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Digital competence of preservice teachers of pre-school and primary education: a multiple comparisons study

Competencia digital del futuro docente de Educación Infantil y Primaria: un estudio por comparaciones múltiples

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Abstract: Digital competence is an essential element for initial teacher training, as it allows them to integrate technologies into their practice. The objectives set were: (1) to know the self-perceived level of future primary and early childhood education teachers regarding their digital competence; (2) compare if there are significant differences in digital competence between future teachers of both educational stages; (3) to identify if there are significant differences in competence between the different academic courses of the degree, for each educational stage. We proposed a non-experimental study of the ex post facto type and a sample of 897 students of Early Childhood and Primary Education. The results showed that they have a medium-high self-perceived level of digital competence in both educational stages, finding significant differences between future teachers of Early Childhood and Primary Education, the latter being the ones who obtained the highest scores. In Early Childhood Education, significant differences were found between those of the first and fourth year, while in Primary Education, differences were found between all academic courses, except between the third and fourth. These results suggest that initial training should focus on developing the digital competence of future teachers, with special attention to the first academic courses.

Keywords: Digital competence, Preservice teachers, University students, Educational technology, ICT.

Resumen: La competencia digital es un elemento esencial para la formación inicial de docentes, ya que les permite integrar las tecnologías digitales en su práctica. Los objetivos planteados fueron: (1) conocer el nivel auto percibido de futuros maestros de Educación Primaria e Infantil respecto a sus competencias digitales; (2) comparar si existen diferencias significativas en competencias digitales entre los futuros docentes de ambas etapas educativas; (3) identificar si existen diferencias significativas en competencias entre los diferentes cursos académicos del grado educativo, para cada grado educativo. Planteamos un estudio no experimental de tipo ex post facto y muestra de 897 estudiantes de Infantil y Primaria. Los resultados mostraron que tienen un nivel auto percibido medio-alto de competencia digital en ambos grados educativos, encontrando diferencias significativas entre los futuros docentes de Educación Infantil y Primaria, siendo estos últimos los que obtuvieron puntuaciones más altas. En Educación Infantil se encontraron diferencias significativas entre los de primero y cuarto curso, mientras que en Educación Primaria se encontraron diferencias entre todos los cursos académicos, excepto entre tercero y cuarto. Estos resultados sugieren que la formación inicial debe centrarse en desarrollar las competencias digitales de los futuros maestros, con especial atención en los primeros cursos académicos.

Palabras-Clave: Competencia Digital, Formación inicial del profesorado, Estudiantes universitarios, Tecnología Educativa, TIC.

1. Introduction

In recent years, Information and Communication Technologies (ICT) have significantly transformed the way we live, work, communicate and learn, and have profoundly impacted society (Cabero-Almenara et al., 2023). So important have they become that, according to Tomczyk et al., 2023, having ICT skills, access to new media and the internet, the ability to use popular e-services, a willingness to use ICT, and a critical-constructive attitude towards it are all essential for being able to cope in today's information society. Given the increasing integration of technology into our society, it is imperative that both students and teachers develop the necessary skills to use it effectively (Gabarda-Méndez et al., 2021).

As such, teachers should be trained not only in active techniques and methodologies that engage students in their learning process (Guillén-Gámez et al., 2020a), but also in digital competences (Oguguo et al., 2023). This demands teacher training that goes beyond traditional methods, redefining the teacher's role as a facilitator of learning and proficient in using digital resources for teaching purposes (Fernández-Martín et al., 2023, Alastor et al., 2023).

The scientific literature has demonstrated that teachers who receive continuous training to enhance their digital skills effectively utilise ICT (Ruiz-Palmero et al., 2023), leading to improved academic performance among their students (Cabero-Almenara et al., 2023). However, achieving this goal necessitates the use of valid and reliable tools to assess teachers' levels of digital competence (Guillén-Gámez et al., 2023), with the aim of focusing on specific groups that require digital skills training (Martínez-Pérez et al., 2022).

With this in mind, there is a widely accepted consensus that initial teacher training should equip future educators to use ICT effectively in the classroom, aligning with the objectives outlined in the Horizon Reports (Valencia, 2023). This underscores the need for initial teacher training programmes to develop teachers' digital competence, covering skills such as the safe and ethical use of ICT, its integration into the curriculum and a critical approach to its use (Pinto-Santos et al., 2023). Additionally, these programmes should provide opportunities for future teachers to apply their skills in real-world environments (Aroca-Reyes and Llorente-Cejudo, 2023).

