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STUDY ON THE DIGITAL COMPETENCIES OF PROSPECTIVE PRE-SCHOOL AND PRIMARY SCHOOL TEACHERS AND THE INFLUENCE OF GENDER AND ACADEMIC PERFORMANCE

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Abstract

ICT can be a powerful tool for learning, but it is crucial that teachers know how to use it effectively. Digital competence enables teachers to tailor learning to the individual needs of students, making it more engaging and motivating, while creating more meaningful learning experiences. The objectives of this study were: (1) to assess the self-perceived digital competencies of future teachers, considering gender and educational stage, (2) to compare the self-perceived digital competencies of future teachers based on their educational stage and gender, and the interaction between these two factors, and (3) to explore how students' academic performance influences their digital competencies. This study is a non-experimental, ex post facto analysis with a sample of 897 students from both Infant and Primary School levels. The findings reveal no significant differences in digital competencies between future teachers based on gender, nor in the intersection of gender and educational stage. However, significant differences were found according to educational stage, both in the individual dimensions of the instrument and in overall competence. Primary education students reported higher levels of self-perceived digital competence compared to prospective EFL teachers.

Keywords **–** Digital competency, Initial training, Educational performance, Educational technology, Gender.

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1. Introduction

In today's society, digital competence is essential for both academic and professional success. Information and communication technology (ICT) is increasingly present in educational settings and has become a crucial tool in the learning process (Cabero-Almenara, Gutiérrez-Castillo, Guillén-Gámez & Gaete-Bravo, 2023).

A strong foundation in digital skills is a critical requirement for future teachers in an increasingly digitized world. The Horizon reports (Valencia, 2023) highlight the urgency of integrating technology into teaching. Only teachers who are highly trained in educational technology will be equipped to guide their students in this ever-evolving environment, designing innovative learning experiences, assessing the impact of ICT, serving as role models, promoting collaboration, and adapting to continuous technological advancements.

This high level of digital literacy not only benefits students but also has a positive impact on the education system as a whole. It improves the quality of education, helps reduce the digital divide, prepares new generations for the future workforce, and fosters educational innovation (Alastor, Guillén-Gámez & Ruiz-Palmero, 2024).

If, as stated before, ICT is being increasingly integrated into education, it is important that teachers are prepared to use it effectively. To do so, they must be trained to develop active techniques and methodologies that involve students in their own learning. This means that the teacher must move from being the main transmitter of knowledge to a facilitator of learning, who guides and orients students in their process of acquiring knowledge and skills. In addition, teachers must be able to use ICT as a didactic tool that makes it possible to personalize learning, adapt it to the individual needs of students and make it more attractive and motivating (Alastor & Martínez-García, 2020; Alastor, Martínez-García, Fernández-Martín & Sánchez-Rodríguez, 2023; Fernández-Martín, Alastor, Martínez-García & Linde-Valenzuela, 2023; Oguguo, Ezechukwu, Nannim & Offor, 2023).

For all these reasons, it is essential to have valid and reliable assessment tools to measure the digital competence of the educational community. These tools help identify digital gaps and prioritize training for the groups that need it most. This approach optimizes resources, maximizes the impact of training, and ensures effective, high-quality development. By focusing training on the specific needs of each group and designing customized courses, we can create a more prepared and capable educational community (Martínez-Pérez, Cabero-Almenara, Barroso-Osuna & Palacios-Rodríguez, 2022; Guillén-Gámez, Mayorga-Fernández & Contreras-Rosado, 2021; Feridouni-Solimani & Ahmed-Mohamed, 2024).

Some of the most widely used tools and conceptual frameworks for measuring digital competencies include DigCompEdu, which outlines five dimensions of digital competence: digital literacy, online communication and collaboration, digital content creation, problem-solving, and critical thinking. This model has been analyzed by numerous researchers (Palacios-Rodríguez, Guillén-Gámez, Cabero-Almenara & Gutiérrez-Castillo, 2023; Rubio-Gragera, Cabero-Almenara & Palacios-Rodríguez, 2023). Another key framework is PEAT, developed by DiCTE (2019), which identifies four dimensions of digital competence: pedagogical, ethical, attitudinal, and technical. Additionally, TPACK offers an integrated framework that combines content knowledge, pedagogical knowledge, and technological knowledge. To assess these competencies, various self-perception, heteroperception, and mixed methods instruments have been employed, some developed by the authors themselves (Cabero-Almenara, Barroso-Osuna, Gutiérrez-Castillo & Palacios-Rodríguez, 2020; Ghomi & Redecker, 2019; Miguel-Revilla, Martínez-Ferreira & Sánchez-Agustí, 2020; Cabero-Almenara & Palacios-Rodríguez, 2020; Guillén-Gámez et al., 2021; Gutiérrez-Castillo, Cabero-Almenara & Estrada-Vidal, 2017).

2. Incidence of Predictors in the Digital Competencies of Teachers in Training

2.1. Incidence of the Future Teacher's Gender

In the studies reviewed that analyzed the gender variable, Cantón-Mayo, Cañón-Rodríguez and Grande-de-Prado (2016) conducted research with 329 first-year Primary Education students at the University of León (Spain). They found that, overall, men scored significantly higher in digital skills than women in several areas, including the use of collaborative tools and sharing resources and information. On the other hand, women were more familiar with social networks. Another notable study by Castiñeira-Rodríguez, Lorenzo-Rial and Pérez-Rodríguez (2022), which involved 115 second-year students

in the Infant and Primary Education programs at the University of Vigo (Spain), found significant differences between men and women, with men showing higher levels of digital competence.

