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The Analysis of Pre-Service Teachers' Self-Assessed Digital Competence Based on The ISTE Standards

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Abstract

This study examined the digital competence of pre-service teachers within the frameworkof the International Society for Technology in Education (ISTE) Standards and explored differences according to demographic and access-related variables. A quantitative survey design was employed, and data were collected from undergraduate students enrolled in a teacher education program. The instrument comprised seven ISTE domains and demonstrated excellent internal consistency (α = .986 overall; subscale α values ranging from .919 to .949).Descriptive findings indicated moderate levels of self-perceived digital competence across all domains. Higher mean scores were observed in Knowledge Constructor and Empowered Learner, whereas lower scores emerged in Innovative Designer and Computational Thinker. Due to non-normal data distribution, non-parametric tests were conducted. Kruskal–Wallis analyses revealed significant differences by year of study in five domains, primarily between first- and third-year students, suggesting developmental progression during teacher education. No significant differences were identified across academic majors. Mann–Whitney U tests showed statistically significant differences across all domains based on personal computer ownership and internet access, favoring students with greater technological access.The findings indicate that digital competence develops throughout teacher education but remains strongly associated with structural access factors. Strengthening innovation-oriented competencies and ensuring equitable technological resources are critical for comprehensive digital competence development.

Keywords:*Digital competence; Pre-service teachers; ISTEStandards; Teacher education; Technology access; Digital divide*

1. Introduction

The rapid digital transformation of educational environments has fundamentally redefined the competencies expected of future teachers. Contemporary classrooms increasingly require educators who can integrate digital tools pedagogically, foster responsible technology use, and cultivate students' higher-order thinking within technology-rich environments. As a result, digital competence has emerged as a central construct in teacher education research and policy discourse (Redecker, 2017; Voogt et al., 2012). Beyond operational skills, digital competence encompasses cognitive, ethical, creative, and collaborative dimensions that enable meaningful participation in digitally mediated learning ecologies.



Within this landscape, the framework developed by the International Society for Technology in Education has gained international recognition. The ISTE Standards for Students conceptualize digitally competent learners as empowered learners, digital citizens, knowledge constructors, innovative designers, computational thinkers, creative communicators, and global collaborators (ISTE, 2016). Although originally articulated for students, these standards provide a comprehensive architecture for examining digital competence among pre-service teachers, who are expected not only to embody these competencies but also to cultivate them in their future classrooms.

In teacher education, digital readiness has been examined through various conceptual lenses, including technological pedagogical content knowledge (TPACK) (Mishra & Koehler, 2006), digital competence frameworks (Redecker, 2017), and teacher self-efficacy models (Bandura, 1997). However, while multiple instruments assess teachers' technology integration skills, fewer studies have operationalized the multidimensional constructs embedded within the ISTE framework in a self-assessment format. Moreover, self-perceived digital competence plays a critical role in shaping technology integration practices, as teachers' beliefs about their capabilities significantly influence instructional behavior (Ertmer& Ottenbreit-Leftwich, 2010).

Accordingly, the present study aims to examine pre-service teachers' self-assessed digital competence based on the ISTE Standards for Students developed by the International Society for Technology in Education.The research addressed the following questions:

1.What are the internal consistency reliability levels of the questionnaire and its subdimensions?

2.What are the self-assessed digital competence levels of pre-service teachers across the ISTE Standards domains?

3.Which ISTE domains demonstrate the highest and lowest perceived competence levels?

4.Are there statistically significant differences in self-assessed digital competence based on demographic variables?

