had several limitations. First, it was conducted with 140 science teacher education students studying at a university in Türkiye, which might limit the diversity of perspectives represented in the results. Second, criterion and convenience sampling methods were used in the study. While these methods enabled efficient data collection within the defined context, they might restrict the extent to which the results could be generalized to broader populations. Additionally, the sample consisted of voluntary participants from a single university, which might have introduced a degree of sampling bias. Therefore, the study's results should be interpreted within the context of sample characteristics. Future studies involving larger and more diverse samples could further strengthen the generalizability of the findings.

The following recommendations could be made based on the study's results:

- In their courses at faculty of education, pre-service teachers should be encouraged to develop original teaching materials for science education using digital tools and to apply these in real classroom settings.
- Instructional programs aimed at developing pre-service teachers' and teachers' digital competence should be planned and implemented.
- Opportunities for workshops and laboratories where pre-service teachers could produce digital content and develop their problem-solving skills should be increased in education faculties.
- Deeper results regarding pre-service teachers' digital competence and scientific literacy perceptions could be obtained by conducting mixed-methods studies that utilize not only the scales used in this research but also qualitative data collection methods such as observation, interview or performance test.
- The relationship between scientific literacy (or subject-specific literacy) and digital competence among pre-service teachers studying in different disciplines could be examined comparatively.

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Participants were informed about ethics committee approval, and informed consent was obtained from participants. Anonymity of the participants was provided in the reporting. In the study, no images were used by revealing the identity of the participants.

Declaration of generative AI and AI-assisted technologies in the writing process

Microsoft M365 Copilot, QuillBot, and DeepL were used during the preparation of this manuscript to support text editing, paraphrasing, and improving the clarity and academic tone of certain sections. The tools did not generate research ideas, conduct analyses, interpret findings, or make any intellectual contributions. All scientific judgments, content decisions, and final revisions were made solely by the authors.

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