Similarly, the work by Rodríguez-García, Cardoso-Pulido, Cruz-Campos and Martínez-Heredia (2022), analyzed the self-perception of digital competence of trainee teachers in Spanish universities, particularly in communication and collaboration through digital technologies. The research, which used a questionnaire with 698 prospective teachers, showed significant gender differences. Female participants claimed to have a higher digital competence to interact through digital technologies. In addition, women maintain a high level of competence in participating in the network with appropriate behaviors, respect and appreciation of cultural, religious, racial, political and sexual orientation diversity. On the other hand, men show greater competence in sharing information and content. They also highlight their skills in creating websites, blogs or portals to share knowledge with others.

Teo, Fan and Du (2015), in a study with 339 trainee teachers from a Southeast Asian country, reached similar conclusions. They found that, compared to their male counterparts, female trainee teachers exhibited lower levels of digital competence, which could limit their acceptance and use of technology in educational settings. Similarly, in an international context, Çebi and Reisoglu (2020) conducted research with 518 future teachers from several Turkish universities and found that male future teachers outperformed their female peers in areas such as information and data literacy, digital content creation, security, and problem-solving.

In contrast, the study by Cózar-Gutiérrez, Moya-Martínez, María, Hernández-Bravo and Hernández-Bravo (2016), conducted with 162 final-year students in Early Childhood and Primary Education programs at the Faculty of Education in Albacete (Spain), challenges the notion of a gender digital gap in teaching competencies. Their findings showed that women outperformed men in most areas, with statistically significant differences in nine of the items. Similar results, albeit in different contexts, were found by Pozo-Sánchez, López-Belmonte, Fernández-Cruz and López Núñez (2020), who found that women scored higher than men in digital content creation. Likewise, Arras-Vota, Torres-Gastelú and Valcárcel-Muñoz-Repiso (2011) observed that when evaluating overall ICT skills, women achieved significantly higher scores than men.

2.2. The Impact of Different Educational Stages on Future Teachers

One study comparing different educational degrees is by Girón-Escudero, Cózar-Gutiérrez and González-Calero-Somoza (2019), conducted with fourth-year students in the Early Childhood and Primary Education programs at the Faculty of Education in Albacete (Spain) during the 2017-2018 academic year. The sample included 117 students, 63 from Early Childhood Education and 54 from Primary Education. The results revealed that Early Childhood Education students faced more difficulties understanding content creation applications and using basic computer concepts. In contrast, Primary Education students demonstrated stronger skills in planning, developing, and evaluating instructional activities using digital tools, as well as applying advanced computer and telecommunications knowledge in their teaching practices.

Galindo-Domínguez and Bezanilla (2021), in a study with 200 Early Childhood Education and Primary Education students from two Spanish universities, found no statistically significant differences in any of the dimensions analyzed. They inferred that there is a level of uniformity in digital competence among students in training, regardless of their university specialization. Similarly, the study by Tárraga-Mínguez, Sanz-Cervera, Pastor-Cerezuela and Fernández-Andrés (2017), conducted with 107 prospective Early Childhood and Primary Education teachers from a Spanish university, also found no significant differences in digital competencies between the two groups.

Another study that identifies differences between the two degrees is by Pegalajar (2017), who conducted research with 231 undergraduate Early Childhood and Primary Education students from a Spanish university. The differences were found only in their attitudes toward ICT as a tool for inclusion, with Early

Childhood Education students achieving higher scores. Similarly, Urrea-Solano, Hernández-Amorós, Merma-Molina and Baena-Morales (2021) found differences in their study with 348 teacher training students from both degrees at a Spanish university. Their findings showed that Early Childhood Education students demonstrated superior competencies and skills in all the areas examined.

There are very few studies that compare the digital competencies of future Early Childhood and Primary Education teachers outside of Spain. One such study is by Çam and Kiyici (2017), who analyzed the digital competence of 354 future teachers from various departments or specialties at Sakarya University College of Education in Turkey, including Primary Education, Early Childhood Education, and English. When comparing across specialties using Bonferroni's multiple comparison test, they found that students in the Computer Education and Educational Technology specialty had the highest levels of digital competence.

2.3. Incidence of the Academic Performance of Future Teachers

Regarding the academic performance variable, a study by García-Valcárcel and Martín-del-Pozo (2016), conducted with 301 students in the third and fourth years of Primary Education degree programs at several universities in Spain, found that students who achieved an outstanding performance perceived themselves as more competent in digital skills than those with a high pass or notable performance. This suggests a positive relationship between academic performance and perceived digital competence. Similar results were found by Cabero-Almenara et al. (2023) in a study with 17,301 students in Chile. They found that students who had never repeated an academic year exhibited higher levels of digital competence than those who had, a difference that was evident across all dimensions analyzed in the study.

In the study by Meroño, Calderón and Arias-Estero (2020), which analyzed the responses of 293 student teachers from a Spanish university, the researchers found that trainee teachers who experienced a pedagogical approach based on the TPACK model and Cooperative Learning showed improvements in both their perception of TPACK and their academic performance. A significant relationship was found between the perception of TPACK and academic performance. Similar conclusions were reached by Bahar, Öz and Kayalar (2023) in a study conducted in Turkey with 411 students. They found that both ICT skills and academic self-efficacy are significant predictors of academic performance. The research suggests that students' ICT skills and their confidence in their own academic abilities play a crucial role in determining their overall academic success.

Chaw and Tang (2023), in a study with a sample of 314 students, reached similar conclusions. They found that digital competence skills–such as the ability to handle information and data, communication and teamwork, digital content creation, and technological problem-solving—are essential for students' academic success.

This paper explores the digital competence of future Early Childhood and Primary Education teachers. Through a quantitative study, it examines various variables, including the influence of gender and academic performance. The goal is to provide a comprehensive understanding of the technological preparedness of these educators in training and to offer valuable insights for designing teacher training programs that address the specific needs in this area.