2. Literature Review

2.1.Digital competence in teacher education

Digital competence in teacher education has increasingly become a central construct in both research and policy discourses as educational environments evolve in tandem with rapid technological change. Digital competence encompasses not only operational skills for using digital tools but also pedagogical, ethical, communicative, and critical dimensions necessary



for effective teaching and learning in digitally mediated contexts (Redecker, 2017; Ferrari, 2013). In teacher education, this multifaceted competence is often framed through comprehensive frameworks such as the European DigCompEdu and the ISTE Standards for Educators, which articulate knowledge, skills, and professional dispositions required for meaningful technology integration (Krumsvik, 2014; Mishra & Koehler, 2006). Research indicates that pre-service teachers with stronger digital competence are more likely to integrate technology into instructional design, differentiate learning experiences, and engage students in creative, inquiry-based activities (Tondeur et al., 2017; Lawless & Pellegrino, 2007).

Empirical work on digital competence underscores the importance of both conceptual understanding and self-regulated professional growth. Bandura's self-efficacy theory posits that individuals' beliefs about their digital capabilities predict their instructional technology use more strongly than objective measures of skill alone (Bandura, 1997; Tschannen-Moran et al., 1998). Consistent with this perspective, studies have found that experienced teacher educators' confidence with digital tools significantly mediates their adoption of innovative pedagogies (Ertmer& Ottenbreit-Leftwich, 2010; Hsu, 2016). Moreover, research deploying structural models suggests that digital pedagogical competence relates positively to reflective practice, collaborative learning, and learner-centered instruction among pre-service teachers (Sánchez-Prieto et al., 2019; Ifenthaler&Schweinbenz, 2013). Such findings highlight that digital competence is not solely technical proficiency but encompasses metacognitive, social, and pedagogical dimensions central to effective teacher preparation.

2.2.ISTE Standards

The International Society for Technology in Education (ISTE) Standards constitute a globally recognized framework for guiding effective use of technology in teaching and learning. Originally introduced in the 1990s, the ISTE Standards have evolved through iterative revisions to reflect changes in pedagogical practice and digital innovation (ISTE, 2016; ISTE, 2021). The standards are designed to articulate competencies not merely as technical skills but as practice-based dispositions that learners and educators should embody to thrive in digitally mediated environments (Ertmer& Ottenbreit-Leftwich, 2010; Mishra & Koehler, 2006). Grounded in constructivist and socio-cultural theories of learning, the ISTE Standards emphasize learner agency, creativity, critical thinking, and collaborative problem solving—dimensions aligned with twenty-first-century skill frameworks and digital competence models (Voogt& Roblin, 2012; Redecker, 2017).



ISTE distinguishes among different stakeholder groups through specific sets of standards, including ISTE Standards for Students, Educators, Education Leaders, and Coaches, each tailored to role-specific expectations (ISTE, 2016; ISTE, 2021). The ISTE Standards for Students identify competencies such as empowered learner, digital citizen, knowledge constructor, innovative designer, computational thinker, creative communicator, and global collaborator (Miles & Feinstein, 2019; Aqel, 2021). Research applying these standards has demonstrated positive associations between ISTE-aligned instructional practices and student engagement, digital literacy, and problem-solving outcomes (Buschmann& Fiore,2025; Consoliet al.,2025; Crompton&Burke,2024). Similarly, the ISTE Standards for Educators focus on pedagogical leadership, inclusion, and continual professional growth, situating technology as a means to amplify powerful teaching rather than an end in itself (Kivunja, 2013; Ertmer et al., 2012).

Despite widespread adoption of technology standards such as the ISTE Standards, empirical research has consistently highlighted challenges in implementation and measurement of technology integration practices. Some studies report that teachers' self-reported technology use often does not align with observed classroom practices, indicating that self-reports may overestimate actual integration (Bice & Tang, 2022; Parker et al., 2019). Furthermore, researchers emphasize the need for validated and observation-based instruments to more accurately assess instructional use of technology and to inform sustained professional development (Parker et al., 2019; Martínez et al., 2022). These findings underscore the complexity of translating standards-driven expectations into authentic classroom enactment and call for measurement approaches beyond self-report surveys.