Bearing in mind the crucial need to digitally train future teachers in order to meet the demands of an increasingly digitised society, this study will address the following questions: What is the digital competence level of preservice early childhood and primary school teachers? Are there differences in the digital competence level among preservice early childhood and primary school teachers? Does the digital competence level of preservice early childhood and primary school teachers show positive changes during the teacher training course?

1.1. Other research on digital competence

Numerous studies have explored the digital competence of preservice early childhood teachers (e.g., Marimon-Martí et al., 2023b; Castiñeira-Rodríguez et al., 2022; Martínez-Serrano et al., 2021; Casillas-Martín et al., 2020). For example, Roig-Vila and Pascual-Luna (2012) analysed ICT use and proficiency in a sample of 61 students at the

University of Alicante, revealing a high level of digital competence. Similarly, Pinto-Santos et al. (2020) analysed the self-perception of digital competence among a sample of 218 Colombian students, finding high levels of digital competence, particularly among students in their final semester. Similar findings were reported by Casillas-Martín et al. (2020). However, these studies contrast with that of Casillas-Martín and Cabezas-González (2019), which analysed a sample of 307 students from Salamanca, Spain, and highlighted the need for addressing digital competence in the initial teacher training of early childhood education teachers (p. 1337). Similar findings regarding knowledge of educational technology were also reported by Guillén-Gámez and Mayorga-Fernández (2020), as well as Santos and Garcias (2022), who called for strengthening the digital training processes.

With regard to studies on preservice primary education teachers, Pascual et al. (2019) analysed the digital knowledge and skills of 559 students in the first year of primary teacher training courses at the universities of Granada, Jaén, and Oviedo,Spain. The authors found deficiencies among preservice teachers in information management, digital communication, and computer problem solving. Similarly, García et al. (2019) analysed the digital competences of 698 preservice teachers in primary education in terms of their ability to access, select, evaluate, and store information. They found that these preservice teachers did not have sufficient knowledge or skills to assess the reliability and veracity of the information they found online. In contrast, other authors have reported contradictory findings, including Guillén-Gámez et al. (2020b), who explored the use of digital resources among preservice teachers in Salamanca, Spain. Based on a sample of 108 participants, the findings showed extensive use of digital tablets, digital whiteboards, web browsers, and multimedia presentations. Similarly, for a sample of 153 preservice teachers at the University of Valencia, Spain, Colomer-Rubio et al. (2018) reported a high perception of their pedagogical knowledge. These results are similar to those of Llopis-Nebot et al. (2021), Aguilar-Cuesta et al. (2021), Marimon-Martí et al. (2023a) or Guillén-Gámez and Linde-Valenzuela (2022).

Furthermore, there are very few recent studies in the scientific literature comparing and analysing the digital competences of preservice teachers based on the educational stage they teach (Cózar-Gutiérrez et al., 2016). Among the existing studies, Cózar-Gutiérrez et al. (2016) compared a sample of 62 preservice teachers in early childhood and primary education in Albacete, Spain, and found that these competences were higher in the early childhood group. Similarly, Tárraga-Mínguez et al (2017) compared digital competences in a sample of 107 preservice teachers and found no significant differences between early childhood and primary teachers. Other education-related studies, albeit with in-service rather than preservice teachers, include the study by Basgall et al. (2023), which analysed digital competences in the use of YouTube. Based on a sample of 2157 in-service teachers from different educational stages, he found that primary teachers had superior skills in content creation, although their skills in searching for and communicating information were comparable. However, Portillo-Berasaluce et al. (2022) reported conflicting results, finding no significant differences between early childhood and primary teachers, as scores were similar. Given the scarcity and outdated nature of these studies, further research in this area is crucial for advancing our understanding and contributing to this field of science.

Finally, regarding studies that analyse whether there is an increase in the acquisition of new digital competences according to the academic year of education, López-Belmonte et al. (2019) examined the digital competence levels of 169 students in Ceuta, Spain, across various academic years. Their findings revealed a noticeable increase in digital competence—particularly in content creation and problem-solving—among students in their final year. Similar results were reported by Gabarda-Méndez et al. (2017) in a study involving 104 preservice teachers at the International University of Valencia, Spain. They observed a gradual, positive, and significant increase in digital competences between the first and fourth years of study. In addition, Galindo-Domínguez and Bezanilla (2021) also reported an increase in digital literacy from one academic year to the next among 200 students from the Basque Country, Spain, although the increase was not significant. Similarly, Demirtaş and Mumcu (2021) and Özcan (2022) also reported significant improvements in digital competences.