Building on the arguments outlined above, this study will focus on the following questions: What is the self-perceived level of digital competencies among future teachers at the Early Childhood Education and Primary Education stages? Are there differences in the self-perceived digital competencies of future teachers at different educational stages? Are there differences in the self-perceived digital competencies of future teachers based on gender? Is there a relationship between academic performance and the digital competencies of future teachers?

The objectives of this study are as follows:

O1. *To describe the self-perceived digital competencies of future teachers, categorized by gender and educational stage.*

O2. *To identify and compare the self-perceived digital competencies of future teachers in relation to their educational stage and gender, as well as the intersection of these two variables.*

O3. *To analyze the impact of students' academic performance on their digital competencies.*

3. Methodology

3.1. Design and Participants

To achieve the study's objectives, an ad hoc questionnaire was developed using a non-quantitative, non-experimental design, conducted through surveys. The study sample consisted of future teachers enrolled in Early Childhood Education and Primary Education programs at the Faculty of Educational Sciences at the University of Málaga. Data collection took place during the second semester of the 2022/2023 academic year. The confidentiality and privacy of the participants was assured at all times. The sampling method used was non-probabilistic and purposive. The total sample included 897 prospective teachers, distributed as follows: 33.10% (n = 297) from the Early Childhood Education stage, with a mean age of 21.63 years and a standard deviation of 4.07 years, and 66.90% (n = 600) from the Primary Education stage, with a mean age of 20.47 years and a standard deviation of 3.06 years.

3.2. Data Collection Instrument

The measurement instrument used was developed by Cabero-Almenara et al. (2020) to assess the digital competencies of future teachers in Early Childhood and Primary Education. The questionnaire consisted of 20 items, which were measured using an 11-point Likert scale, where 0 represents the minimum value and 10 the maximum. The five latent factors were classified as follows:

- **Dimension A** (Communication and Collaboration): Focused on digital skills for using digital resources and technologies to interact with other users on the network.
- **Dimension B** (Technological Literacy): Related to the skills needed to use operating systems, email, music and video editors, or digital resources for synchronous communication.
- **Dimension C** (Information Search and Processing): Focused on users' skills to access, modify, create, and share information.
- **Dimension D** (Digital Citizenship): Focused on users' attitudes toward using digital information responsibly, respecting and protecting data, and acknowledging the rights of authors regarding their digital work.
- **Dimension E** (Creativity and Innovation): Focused on users' digital skills to generate ideas or solve problems within a digital ecosystem.

The measurement instrument demonstrated adequate psychometric properties, which were validated through construct validity (exploratory and confirmatory factor analysis) and internal consistency (reliability). In the exploratory factor analysis, the authors used the principal component and varimax methods for factor selection, as the factors were orthogonal. Both the Kaiser-Meyer-Olkin (KMO) measure (0.736) and Bartlett's test of sphericity ($p < .05$) were significant. The selection of the five factors accounted for 74.60% of the variance (true scores of the prospective teachers). In the confirmatory analysis, the authors assessed validity using a structural equation model with the weighted least squares (WLS) method. The model was found to be significant, with the following indices and their corresponding coefficients: chi-square (CMIN) = 176.88, goodness-of-fit index (GFI) = 0.944, parsimonious goodness-of-fit index (PGFI) = 0.758, normalized fit index (NFI) = 0.993, and normalized parsimonious fit index (PNFI) = 0.836. Regarding the internal consistency of the instrument, it was assessed in this study using Cronbach's alpha to ensure that the items remained consistent within their respective factors. The results confirmed the internal consistency of the instrument: DIM A (0.768), DIM B (0.727), DIM C (0.828), DIM D (0.831), DIM E (0.872), and the overall reliability of the instrument (0.930).

3.3 Data Analysis Procedure and Techniques

- To address the first objective of the study, a descriptive analysis was conducted on the digital competencies of future preschool and primary school teachers. The arithmetic means of the items within each latent factor of the instrument were used as the starting point for this analysis.

- For the second objective, an ANOVA model was designed with two factors, as well as their intersection. To ensure the validity of the analysis, the assumptions of normality for the dependent variable (DV) and homoscedasticity were tested. While the assumption of normality was not fully met, some researchers argue that violations of normality are not a major concern unless they are particularly severe (1982). The F-test remains robust to moderate deviations from normality when sample sizes are sufficiently large (Srivastava, 1959; Winer, Brown & Michels, 1971). Matore and Khairani (2020) note that for sample sizes greater than 300, the normality assumption can be assessed using skewness and kurtosis values, without considering the Z value. The sample size for this study is 897 prospective teachers, which is considered large. Given this sample size, the F-statistic is robust for the post-hoc comparisons made in this study. To test the homoscedasticity assumption (equality of variance), Levene's test was applied. For significant interactions, effect size was calculated using partial eta squared (η^2), where $\eta^2 = 0.01$ represents a small effect, $\eta^2 = 0.06$ indicates a medium effect, and $\eta^2 = 0.14$ suggests a large effect (Richardson, 2011). In cases where pairwise comparisons were found to be significant, Cohen's d was used to interpret the effect size of the difference between means. According to Cohen, d = 0.2 is considered a "small" effect size, 0.5 represents a "medium" effect size, and 0.8 is a "large" effect size.

- To address the third objective, a correlational analysis was conducted to determine the impact of students' academic performance on their digital competencies. This was measured using two variables. The first variable represented the question "What is your average university entrance grade?" and the second variable referred to "What is your current average grade in your university studies?" The correlations were calculated using the Pearson method. According to Akoglu (2018), if the correlation value is ≥ .3, the effect size is weak; if the value falls between .4 and .7, the effect size is moderate; and if it is ≤ .7, the effect size is strong.

4. Results

4.1. Descriptive and Inferential Analysis of Digital Competencies by Gender

Figures 1 and 2 display the scores assigned by prospective teachers regarding their self-perceived levels of digital competencies, broken down by gender and educational stage. These scores correspond to the arithmetic mean of the items within each dimension.