3. Methods

3.1.Research Design

This study employed a quantitative, cross-sectional survey design to examine pre-service teachers' self-assessed digital competence based on the ISTE Standards for Students developed by the International Society for Technology in Education. The study was designed as a descriptive investigation aiming to determine participants' perceived competence levels across the ISTE domains. Because the instrument was constructed directly from predefined ISTE performance descriptors, the study did not seek to test or modify the theoretical structure of the standards; rather, it aimed to analyze participants' responses within the existing conceptual framework.

3.2.Participants



The study sample consisted of 497 pre-service teachers enrolled at Kazakh State Women's Pedagogical University. Participants were recruited using a convenience sampling strategy. All respondents voluntarily participated in the study. Prior to data collection, participants were informed about the purpose of the research, the confidentiality of their responses, and their right to withdraw at any stage.The sample size exceeds the commonly recommended minimum thresholds for survey-based quantitative research and ensures adequate statistical power for reliability and comparative analyses.

3.3.Instrument

Data were collected using a 30-item self-assessment questionnaire developed by the researcher. The items were constructed by transforming the performance indicators and descriptors of the ISTE Standards for Students into Likert-type statements. Each item was mapped directly onto one of the seven ISTE domains: Empowered Learner, Digital Citizen, Knowledge Constructor, Innovative Designer, Computational Thinker, Creative Communicator, and Global Collaborator.Participants rated their agreement with each statement on a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Higher scores indicated higher levels of perceived digital competence.Because the questionnaire items were derived directly from the established ISTE framework and retained the original domain structure, the study did not aim to explore or confirm latent factor structures through exploratory or confirmatory factor analysis. Instead, the instrument was treated as a criterion-referenced operationalization of the ISTE standards.To ensure content validity, the item pool was reviewed for alignment with the ISTE descriptors. Internal consistency reliability was assessed using Cronbach’s alpha coefficients for both the overall scale and each ISTE domain.

3.4.Data Collection Procedure

Data were collected during the academic term through an online survey platform. Participants completed the questionnaire electronically. Completion time ranged between approximately 10 and 15 minutes. All responses were anonymized prior to analysis.

3.5.Data Analysis

Data were analyzed using SPSS29 software. First, descriptive statistics (mean, standard deviation) were calculated for each item and for each ISTE domain. Domain scores were computed by averaging the items corresponding to each standard.Second, internal consistency reliability was assessed using Cronbach’s alpha coefficients for the overall 30-item scale and for each domain separately.Third, Kruskal–Wallis H and Mann–Whitney U tests were



conducted to examine potential differences in digital competence across groups. Where significant differences were identified, effect sizes were calculated to determine the magnitude of differences.

4. Findings

4.1.Participant Demographics

497 students who are having education in the pre-service teacher education programs in Kazakh State Women's Pedagogical University participated in the study. The frequency distribution tables below present the demographic characteristics of the participants.

Table 1. Gender and age of the participants

		Frequency	Percent	Valid Percent	Cumulative Percent
Gender	Female	497	100.0	100.0	100.0
Age	16.00	7	1.4	1.4	1.4
	17.00	150	30.2	30.2	31.4
	18.00	151	30.4	30.4	61.8
	19.00	114	22.9	22.9	84.7
	20.00	45	9.1	9.1	93.8
	21.00	24	4.8	4.8	98.6
	22.00	5	1.0	1.0	99.6
	23.00	1	.2	.2	100.0

With respect to gender, all participants in the study were female (n = 497, 100%). Since there are no missing cases, the percent and valid percent values are identical.Regarding age distribution, participants range from 16 to 23 years old. The largest age groups are 18 years (n = 151, 30.4%) and 17 years (n = 150, 30.2%), together accounting for approximately 60.6% of the sample. This is followed by 19-year-old participants (n = 114, 22.9%). Smaller proportions are observed among 20-year-olds (9.1%), 21-year-olds (4.8%), 16-year-olds (1.4%), 22-year-olds (1.0%), and 23-year-olds (0.2%). The cumulative percentages indicate that 84.7% of the participants are 19 years old or younger, suggesting that the sample primarily consists of early-year undergraduate students.