Examining the scientific literature on how digital competence has been studied in the last decade reveals that there are few studies dealing with and comparing the self-perceived levels of digital competence among preservice teachers in early childhood and primary education, considering the four academic years required for a teaching degree in Spain, and where ICT training is provided in different subjects and in a cross-cutting manner.

2. Method

2.1. Design and participants

In order to meet the objectives of this study, a quantitative non-experimental ex post facto design was used through surveys. Descriptive analyses using measures of central tendency and dispersion, as well as inferential analyses, were carried out based on the collected data. In addition, a non-probability, purposive sample was chosen for the study, comprising 897 preservice teachers from the Faculty of Education at the University of Malaga during the academic year 2022-2023. Concerning the categorical distribution, 77.90% of the students were female (n= 699), with a mean age of 20.793.27±. The remaining participants were male (22.10%, n= 198), with a mean age of 21.09±4.10. In terms of the type of education, 33.10% (n= 297) were taking early childhood education degrees, while 66.90% (n= 600) were taking primary education degrees. Table 1 shows the distribution by academic year.

Table 1. Sample distribution by academic year.

Curso	Early Childhood	Primary
First	30% (104)	70% (243)
Second	22.5% (38)	77.50% (131)
Third	33.20 % (65)	66.80% (131)
Fourth	48.6 % (90)	51.40 % (95)

2.2. Instrument

Preservice teachers' self-perceptions were measured using an instrument developed by Cabero Almenara et al. (2020). This instrument analyses the strengths and needs related to digital learning through 20 items categorised into the following five dimensions:

Dimension A - technological literacy (4 items); Dimension B - communication and collaboration (3 items); Dimension C - information searching and processing (4 items); Dimension D - digital citizenship (3 items), and Dimension E - creativity and innovation (6 items). Each item was measured in the same way as the authors of the study, using an 11-point Likert scale, where 0 represents the minimum and 10 the maximum.

The instrument demonstrated satisfactory psychometric properties in both reliability and construct validity. In terms of construct validity, an exploratory factor analysis (EFA) was conducted using SPSS software, employing the principal components method with Varimax rotation. The results explained 74.6% of the variance across the five theoretical factors. In addition, the Kaiser-Meyer-Olkin criterion (KMO = 0.736) and Bartlett's test of sphericity (sig. < .05) were confirmed. For the confirmatory factor analysis (CFA), the weighted least squares (WLS) method was applied with AMOS software. Model fit was assessed by the authors based on the criteria recommended by Lévy-Mangin (2006) CMIN = 176.88 <500; GFI = 0.944 >0.7; PGFI = 0.758 > 0.7; NFI = 0.993 > 0.7; PNFI = 0.836 > 0.7. The theoretical model proposed in the EFA was tested using the CFA.

The internal consistency of the instrument was checked in this study to confirm that the items still showed homogeneity in their respective factors. Table 2 shows the coefficients obtained by the authors of the instrument and the coefficients obtained in this study. Although the overall reliability of the instrument was not initially calculated by the authors, it was included in this study. Both were analysed using Cronbach's alpha. The coefficients obtained in both studies confirm the reliability of the instrument.

Table 2. Internal consistency of the instrument.

	DIM. 1	DIM. B	DIM. C	DIM. D	DIM. E	Total
Cabero Almenara et al. (2020)	.838	.838	.889	.889	.889	-
For this study	0.768	0.727	.828	.831	.872	.930

The table shows the reliability values of the dimensions of digital competence in teaching according to the study by Cabero Almenara et al. (2020) and this study. It can be seen that the values are similar in both studies, although they are slightly higher in the study by Cabero Almenara et al. (2020) for dimensions 1, B and C, and slightly higher in this study for dimensions D and E. The overall reliability value in this study is very high (.930), indicating a good internal consistency of the instrument used.