Digital competencies exhibited considerable variation in both groups. In Early Childhood Education, standard deviations ranged from ±1.67 (Digital Citizenship) to ±2.26 (Communication and Collaboration), with an overall dispersion of ±1.48. In Primary Education, standard deviations ranged from ±1.61 (Digital Citizenship) to ±2.09 (Communication and Collaboration), with an overall dispersion of ±1.46. These values suggest similar variability in both groups regarding their self-perceived digital competencies.

Regarding future teachers in the Early Childhood Education stage, it is observed that both genders exhibit medium-high levels of competence in skills related to communication and collaboration with other users, with similar scores for both genders (DIM A, Female = 7.21, Male = 7.13). The same trend is seen in skills related to accessing, modifying, or creating information and sharing it (DIM C, Female = 6.93, Male = 9.94), as well as in participants' attitudes towards using digital information responsibly (DIM D, Female = 7.55, Male = 7.7) and their digital skills for educational innovation (DIM E, Female = 6.68, Male = 6.81). However, the prospective teachers show only average digital skills in technological literacy (DIM B, Female = 5.51, Male = 5.96).

Dimension	Early Childhood Education	Primary Education
	M (DT)	M (DT)
DIM. A (Technological literacy)	7.21 (1.70)	7.29 (1.82)
DIM. B (Communication and collaboration)	5.55 (2.26)	6.24 (2.09)
DIM. C (Search for information)	6.93 (1.81)	7.36 (1.70)
DIM. D (Digital citizenship)	7.57 (1.67)	7.79 (1.61)
DIM. E (Creativity and innovation)	6.19 (2.05)	6.78 (1.81)
Global Competence	6.69 (1.48)	7.09 (1.46)

Table 1. Means and standard deviations of digital competencies by dimension and educational stage

In the Primary Education stage, similar scores are observed compared to the Early Childhood Education stage. For dimension A (communication and collaboration), both genders show comparable scores (Female = 7.33, Male = 7.19), which is also the case for dimension C (information search and processing) (Female = 7.42, Male = 7.21). In dimension D (digital citizenship), the female gender shows a slightly higher mean (M = 7.89) compared to the male gender (M = 7.54), while in dimension E (creativity and innovation), both genders have identical means (M = 6.23). The only exception is technological literacy (DIM B), where future teachers show only average digital skills (Female = 6.19, Male = 6.35), though these scores are higher compared to those in the Early Childhood Education stage.

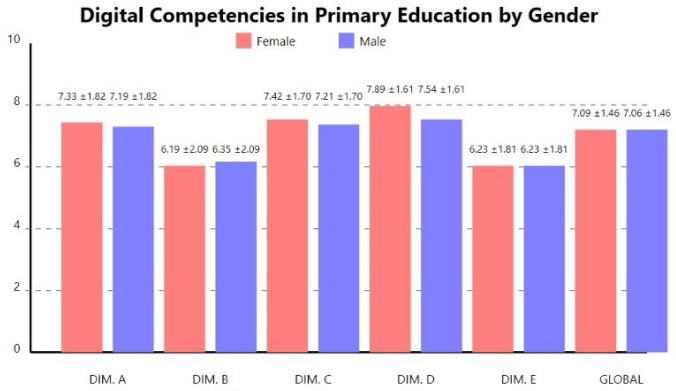

Figure 1. Digital competencies in primary education by gender

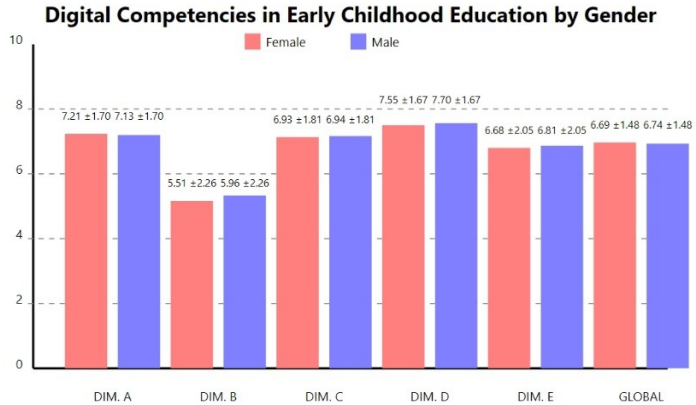

Figure 2 Digital competencies in early childhood education by gender

4.2. Univariate Analysis with Multiple Comparisons

To address objective 2, a univariate ANOVA was conducted to determine whether there are statistically significant differences in the self-perceived digital competencies of future teachers based on their educational stage, gender, and the interaction between the two variables. The factors of the measurement instrument served as dependent variables (DVs), with one DV for each factor, while educational stage, gender, and the interaction between both (educational stage * gender) were used as independent variables (IVs).

Table 2 tested the homoscedasticity of the data through Levene's test, for each factor of the instrument and for each educational stage. It is observed that Levene's test of equality was fulfilled for all the factors of the instrument (p. > .05), so that the groups designed in this univariate model have homogeneous variances, except for dimension E (creativity and innovation). Even so, the model was still ahead as the homoscedasticity assumption was also met for global digital competence, F (3, 893) = .652, p. > .05. Inter-subject multiple comparisons were performed by the Bonferroni method. The results of the between-groups single-factor ANOVA indicate that the models posed for each instrument factor between the two VIs and their interaction are significant, except for the **DIM. A** (communication and collaboration), F (3, 893) = .531, p> .05.