Table 2 presents the distribution of participants according to their academic major. A total of 497 valid responses were obtained, with no missing data; therefore, the percent and valid percent values are identical across categories.

Table 2. Participants' major

		Frequency	Percent	Valid Percent	Cumulative Percent
Major	Informatics&Robotics	86	17.3	17.3	17.3



	DesignAnalyticTechnology	29	5.8	5.8	23.1
	Biology	38	7.6	7.6	30.8
	Sociology	57	11.5	11.5	42.3
	InformationTecnology	29	5.8	5.8	48.1
	Physics	125	25.2	25.2	73.2
	Mathematics	89	17.9	17.9	91.1
	Chemistry	11	2.2	2.2	93.4
	Pedagogy	24	4.8	4.8	98.2
	Tourism	9	1.8	1.8	100.0
	Total	497	100.0	100.0	

The largest proportion of participants is enrolled in Physics (n = 125, 25.2%), representing approximately one-quarter of the sample. This is followed by Mathematics (n = 89, 17.9%) and Informatics & Robotics (n = 86, 17.3%). Together, these three majors account for 60.4% of the total sample, indicating a strong concentration in STEM-related teacher education fields.Moderate representation is observed in Sociology (n = 57, 11.5%) and Biology (n = 38, 7.6%). Smaller proportions are found in Design Analytic Technology (n = 29, 5.8%) and Information Technology (n = 29, 5.8%), followed by Pedagogy (n = 24, 4.8%), Chemistry (n = 11, 2.2%), and Tourism (n = 9, 1.8%). The cumulative percentages show that 73.2% of participants are enrolled in Physics or other majors listed before it, and 91.1% are concentrated within the first seven listed disciplines.Overall, the sample is predominantly composed of students from science and technology-oriented majors, particularly Physics, Mathematics, and Informatics & Robotics.

Table 3 presents the distribution of participants according to their year of study. A total of 497 valid responses were recorded, and no missing data were reported; therefore, the percent and valid percent values are identical across all categories.

Table 3. Participants' year at the university

		Frequency	Percent	Valid Percent	Cumulative Percent
Year	1st	190	38.2	38.2	38.2
	2nd	94	18.9	18.9	57.1
	3rd	72	14.5	14.5	71.6
	4th	141	28.4	28.4	100.0
	Total	497	100.0	100.0	

The largest group consists of first-year students (n = 190, 38.2%), representing more than one-third of the sample. This is followed by fourth-year students (n = 141, 28.4%), indicating that a substantial proportion of participants are in the final stage of their undergraduate



education. Second-year students account for 18.9% (n = 94), while third-year students represent 14.5% (n = 72) of the sample.The cumulative percentages show that 57.1% of the participants are in their first or second year, suggesting that more than half of the sample consists of lower-level undergraduate students. At the same time, 42.9% are in the third and fourth years, providing representation from more advanced cohorts.Overall, the distribution reflects a relatively balanced representation across academic years, with stronger participation from first- and fourth-year students.

Table 4. Having personal computer and internet connection

		Frequency	Percent	Valid Percent	Cumulative Percent
PersonalComp	No	179	36.0	36.0	36.0
uter	Yes	318	64.0	64.0	100.0
Internet	No	137	27.6	27.6	27.6
Connection	Yes	360	72.4	72.4	100.0
	Total	497	100.0	100.0	

Table 4 presents the distribution of participants according to their access to a personal computer and an internet connection. The analysis is based on 497 valid responses, with no missing data; therefore, the percent and valid percent values are identical.Regarding personal computer ownership, 318 participants (64.0%) reported that they have a personal computer, whereas 179 participants (36.0%) indicated that they do not. This finding demonstrates that nearly two-thirds of the sample possess individual access to a computing device, while more than one-third lack personal hardware resources.Concerning internet connectivity, 360 participants (72.4%) stated that they have access to an internet connection, compared to 137 participants (27.6%) who reported no access. Thus, internet availability appears to be more widespread than personal computer ownership within the sample.Overall, the results indicate that although the majority of participants have access to both a personal computer and internet connectivity, a substantial proportion—approximately one-quarter to one-third—experience limited technological access.