2.3. Procedure

The analysis of the data involved several procedures, as described below:

a) To achieve the first objective, a descriptive analysis of the preservice teachers' self-perceived level was carried out for each academic year (1st, 2nd, 3rd, and 4th) and for each educational stage (early childhood and primary).

b) For the second objective, we examined whether there were significant differences between the digital competences of preservice teachers taking an early childhood education degree and a primary education degree, so as to proceed with further univariate or bivariate analyses.

c) Lastly, a multiple comparison analysis was conducted to determine whether there were statistically significant differences in the self-perceived level of digital competence of preservice teachers across the four years of the teacher training degree for both educational stages.

2.4. Objectives

O1. To determine preservice teachers' self-perceived level of digital competence for each educational stage (early childhood and primary).

O2. To compare whether there are significant differences in preservice teachers' self-perceived competence according to their degree.

O3. To determine whether there are significant differences in preservice teachers' self-perceived competence according to academic year in both early childhood and primary education.

3. Results

3.1. Descriptive analysis of preservice teachers' self-perceived digital competences

Table 3 presents preservice teachers' perceptions categorised by academic year and educational stage. This was measured by calculating the arithmetic mean of each instrument item, grouped by the dimension they belong to. Noteworthy findings include high scores for both degrees in technological literacy, specifically in synchronous communication tools. On the other hand, the use of simulations to explore complex systems and issues using ICT yielded the lowest scores in the dimension of creativity and innovation.

Table 3. Digital competences according to academic year and educational stage.

	Early Childhood		Primary	
	M	**SD**	**M**	**SD**
A. Technological literacy				
I can use different operating systems on computers.	7.66	1.90	7.67	1.99
I can set up and use an email manager.	7.73	2.22	7.78	2.12
I can use some audio editing software.	6.21	2.34	6.40	2.46
I can use some synchronous communication tools.	9.30	1.14	9.09	1.54
B. Communication and collaboration				
I can use Web 2.0 tools to share and publish resources online.	8.79	1.80	8.76	1.65
I can design, create, or modify a web page.	4.88	2.78	5.60	2.65
I can find, save, and tag internet resources.	6.22	2.47	6.87	2.23
C. Information searching and processing				
I can identify useful information by evaluating different sources and their sources.	6.73	2.13	7.23	2.01
I can organise, analyse, and ethically use information from different sources and media.	6.88	2.08	7.37	1.90

	Early Childhood		Primary	
	M	SD	M	SD
I can synthesise information and make appropriate choices for the production and assimilation of new content.	7.20	1.90	7.48	1.77
I use software to create concept and mind maps, diagrams, or charts to show the relationship between ideas and concepts.	8.36	1.86	8.22	1.92
D. Digital citizenship				
I advocate and practise the safe, legal, and responsible use of information and ICT.	7.79	1.98	7.91	1.87
I commit to lifelong learning using ICT.	7.68	1.90	8.07	1.77
I consider myself competent to offer constructive criticism, judgements, and contributions to the ICT work of my peers.	7.24	1.96	7.39	1.94
E. Creativity and innovation				
I can generate original, novel, and useful ideas using ICT.	7.37	1.95	7.68	1.84
I can produce original work using new ICT resources, such as augmented reality, robotics, etc.	5.63	2.97	6.35	2.68
I identify trends and forecast possible uses of ICT.	6.00	2.30	6.85	2.08
I use simulations to explore complex systems and issues using ICT.	4.90	2.96	5.54	2.63
I produce materials in which I use ICT creatively to support the construction of my knowledge.	6.73	2.41	7.31	2.14
I can adapt to new situations and technological environments.	7.69	1.84	7.83	1.85

3.2. Comparative analysis of the self-perceived digital competences of preservice teachers between the two educational stages

Table 4 shows the self-perceived level of the preservice teachers in both educational stages for each dimension of the instrument. Mean levels, standard deviations, skewness, and kurtosis for each dimension are provided. In terms of technological literacy, preservice teachers in the primary educational stage (M=7.29±1.82) scored slightly higher scores than their counterparts in the early childhood educational stage (M=7.20±1.70). Similarly, scores for digital communication and collaboration skills were higher in the primary stage (M=6.24±2.09) compared to the early childhood stage (M=5.55±2.26). Preservice teachers in the primary stage also demonstrated higher skills in information searching and processing using digital applications (M=7.36±1.70) compared to those in the early childhood stage (M=6.93±1.81). In relation to digital citizenship, scores were slightly higher for the primary educational stage (M=7.79±7.57) than for the early childhood stage (M=7.57±1.67). In creativity and digital innovation, preservice teachers in primary education (M=6.78±1.81) had slightly higher scores than those in early childhood education (M=6.19±2.05). Overall, preservice teachers in primary education demonstrated higher digital skills (M=7.09±1.46) than their counterparts in early childhood education (M=6.69±1.48).