For **DIM B** (Technological literacy), the model was significant, with a small to medium effect size, $F(3, 893) = 8.183$, $p < .05$, $\eta^2 = .027$. Specifically, the educational stage variable was significant, $F(1, 893) = 4.937$, $p < .05$, while gender was not significant, $F(1, 893) = 1.477$, $p > .05$, nor was the interaction between the two variables, $F(1, 893) = .416$, $p > .05$. For **DIM C** (Information search and processing), the model was also significant, with a small to medium effect size, $F(3, 893) = 6.108$, $p < .05$, $\eta^2 = .020$. The educational stage variable was significant, $F(1, 893) = 4.159$, $p < .05$, but gender was not significant, $F(1, 893) = .227$, $p > .05$, nor was the interaction between the two, $F(1, 893) = .536$, $p > .05$. For **DIM D** (Digital citizenship), the model was significant, with a small effect size, $F(3, 893) = 3.743$, $p < .05$, $\eta^2 = .012$. The educational stage variable was significant, $F(1, 893) = 3.759$, $p < .05$, but gender was not significant, $F(1, 893) = .115$, $p > .05$, nor was the interaction between the two, $F(1, 893) = 2.428$, $p > .05$. For **DIM E** (Creativity and Innovation), the model was significant with an effect size between small and medium, $F(3, 893) = 7.158$, $p < .05$, $\eta^2 = .023$. The educational stage variable was significant in the model, $F(1, 893) = 6.179$, $p < .05$, while gender was not significant, $F(1, 893) = .040$, $p > .05$, nor was the interaction between the two, $F(1, 893) = .226$, $p > .05$. Finally, the model's fit for **global competence** was also analyzed, yielding significant results with a small to medium effect size, $F(3, 893) = 6.390$, $p < .05$, $\eta^2 = .021$. The educational stage variable was significant in the model, $F(1, 893) = 3.905$, $p < .05$, while gender was not significant, $F(1, 893) = .014$, $p > .05$, nor was the interaction between the two, $F(1, 893) = .776$, $p > .05$.

	Levene's test of equality				Inter-subject ANOVA		
Dimension	**F**	**df1**	**df2**	**Sig.**	**F**	**Sig.**	
DIM. A	.422	3	893	.737	.531	.661	–
DIM. B	1.905	3	893	.127	8.183	.001	.027
DIM. C	2.226	3	893	.084	6.108	.001	.020
DIM. D	0.241	3	893	.868	3.743	.011	.012
DIM. E	3.407	3	893	.017	7.158	.001	.023
GLOBAL	.652	3	893	.582	6.390	.001	.021

Table 2. Levene's Test and ANOVA for the Proposed Model

Based on the results presented in Table 2, it can be observed that for DIM. A, the model was not significant. As a result, the variables of gender, educational stage, and the interaction between the two were not significant in determining the digital competencies of prospective teachers. However, for the other dimensions of the instrument, including global competence, the univariate models were found to be

significant, with the educational stage variable emerging as the only one that remained significant in further analyses. Therefore, multiple comparisons will be conducted only between the two educational stages (Early Childhood Education and Primary Education) across all dimensions of the instrument and overall competence, excluding **DIM. A** (*communication and collaboration*).

Table 3 displays the significant levels for comparisons between educational stages where significant differences were found. It shows that there were statistically significant differences in the self-perceived digital competencies of student teachers between the two educational stages across all dimensions of the instrument, as well as in overall competency, with the exception of **DIM. D** (digital citizenship), where no significant differences were found as both groups reported similar scores. Specifically, for **DIM. B** (technological literacy), Primary Education student teachers (M = 6.27) scored higher than their Early Childhood Education counterparts (M = 5.74), with a small to medium effect size (d = .35). For DIM. C (searching for and processing information), future Primary Education teachers scored higher (M = 6.94) than their Early Childhood Education counterparts (M = 7.32), with a small to medium effect size (d = .30). In **DIM. E** (Creativity and Innovation), future Primary Education teachers also outperformed Early Childhood Education teachers, scoring higher (M = 6.21 vs. M = 6.75), with a medium effect size (d = .44). **At the global level**, Primary Education teachers (M = 7.06) demonstrated slightly higher digital competencies compared to Early Childhood Education teachers (M = 6.74), with a small to medium effect size (d = .28).

Instrument latent factors	Primary Education	Early Childhood Education	p	d	95% confidence interval for difference	
					Lower limit	Upper limit
DIM. B - Technological Literacy	6.27	5.74	.034*	.35	-1.032	-.041
DIM. C - Information search and Processing	7.32	6.94	.042*	.30	-.813	-.016
DIM. D - Digital Citizenship	7.72	7.66	.764	-	-.433	.318
DIM. E - Creativity and innovation	6.75	6.21	.016*	.44	-.974	-.102
GLOBAL Competence	7.06	6.74	.048*	.28	-.678	-.002

* The difference in means is significant at the 0.05 level.

Table 3. Comparing Digital Competencies of Future Teachers Across Educational Stages

4.3. Correlational Analysis of Future Teachers' Digital Competencies and Academic Performance

The study examined the correlations between future teachers' digital competencies and their academic performance, using two academic indicators. The first indicator was the students' average university entrance qualification for both educational stages, and the second was the average grade participants had achieved during their university studies.

Table 4 presents the coefficients for the relationships, highlighting the cases where these relationships were significant. It can be observed that for both groups of future teachers, the academic performance predictor "Access to the University" is not significant in any of the dimensions of the instrument, nor in global competence. However, the academic performance predictor "Current Grade in the Degree" is significant in most dimensions for Early Childhood Education students, and fully significant across all dimensions for Primary Education students. For prospective Early Childhood Education teachers, positive correlations are noted, albeit with small effect sizes, in DIM. B (Technological literacy), DIM. C (Information search and processing), DIM. E (Creativity and innovation), as well as in global competence. In contrast, for Primary Education students, the correlations were all significant and positive across all factors of the instrument, though the effect sizes remain small.