4.2.Internal consistency reliability levels of the questionnaire and its subdimensions

To test the internal reliability of the questionnaire, Cronbach's Alpha coefficients were calculated for both the overall instrument and for each subdimension.

Table 5. Cronbach's Alpha coefficients of the overall questionnaire and subdimensions

Reliability Statistics



	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
All	.986	.986	30
Empowered Learner	.946	.946	7
Digital citizen	.949	.949	6
Knowledge Constructor	.919	.919	2
Innovative Designer	.930	.930	2
Computational Thinker	.949	.949	5
Creative Communicator	.929	.929	4
Global Collaborator	.938	.938	4

The reliability analysis indicates exceptionally high internal consistency for the overall 30-item instrument and for each ISTE domain. The total scale yielded a Cronbach's alpha coefficient of .986, which reflects extremely strong internal consistency among the items. The identical values obtained for Cronbach's alpha and the standardized alpha suggest that item variances are relatively homogeneous and that scale reliability is stable regardless of standardization. At the subdimension level, all ISTE domains demonstrate excellent reliability. The Empowered Learner (α = .946), Digital Citizen (α = .949), Computational Thinker (α = .949), Global Collaborator (α = .938), Knowledge Constructor (α = .919), Innovative Designer (α = .930), and Creative Communicator (α = .929) domains all exceed the commonly accepted threshold of .70, indicating highly consistent responses within each domain. These coefficients suggest that items within each subscale measure a coherent construct aligned with the ISTE framework. The results collectively indicate that the instrument possesses strong internal consistency reliabilityacross domains.

4.3. Self-assessed digital competence levels of pre-service teachers across the ISTE Standards domains

In order to investigate the self-assessed digital competence across the seven ISTE Standards domains, descriptive statistics were calculated based on responses from 497 pre-service teachers.

Table 6. Meanscoresof digitalcompetenceacross ISTE domains

	N	Mean	Std. Deviation
EmpoweredLearner	497	3.2627	1.20358



DigitalCitizen	497	3.2307	1.21122
KnowledgeConstructor	497	3.2646	1.29278
InnovativeDesigner	497	2.9225	1.27140
ComputationalThinker	497	3.1207	1.21936
CreativeCommunicator	497	3.0890	1.22587
GlobalCollaborator	497	3.0900	1.25706

The mean scores range from 2.92 to 3.26, indicating that participants generally report moderate levels of digital competence across domains. Knowledge Constructor (M = 3.26, SD = 1.29) and Empowered Learner (M = 3.26, SD = 1.20) demonstrate the highest mean scores. These results suggest relatively stronger perceived competence in locating, evaluating, and constructing knowledge using digital tools, as well as in self-directed digital learning practices.Digital Citizen (M = 3.23, SD = 1.21) also reflects a moderate level of competence, indicating that participants perceive themselves as reasonably aware of ethical, responsible, and safe technology use.Computational Thinker (M = 3.12, SD = 1.22), Global Collaborator (M = 3.09, SD = 1.26), and Creative Communicator (M = 3.09, SD = 1.23) exhibit slightly lower, yet still moderate, levels of perceived competence.Innovative Designer (M = 2.92, SD = 1.27) records the lowest mean score among all domains. This suggests comparatively weaker self-perceptions in designing innovative solutions, engaging in iterative problem-solving, and applying design-thinking processes.Overall, pre-service teachers demonstrate moderate self-assessed digital competence across ISTE domains, with relative strengths in knowledge construction and empowerment as learners, and comparatively lower confidence in innovative design skills. The substantial variability suggests heterogeneity in digital skill development within the sample.