The normality of the data was checked before making statistical comparisons between the two educational stages. Table 4 shows the statistics of central tendency (mean, standard deviation) and dispersion (skewness and kurtosis) for each dimension of the instrument, as well as for global competence (mean of all items). In addition, the normality of the data was tested using the Kolmogorov-Smirnov test. Since the values

of the Kolmogorov-Smirnov (KS) and Shapiro-Wilk (SW) statistics indicated that the assumption of normality was not met, the Mann-Whitney U-test was used to compare scores between the preservice teachers of both educational stages. In cases of significant contrast, effect sizes were calculated. Cohen (1988) classified effect sizes of less than 0.4 as small, between 0.5 and 0.7 as medium, and greater than 0.8 as large. Significant differences were found in the scores of the two types of teachers for dimension B (communication and collaboration), with a small effect size (d=0.292), for dimension C (information search and processing), also with a small effect size (d=0.224), for dimension E (creativity and innovation), again with a small effect size (d=0.271), and finally for the global score—which combines all the dimensions of the instrument—with a small effect size (d=0.262).

Table 4. Digital competences by dimensions and comparative analysis between educational stages.

		M	SD	A	C	KS	Mann-Whitney U	Z	Effect size (d)
DIM. A	Early Ch.	7.20	1.70	-0.754	0.482	0.103	85210.500	-1.067	-
	Primary	7.29	1.82	-0.849	0.757	0.107			
DIM. B	Early Ch.	5.55	2.26	-0.352	-0.409	0.073	73317.500*	-4.332	0.292
	Primary	6.24	2.09	-0.421	-0.250	0.090			
DIM. C	Early Ch.	6.93	1.81	-0.815	1.057	0.101	76945.500*	-3.336	0.224
	Primary	7.36	1.70	-0.797	1.061	0.099			
DIM. D	Early Ch.	7.57	1.67	-0.783	0.611	0.107	-82358.500	-1.851	-
	Primary	7.79	1.61	-0.735	0.381	0.093			
DIM. E	Early Ch.	6.19	2.05	-0.521	-0.52	0.069	74438.500*	-4.017	0.271
	Primary	6.78	1.81	-0.574	0.205	0.070			
GLOBAL CD	Early Ch.	6.69	1.48	-0.449	0.092	0.069	74882.000*	-3.893	0.262
	Primary	7.09	1.46	-0.529	0.290	0.051			

Note: M (mean), SD (standard deviation), A (skewness), C (kurtosis), KS (Kolmogorov-Smirnov). * Significance level at 0.05.

3.3. Multiple comparisons analysis of the use of ICT to teach, evaluate and research (UICT-TER) model

To address the third objective of the study, a non-parametric analysis was conducted due to the lack of normality in the scores for both types of teachers across each dimension of the instrument ($p < 0.05$). The Kruskal-Wallis test, suitable for three or more independent categorical groups, was employed. In this study, the grouping variable was the academic year in which the students were enrolled, ranging from the first to the fourth year. For cases where there were significant differences between the groups (academic years) in terms of the effect sizes, the eta-squared was calculated, with $\eta 2 = .01$ indicating a small effect; $\eta 2 = .06$ indicating a medium effect, and $\eta 2 = .14$

indicating a large effect (Richardson, 2011). However, as this coefficient tends to be biased in small populations, Cohen's d was also calculated.

Table 5 shows statistically significant differences (p. < 0.05) in all dimensions of the instrument and in the overall assessment for the four academic years of teacher training in both educational stages. Effect sizes were found to be small in the early childhood education stage and large in the primary education stage.

Table 5. Comparative analysis between the digital competences of preservice teachers and the four academic years of the teaching degree.