Factors	Early Childhood Education		Primary Education	
	University entrance qualification	Average grade currently in the degree program	University entrance qualification	Average grade currently in the degree program
DIM. A	.096	.106	.029	.191*
DIM. B	.089	.152*	.046	.088*
DIM. C	.045	.132*	.023	.191*
DIM. D	.085	.103	.011	.169*
DIM. E	-.051	.158*	.041	.095*
Global	.065	.170*	.038	.178*

*Correlation is significant at 0.05 level.

Table 4. Correlations between Future Teachers' Digital Competencies and Their Academic Performance

5. Conclusions

This study examined the self-perceived digital competence of student teachers, taking into account gender, educational stage, and academic performance. A quantitative approach was employed to analyze the data collected from a representative sample of future teachers.

The results indicate that there are no significant differences in the digital competencies of future teachers based on gender, nor in the interaction between gender and educational stage. However, significant differences were found based on educational stage, both across the dimensions of the instrument and in overall digital competence. Primary Education students reported higher levels of self-perceived digital competencies compared to Early Childhood Education students in all dimensions of the instrument, except for the digital citizenship dimension.

The predictor "access to university" was not significant in any of the instrument's dimensions or in overall competence. This suggests that academic performance prior to university entry does not appear to influence the digital competencies of future teachers. On the other hand, the predictor "current grade in the degree" was significant in most dimensions of the instrument for Early Childhood Education students, and in all dimensions for Primary Education students. As a result, prospective teachers with higher grades in their degree programs tend to report higher levels of digital competencies. For Early Childhood Education students, the correlations between grade level and digital competencies were positive, though with a small effect size, indicating a weak but existent relationship. For Primary Education students, the correlations between grade level and digital competencies were positive and significant across all dimensions, suggesting a stronger relationship between the two variables in this group. Regarding global competence, Primary Education students scored slightly higher on average (7.06 vs. 6.74), with a small to medium effect size.

Regarding the first objective (**O1**), the results of the present study contrast with those of research in which males report higher self-perceived digital competence than females (Cantón-Mayo et al., 2016; Castiñeira-Rodríguez et al., 2022; Çebi & Reisoglu, 2020; Teo et al., 2015), as well as with studies where females report higher self-perceived digital competence (Cózar-Gutiérrez et al., 2016; Pozo-Sánchez et al., 2020; Arras-Vota et al., 2011). However, there is some alignment with the findings of Rodríguez-García et al. (2022), where the scores varied by dimension, with both males and females showing stronger results in different areas. A possible explanation for these differing results could lie in the context of each study, the sample size and representativeness, and the academic curricula of the institutions where the surveys were administered.

Focusing on the second objective (**O2**) and comparing the results with previous research that also takes into account the educational stage variable (i.e., the grade being studied), this study does not align with others where future Early Childhood Education teachers score higher than Primary Education teachers (Pegalajar, 2017; Urrea-Solano et al., 2021). However, it does align with studies that report the opposite (Girón-Escudero et al., 2019). In the other studies reviewed, no significant differences were found

between the two stages (Galindo-Domínguez and Bezanilla, 2021; Tárraga-Mínguez et al., 2017). These findings suggest That teachers must be trained in the basics of ICT.

Finally, regarding the third objective (**O3**) and the impact of academic performance, specifically the positive correlation between academic performance and perceived digital competence, this study aligns with the findings of García-Valcárcel & Martín-del-Pozo (2016) and Cabero-Almenara et al. (2023). It also mirrors research conducted in international contexts (Bahar et al., 2023; Chaw & Tang, 2023) and from a different perspective (Meroño et al., 2020).

The variations in the results of studies on the digital competencies of prospective teachers, as noted above, may be influenced by factors such as age, gender, ICT experience, teacher training, context, curriculum, and assessment instruments. These factors should be taken into account in future studies, as differences in digital skills levels can impact the quality of teaching and learning.

The study has several limitations that should be considered. One constraint is that it is not longitudinal, meaning it is not possible to determine whether the differences observed are due to temporal factors or permanent ones. Another limitation is that the sample is non-probabilistic, so the results may not be fully representative of the general population of prospective teachers. Additionally, the study is based on a single assessment instrument, which may introduce potential bias in the results.

To address these limitations, it is recommended that longitudinal studies be conducted to track the evolution of digital competencies in future teachers from their first academic year to their last. This would provide a clearer understanding of whether there is a significant improvement in these competencies as they progress through their educational technology training (Villalustre-Martínez, 2024). Additionally, it would be valuable to examine the impact of specific subjects related to educational technology on the development of digital competencies. This approach could help identify which courses are most effective for training in this area. It is also important to consider external factors that may influence digital competence development, such as students' socioeconomic backgrounds or access to technological resources. Furthermore, future studies should aim to diversify their samples by including prospective teachers from different universities, countries, and educational contexts.

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References

Alastor, E., Guillén-Gámez, F.D., & Ruiz-Palmero, J. (2024). Competencia digital del futuro docente de Educación Infantil y Primaria: un estudio por comparaciones múltiples. *Revista Latinoamericana de Tecnología Educativa - RELATEC*, 23(1), 9-24. https://doi.org/10.17398/1695-288X.23.1.9

Alastor, E., Martínez-García, I., Fernández-Martín, E., & Sánchez-Rodríguez, J. (2023). El aula invertida en Educación Superior como experiencia de innovación docente. *UTE Teaching & Technology (Universitas Tarraconensis),* 1, 66-81. https://doi.org/10.17345/ute.2023.3517

Alastor, E., & Martínez-García, I. (2020). Evolución de las herramientas innovadoras en el aula a lo largo del siglo XXI. Revisión bibliográfica. In F. J. Hinojo-Lucena, J. M. Trujillo-Torres, J.M., Sola Reche, & S. Alonso-García (Eds.), *Innovación Docente e Investigación Educativa en la Sociedad del Conocimiento* (pp. 717-732). Dykinson.