4.4. Differences in self-assessed digital competence based on demographic variables

4.4.1. Comparison of digital competence by year

First of all, Kruskal–Wallis H tests were conducted to examine whether self-assessed digital competence differs significantly according to year of study. Since normality assumptions were not met, the Kruskal–Wallis test—a non-parametric alternative to one-way ANOVA—was appropriately employed. The grouping variable consists of four categories (df = 3).

Table 7. Kruskal Wallis test result on year



	Kruskal-Wallis H	df	Asymp. Sig.
EmpoweredLearner	14.017	3	.003*
DigitalCitizen	7.648	3	.054
KnowledgeConstructor	4.486	3	.214
InnovativeDesigner	11.952	3	.008*
ComputationalThinker	11.589	3	.009*
CreativeCommunicator	9.136	3	.028*
GlobalCollaborator	9.556	3	.023*

Statistically significant differences across year levels were observed in several ISTE domains. The significance level was evaluated at $\alpha = .05$.

In the Empowered Learner domain ($H(3) = 14.017$, $p = .003$), there is a statistically significant difference in scores across academic years. This indicates that at least one year group differs from the others in perceived competence related to self-directed digital learning.Also, in the Innovative Designer domain ($H(3) = 11.952$, $p = .008$), a statistically significant difference exists between year groups. Perceived competence in innovative design varies depending on academic progression. In the Computational Thinker domain ($H(3) = 11.589$, $p = .009$) a significant difference was found, suggesting that computational thinking skills differ across year levels.Creative Communicator ($H(3) = 9.136$, $p = .028$) and Global Collaborator domain ($H(3) = 9.556$, $p = .023$) also show statistically significant differences, indicating variation in these domains across academic years. On the other hand, no statistically significant difference was found in Digital Citizen ($H(3) = 7.648$, $p = .054$) and Knowledge Constructor ($H(3) = 4.486$, $p = .214$) domains.

Table 8. Post hoc test results

	Empowered Learner		**Innovative Designer**		**Computational Thinker**		**Creative Communicator**		**Global Collaborator**	
Group	Test Statistics	Adj. Sig.	Test Statistics	Adj. Sig.	Test Statistics	Adj. Sig.	Test Statistics	Adj. Sig.	Test Statistics	Adj. Sig.
1st-2nd	-10.458	1.0	-33.312	.374	-23.640	1.0	-8.766	1.0	-14.192	1.0
1st – 3rd	-59.915	.015*	-53.016	.041*	-60.409	.014*	-52.915	.045*	-53.934	.038*
1st- 4th	-40.018	.023*	-45.677	.022*	-39.064	.084	-32.438	.247	-35.220	.158
2nd-3rd	-49.457	.165	-19.704	1.0	-36.769	.603	-44.150	.291	-39.742	.452
2nd-4th	-35.560	.374	-12.365	1.0	-15.424	1.0	-23.672	1.0	-21.028	1.0
3rd- 4th	13.896	1.0	7.339	1.0	21.345	1.0	20.478	1.0	18.714	1.0

α = .05

In the Empowered Learner domain, results indicate that first-year students differ significantly from both third- and fourth-year students in their self-assessed Empowered Learner



competence.The negative test statistic values (-59.915; -40.018) suggest that the mean rank of first-year students is lower than that of third- and fourth-year students. Therefore, third- and fourth-year students report higher perceived competence in the Empowered Learner domain compared to first-year students.In the Innovative Designer significant differences were found between1st – 3rd year (p = .041*) and 1st – 4th year (p = .022*) students. Upper-year students report significantly higher innovative design competence compared to first-year students. When Computational Thinker domain is considered a statistically significant difference was found only for1st – 3rd year (p = .014*). This suggests that computational thinking competence increases notably by the third year. In the Creative Communicator domain, a significant difference emerged for1st and 3rd year (p = .045*). Thus, third-year students report higher levels of creative communication competence than first-year students. Finally, in the Global Collaborator domain, a statistically significant difference was observed for1st – 3rd year (p = .038*). This indicates that perceived global collaboration competence improves by the third year, but differences among other year levels are not statistically meaningful.The findings suggest a developmental progression in digital competence, particularly between the first and third years of study. Competence levels appear to increase during the middle phase of the teacher education program and then stabilize in the final year. The absence of significant differences between third- and fourth-year students supports the interpretation of a plateau effect in advanced stages of training.