		DIM. A	DIM. B	DIM. C	DIM. D	DIM. E	GLOBAL
Early Childhood Education	Kruskal-Wallis H	13.747	8.946	26.490	10.477	10.196	19.006
	Sig.	0.003	0.030	0.001	0.015	0.017	0.001
	D Cohen (d)	0.390	0.288	0.590	0.324	0.317	0.481
	eta-squared	0.037	0.020	0.08	0.026	0.025	0.055
Primary Education	Kruskal-Wallis H	69.976	43,673	70,125	83,544	48,321	89,832
	Sig.	0.001	0.001	0.001	0.001	0.001	0.001
	D Cohen (d)	0.712	0.541	0.713	0.791	0.574	0.826
	eta-squared	0.112	0.068	0.113	0.135	0.076	0.146

The significant results found in the previous table do not allow us to determine exactly where these noteworthy differences lie, i.e. between which academic years such differences exist. Therefore, in the following procedure, the Mann-Whitney U test is used for each pair of levels of the grouping variable academic year, applying the Bonferroni correction to avoid increasing the probability of a type I error. When applying the Bonferroni correction, it should be remembered that contrast decisions must be based on a significance level of 0.05/4= 0.0125. In other words, two groups are considered to be significantly different if the critical level obtained is less than 0.0125. An asterisk (*) indicates that the differences were significant using this criterion.

For the pre-service teachers in early childhood education, significant differences were observed between the first- and fourth-year students for all dimensions of the instrument, as well as for the final assessment. The effect sizes found are in the small to medium range. Remarkable dissimilarities were also found between first- and second-year students for dimension C (information search and processing), with an effect size close to medium (d= 0.44). There were also noticeable differences between first- and third-year students in dimension C (information search and processing) with a medium effect size, in dimension D (digital citizenship) with a small effect size (d= 0.37) and in the overall assessment, with a medium effect size.

Table 6. Multiple comparisons between academic years and the digital competences of preservice teachers (early childhood education).

Year	Year	DIM. A		DIM. B		DIM. C		DIM. D		DIM. E		Global	
		U	d	U	d	U	d	U	d	U	d	U	d
1st	2nd	1630.50	-	1778,50	-	1416,50*	.44	1807.00	-	1751.50	-	1639.00	-
	3rd	2658.50	-	2723.00	-	2355.50*	.53	2539.50*	.43	2866.00	-	2445.50*	.48
	4th	3272.50*	.54	3604.00*	.40	2787.00*	.74	3682.50*	.37	3462.00*	.46	3076.00*	.62
2nd	3rd	1200.50	-	1104.50	-	1171.00	-	1005.00	-	1169.50	-	1122.00	-

	4th	1520.00	-	1473.00	-	1431.00	-	1454.50	-	1450.00	-	1421.50	-
3rd	4th	2681.00	-	2862.50	-	2638.00	-	2860.00	-	2572.00	-	2685.00	-

For preservice primary school teachers, significant differences were observed between first-year and third-year students, and also between first-year and fourth-year students in all dimensions of the instrument, as well as in the final assessment. The effect sizes were in the medium to large range. Significant differences were also found between second- and third-year students, and between second- and fourth-year students, with medium effect sizes in all cases.

Table 7. Multiple comparisons between academic years and preservice teachers' digital competences (primary education)

Year	Year	DIM. A		DIM. B		DIM. C		DIM. D		DIM. E		Global	
		U	d	U	d	U	d	U	d	U	d	U	d
	2nd	15627.00	-	15346.00	-	15127.00	-	14693.50	-	13955.50	-	14957.00	-
1st	3rd	10812.50*	.55	11418.50*	.48	9666.50*	.69	8477.50*	.84	9686.50*	.68	8730.00*	.80
	4th	5894.00*	.82	7180.00*	.62	6539.50*	.72	6308.00*	.75	7771.00*	.53	5657.50*	.86
2nd	3rd	5775.00*	.59	6341.50*	.46	5353.50*	.69	5095.50*	.75	6255.00*	.48	5177.50*	.73
	4th	3208.00*	.91	4007.50*	.64	3585.00*	.78	3768.50*	.72	4895.50*	.41	3363.00*	.85
3th	4th	5109.00	-	5728.50	-	6081.50	-	6193.00	-	5973.50	-	5775.00	-

4. Conclusion

This study analysed the perceived level of digital competences of preservice teachers of early childhood education and primary education. Specifically, the study examined whether there were significant differences in these competences between preservice teachers of both teaching degrees, and whether there were significant differences between students in the four academic years of a teaching degree in Spain, considering each degree separately.