Akoglu, H. (2018). User's guide to correlation coefficients. *Turkish journal of emergency medicine*, 18(3), 91-93. https://doi.org/10.1016/j.tjem.2018.08.001

Arras-Vota, A.M.G., Torres-Gastelú, C.A., & Valcárcel-Muñoz-Repiso, A.M. (2011). Competencias En Tecnologías de Información y Comunicación (TIC) De Los Estudiantes Universitarios. *Revista Latina de Comunicación Social*, 66. 130-155. https://doi.org/10.4185/RLCS-66-2011-927-130-152

Bahar, H.H., Öz, R., & Kayalar, M.T. (2023). The Effect of Preservice Teachers' Information and Communication Technologies Competencies on Academic Self-Efficacy and Academic Achievement. *Advanced Education*, 22, 38-50. https://doi.org/10.20535/2410-8286.277949

Cabero-Almenara, J., Gutiérrez-Castillo, J.J., Guillén-Gámez, F.D., & Gaete-Bravo, A.F. (2023). Digital competence of higher education students as a predictor of academic success. *Technology, Knowledge and Learning*, 28(2), 683-702. https://doi.org/10.1007/s10758-022-09624-8

Cabero-Almenara, J., & Palacios-Rodríguez, A. (2020). Marco Europeo de Competencia Digital Docente «DigCompEdu». Translation and adaptation of the questionnaire «DigCompEdu Check-In». *EDMETIC*, 9(1), 213-234. https://doi.org/10.21071/edmetic.v9i1.12462

Cabero-Almenara, J., Barroso-Osuna, J., Gutiérrez-Castillo, J.J., & Palacios-Rodríguez, A. (2020). Validación del cuestionario de competencia digital para futuros maestros mediante ecuaciones estructurales. *Bordón: Revista de pedagogía*, 72(2), 45-63. https://doi.org/10.13042/Bordon.2020.73436

Cantón-Mayo, I., Cañón-Rodríguez, R., & Grande-de-Prado, M. (2016). La comunicación como subdimensión de la competencia digital en futuros maestros de primaria. *Pixel-Bit. Revista de Medios y Educación*, (50), 33-47. https://doi.org/10.12795/pixelbit.2017.i50.02

Çam, E., & Kiyici, M. (2017). Perceptions of Prospective Teachers on Digital Literacy. *Malaysian Online Journal of Educational Technology,* 4, 29-44.

Castiñeira-Rodríguez, N., Lorenzo-Rial, M.A., & Pérez-Rodríguez, U. (2022). Competencia digital docente para crear contenidos: autopercepción del profesorado en formación didáctico-científica de Galicia (España). *Educação e Pesquisa*, 48, 1-25. https://doi.org/10.1590/S1678-4634202248243510

Çebi, A., & Reisoglu, I. (2020). Digital Competence: A Study from the Perspective of Pre-service Teachers in Turkey. *Journal of New Approaches in Educational Research,* 9, 294-308. https://doi.org/10.7821/naer.2020.7.583

Chaw, L., & Tang, C. (2023). Exploring the relationship between digital competence proficiency and student learning performance. *European Journal of Education*, 59(1). https://doi.org/10.1111/ejed.12593

Cózar-Gutiérrez, R., Moya-Martínez, D., María, V., Hernández-Bravo, J.A., & Hernández-Bravo, J.R. (2016). Conocimiento y Uso de las Tecnologías de la Información y las Comunicaciones (TIC) según el Estilo de Aprendizaje de los Futuros Maestros. *Formación Universitaria*, 9(6), 105-118. https://doi.org/10.4067/S0718-50062016000600010

DiCTE (2019). *Pedagogical, ethical, attitudinal and technical dimensions of digital competence in teacher education. Developing ICT in Teacher Education Erasmus+project.* Available at: https://dicte.oslomet.no/dicte/

Feridouni-Solimani, A., & Ahmed-Mohamed, K. (2024). The impact of collaborative ePortfolios on academic learning in a university setting. *Journal of Technology and Science Education*, 14(2), 553-568. https://doi.org/10.3926/jotse.2150

Fernández-Martín, E., Alastor, E., Martínez-García, I., & Linde-Valenzuela, T. (2023). El uso de las redes sociales como recurso de innovación educativa en la educación formal. In J. Cabero-Almenara, C. Llorente-Cejudo, A. Palacios-Rodríguez & M. Serrano-Hidalgo, M. (Eds.), *Mejorando la enseñanza a través de la innovación educativa* (pp. 263-273). Dykinson. https://doi.org/10.2307/jj.1866701.27

Galindo-Domínguez, H., & Bezanilla, M. (2021). Digital competence in the training of pre-service teachers: Perceptions of students in the degrees of early childhood education and primary education. *Journal of Digital Learning in Teacher Education*, 37, 262-278. https://doi.org/10.1080/21532974.2021.1934757

García-Valcárcel, A., & Martín-del-Pozo, M. (2016). ¿Se sienten preparados los graduados en maestro de primaria para afrontar la profesión docente? *Bordón. Revista de Pedagogía*, 68(2), 69-84. https://doi.org/10.13042/Bordon.2016.68205

Ghomi, M., & Redecker, C. (2019). Digital competence of educators (DigCompEdu): Development and evaluation of a self-assessment instrument for teachers' digital competence. *Proceedings of the 11th International Conference on Computer Supported Education (CSEDU)*. https://doi.org/10.5220/0007679005410548

Girón-Escudero, V., Cózar-Gutiérrez, R., & González-Calero-Somoza, J.A. (2019). Análisis de la autopercepción sobre el nivel de competencia digital docente en la formación inicial de maestros/as. *Revista Electrónica Interuniversitaria de Formación del Profesorado*, 22(3), 193-218. https://doi.org/10.6018/reifop.373421

Guillén-Gámez, F.D., Mayorga-Fernández, M.J., & Contreras-Rosado, J.A. (2021). Validity and reliability of an instrument to evaluate the digital competence of teachers in relation to online tutorials in the stages of Early childhood education and Primary Education. *Revista de Educación a Distancia (RED)*, 21(67), 1-20. https://doi.org/10.6018/red.474981

Gutiérrez-Castillo, J.J., Cabero-Almenara, J., & Estrada-Vidal, L. (2017). Diseño y validación de un instrumento de evaluación de la competencia digital del estudiante universitario. *Espacios*, 38(10), 16.