4.4.2. Comparison of digital competence by major

Kruskal–Wallis H test conducted to examine whether self-assessed digital competence differs significantly across academic majors. The test was employed due to non-normal distribution of the dependent variables and the presence of more than two independent groups (10 majors; df = 9).

Table 9. Kruskal–Wallis test result on major

	Kruskal-Wallis H	df	Asymp. Sig.
EmpoweredLearner	18.422	9	.131
DigitalCitizen	11.283	9	.257
KnowledgeConstructor	9.797	9	.367
InnovativeDesigner	12.344	9	.195
ComputationalThinker	14.550	9	.104
CreativeCommunicator	18.307	9	.132



GlobalCollaborator	16.661	9	.054

The Kruskal–Wallis analysis demonstrates that academic major does not constitute a statistically significant differentiating factor in self-assessed digital competence across ISTE domains. Consequently, variations in digital competence observed in the study are more likely attributable to other variables—such as year of study—rather than disciplinary background.

4.4.3. Comparison of digital competence by having computer and internet connection

Table 10 presents the results of the Mann–Whitney U tests conducted to examine whether self-assessed digital competence differs according to (a) having a personal computer and (b) having an internet connection. Given that each independent variable consists of two groups (Yes/No) and the dependent variables are non-normally distributed, the Mann–Whitney U test represents the appropriate non-parametric alternative to the independent samples t-test.

Table 10. Mann–Whitney U test results on digital access

	HavingPersonalComputer			Having Internet Connection		
	Mann-Whitney U	df	Asymp. Sig.	Mann-Whitney U	df	Asymp. Sig.
EmpoweredLearner	34,093	1	.000*	27,852	1	.025*
DigitalCitizen	32,809	1	.005*	29,202	1	.001*
KnowledgeConstructor	31,702	1	.032*	27,631	1	.035*
InnovativeDesigner	33,398	1	.001*	28,691	1	.004*
ComputationalThinker	33,911	1	.000*	28,158	1	.014*
CreativeCommunicator	34,058	1	.000*	28,004	1	.019*
GlobalCollaborator	33,391	1	.001*	28,536	1	.006*

The findings clearly demonstrate that digital access variables—both hardware ownership and internet connectivity—are significantly associated with self-assessed digital competence across all domains. Students lacking personal computing resources or internet access consistently report lower levels of digital competence.These results underscore the continued relevance of structural access factors in digital competence development and highlight the importance of ensuring equitable technological infrastructure within teacher education contexts.

5. Discussion



The present study aimed to examine self-assessed digital competence levels of pre-service teachers across the ISTE Standards domains, as well as differences based on demographic variables. The findings provide several noteworthy contributions to the literature on digital competence and teacher education.

First, regarding self-assessed digital competence, the results indicate moderate perceived competence across all seven ISTE domains (M = 2.92–3.26). The highest mean scores were observed in Knowledge Constructor and Empowered Learner domains. These findings suggest that pre-service teachers perceive themselves as relatively confident in information literacy practices, self-directed learning, and the use of digital tools for knowledge construction. This aligns with previous research indicating that teacher candidates tend to feel more competent in information searching and general digital literacy skills than in more advanced or design-oriented competencies (Instefjord&Munthe, 2017). Moreover, the prominence of knowledge construction resonates with conceptualizations of digital competence as encompassing information processing and critical evaluation skills (Ferrari, 2013; Carretero, Vuorikari, & Punie, 2017).