Regarding the first objective, the results obtained in this study for the self-perceived level of digital competence among preservice early childhood teachers are in line with those of Pinto-Santos et al. (2020), as the level of self-perceived competence is higher among final year students, which is also in line with the results of Casillas-Martín et al. On the other hand, the results regarding the self-perceived level of students are not in line with those of Casillas-Martín and Cabezas-González (2019), Guillén-Gámez and Mayorga-Fernández (2020) and Santos and Garcias (2022). About preservice primary teachers, different results were obtained from those published by Pascual et al. (2019) and García et al. (2019). However, the results were in line with those of Guillén-Gámez et al. (2020b), Llopis-Nebot et al. (2021), Aguilar-Cuesta et al. (2021), Marimon-Martí et al. (2023a) or Guillén-Gámez and Linde-Valenzuela (2022), in that they considered themselves to be highly digitally competent.

In relation to the second objective, if we compare this study with the results of previous studies comparing the two educational stages, we find studies with contradictory results, such as that of Cózar-Gutiérrez et al. (2016), where higher competences were found in early childhood teachers. The remaining studies analysed which do not agree with our results did not find significant differences between the two degrees.

Regarding the third objective and the differences between academic years, this study found that there are differences between the first year and the later years, in line with López-Belmonte et al. (2019), Gabarda-Méndez et al. (2017), Demirtaş and Mumcu (2021) and Özcan (2022). Moreover, Galindo-Domínguez and Bezanilla (2021) also found an improvement as students progressed from one academic year to the next, albeit with non-significant differences. A plausible explanation for these results can be found in the subjects covered by the degree, in particular the related subjects. While the early childhood education degree does not have a specific ICT subject at the university in question, the primary education degree does include training in information and communication technologies applied to education, which is taught in the second semester of the first year.

The lack of homogeneity between the results of the comparative studies may be due to a variety of factors, such as age, gender, previous experience with ICT, approach to teacher training, context, curriculum, and instruments used, all of which should be carefully analysed in future studies. These differences in digital competence levels may have implications for the quality of future teaching and learning.

It is also important to mention that the COVID-19 pandemic created an extraordinary situation in society that affected all areas of life, including the emotional, family, social, academic, and educational lives of students (Gómez-Gómez et al., 2022). This, in turn, may have influenced their self-perception of their preservice teacher competences.

This study has shown that, in general, preservice teachers in primary education have better digital competence than those in early childhood education. Students in the first year of primary education teacher training score significantly lower than students in the third and fourth years of primary education on all dimensions of the instrument. The effect sizes of these differences are medium to large, indicating that they are significant. Significant differences were also found between second- and third-year students and between second- and fourth-year students, with medium effect sizes. In other words, primary students improve their preservice teacher competencies as they progress through their education. The differences between first-year students and third- and fourth-year students are particularly striking. On the other hand, first-year students in early childhood education score significantly lower than fourth-year students on all dimensions of a preservice teacher assessment instrument. The effect sizes of these differences are small to medium, indicating that they are significant. Significant differences were also found between first- and second-year students in dimension C, with an effect size close to medium; and between first- and third-year students in dimension C, with a medium effect size; in dimension D, with a small effect size; and in the overall assessment, with a medium effect size. And, as with primary students, early childhood students improve their preservice teacher competencies as they progress through their education.

The present study has a number of limitations that should be taken into account when interpreting the results. One of the main limitations is that the study is not longitudinal, so the results must be interpreted with caution, as the participants across years are not dependent but independent samples and there may be different predictors that influence these differences. Therefore, further studies are needed with longitudinal studies on the digital competences of preservice teachers from the first to the last academic year, with the aim of determining whether there is a significant

improvement in the digital competences of preservice teachers as they are trained in educational technology in the different subjects of the teaching degree. Another limitation of the study is that the sample used is not probabilistic, i.e. it was not selected randomly, so it would be useful to carry out random sampling in order to be able to extend the results to the entire population of preservice teachers in these two educational stages. In addition to these limitations, the study also has other constraints that need to be considered, such as the use of a single assessment instrument.

Other future work could be proposed, such as a comparative study between preservice teachers from different universities or countries to identify dissimilarities in the development of digital competence; a qualitative study to better understand the experiences of preservice teachers in developing their digital competence, and an intervention study to implement a specific training programme to improve the digital competence of preservice teachers. This work would deepen our knowledge of preservice teachers' digital competence development and contribute to refining teacher training in this area.

5. References

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