Martínez-Pérez, S., Cabero-Almenara, J., Barroso-Osuna, J., & Palacios-Rodríguez, A. (2022). T-MOOC for initial teacher training in digital competences: Technology and educational innovation. *Frontiers in Education,* 7. https://doi.org/10.3389/feduc.2022.846998

Matore, E.M., & Khairani, A.Z. (2020). The pattern of skewness and kurtosis using mean score and logit in measuring adversity quotient (AQ) for normality testing. *International Journal of Future Generation Communication and Networking*, 13(1), 688-702.

Meroño, L., Calderón, A., & Arias-Estero, J. (2020). Digital pedagogy and cooperative learning: Effect on the technological pedagogical content knowledge and academic achievement of pre-service teachers. *Revista de Psicodidactica*, 26. 53-61. https://doi.org/10.1016/j.psicoe.2020.10.002

Miguel-Revilla, D., Martínez-Ferreira, J.M., & Sánchez-Agustí, M. (2020). Assessing the digital competence of educators in social studies: An analysis in initial teacher training using the TPACK-21 model. *Australasian Journal of Educational Technology.* 36(2), 1-12. https://doi.org/10.14742/ajet.5281

Oguguo, B., Ezechukwu, R., Nannim, F., & Offor, K. (2023). Analysis of teachers in the use of digital resources in online teaching and assessment in COVID times. *Innoeduca. International Journal of Technology and Educational Innovation*, 9(1), 81-96. https://doi.org/10.24310/innoeduca.2023.v9i1.15419

Palacios-Rodríguez, A., Guillén-Gámez, F.D., Cabero-Almenara, J., & Gutiérrez-Castillo, J.J. (2023). Teacher Digital Competence in the education levels of Compulsory Education according to DigCompEdu: The impact of demographic predictors on its development. *Interaction Design and Architecture(s) Journal - IxD&A*, 57, 115-132. https://doi.org/10.55612/s-5002-057-007

Pegalajar, M.C. (2017). Teacher training in the use of ICT for inclusion: Differences between early childhood and primary education. *Procedia - Social and Behavioral Sciences*, 237, 144-149. https://doi.org/10.1016/j.sbspro.2017.02.055

Pozo-Sánchez, S., López-Belmonte, J., Fernández-Cruz, M., & López Núñez, J.A. (2020). Análisis correlacional de los factores incidentes en el nivel de competencia digital del profesorado. *Revista Electrónica Interuniversitaria de Formación del Profesorado*, 23(1). 143-159. https://doi.org/10.6018/reifop.396741

Richardson, J.T. (2011). Eta squared and partial eta squared as measures of effect size in educational research. *Educational Research Review,* 6(2), 135-147. https://doi.org/10.1016/j.edurev.2010.12.001

Rodríguez-García, A., Cardoso-Pulido, M., Cruz-Campos, J., & Martínez-Heredia, N. (2022). Communicating and Collaborating with Others through Digital Competence: A Self-Perception Study Based on Teacher Trainees' Gender. *Education Sciences*. https://doi.org/10.3390/educsci12080534

Rubio-Gragera, M., Cabero-Almenara, J., & Palacios-Rodríguez, A. (2023). Digital Innovation in Language Teaching–Analysis of the Digital Competence of Teachers according to the DigCompEdu Framework. *Education Sciences*, 13(4), 1-12. https://doi.org/10.3390/educsci13040336

Srivastava, A.B.L. (1959). Effect of non-normality on the power of the analysis of variance test. *Biometrika*, 46(1/2), 114-122. https://doi.org/10.1093/biomet/46.1-2.114

Tárraga-Mínguez, R., Sanz-Cervera, P., Pastor-Cerezuela, G., & Fernández-Andrés, M. (2017). Análisis de la autoeficacia percibida en el uso de las TIC de futuros maestros y maestras de Educación Infantil y Educación Primaria. *Revista Electrónica Interuniversitaria de Formación del Profesorado*, 20(3), 107-116. https://doi.org/10.6018/reifop.20.3.263901

Teo, T., Fan, X., & Du, J. (2015). Technology acceptance among pre-service teachers: Does gender matter? *Australasian Journal of Educational Technology*, 31(3). https://doi.org/10.14742/ajet.1672

Urrea-Solano, M., Hernández-Amorós, M.J., Merma-Molina, G., & Baena-Morales, S. (2021). The learning of e-sustainability competences: A comparative study between future early childhood and primary school teachers. *Education Sciences*, 11(10), 644. https://doi.org/10.3390/educsci11100644

Valencia, E.M. (2023). ¿Cómo enfrentarse a las tendencias globales de la Educación Superior? *Diá-logos*, 26, 5-8.

Villalustre-Martínez, L. (2024). Análisis del nivel de pensamiento computacional de los futuros maestros: una propuesta diagnóstica para el diseño de acciones formativas. *Pixel-Bit. Revista de Medios y Educación*, 69, 169-194. https://doi.org/10.12795/pixelbit.101205

Winer, B.J., Brown, D.R., & Michels, K.M. (1971). *Statistical principles in experimental design* (2). McGraw Hill.

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