In contrast, Innovative Designer yielded the lowest mean score. This suggests comparatively weaker self-perceptions in iterative problem-solving, design thinking, and the creation of innovative digital solutions. Similar patterns have been documented in prior studies, where pre-service teachers report lower confidence in computational and design-oriented competencies compared to basic digital literacy skills (Gudmundsdottir&Hatlevik, 2018). The relatively lower scores in Computational Thinker, Creative Communicator, and Global Collaborator domains further reflect the ongoing challenge of integrating higher-order digital competencies into teacher education curricula. These domains require not only technical skills but also pedagogical integration and collaborative digital practices, which may not be systematically embedded in all programs (Koehler & Mishra, 2009; Voogt et al., 2012).

The substantial standard deviations observed across domains suggest considerable heterogeneity in digital competence levels within the sample. This variability may reflect differences in prior digital experiences, informal learning opportunities, and access to technology, which have been widely recognized as influential factors in digital competence development (van Dijk, 2005; Hatlevik et al., 2015).

The analysis of year-level differences revealed statistically significant differences in five of the seven domains, particularly between first- and third-year students. Competence levels



appear to increase during the middle years of teacher education and stabilize in the final year, indicating a developmental progression followed by a plateau effect. This pattern is consistent with research suggesting that structured exposure to technology-integrated coursework and practicum experiences contributes to the gradual development of digital competence (Tondeur et al., 2012; Instefjord&Munthe, 2017). The absence of significant differences between third- and fourth-year students may indicate that digital competence development peaks prior to graduation or that senior-year coursework does not substantially extend digital skill acquisition.

In contrast, academic major did not produce statistically significant differences across ISTE domains. This finding suggests that digital competence development may be shaped more by program-wide experiences and institutional culture than by disciplinary specialization. Previous research has similarly emphasized that technology integration competencies are influenced more by pedagogical beliefs and institutional support than by subject area alone (Ertmer& Ottenbreit-Leftwich, 2010; Voogt et al., 2012).

Notably, access-related variables—having a personal computer and internet connection—were significantly associated with higher self-assessed competence across all domains. These findings reinforce longstanding arguments concerning the digital divide, which emphasize that physical access to technology remains a foundational condition for developing advanced digital skills (van Dijk, 2005). Even in contexts where digital technologies are widespread, disparities in access continue to influence skill acquisition and confidence levels (Hatlevik et al., 2015). Thus, structural and infrastructural factors remain critical determinants of digital competence development in teacher education contexts.

Overall, the findings confirm that while pre-service teachers report moderate digital competence aligned with international frameworks such as ISTE and DigComp (Ferrari, 2013; Carretero et al., 2017), gaps remain in innovative and computational domains. Addressing these gaps requires intentional curriculum design, authentic technology integration experiences, and equitable access to digital resources.

6. Conclusion

This study provides robust evidence regarding self-assessed digital competence of pre-service teachers within the ISTE Standards framework. The instrument demonstrated exceptionally



high internal consistency across domains, supporting its suitability for measuring multidimensional digital competence constructs.

Pre-service teachers reported moderate levels of digital competence overall, with relative strengths in knowledge construction and self-directed learning, and comparatively lower confidence in innovative design and computational thinking. Developmental differences across academic years suggest that digital competence improves during the early and middle stages of teacher education but may plateau in later years. Additionally, digital access variables significantly influence competence levels, underscoring the persistent relevance of structural inequalities in technology access.

These findings highlight the need for teacher education programs to move beyond basic digital literacy toward fostering higher-order competencies such as design thinking, computational problem-solving, and global digital collaboration. Integrating pedagogically grounded technology frameworks (e.g., TPACK) and ensuring equitable technological infrastructure may support more comprehensive digital competence development among future educators.

Future research should incorporate longitudinal designs and mixed-method approaches to further examine how digital competence evolves throughout teacher education and into professional practice.

AI use disclosure

During the preparation of this work the author used Chat GPT in order to improve language and readability. After using this tool, the author reviewed and edited the content as needed and take full responsibility for the content of the publication.

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