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The Challenge of Initial Training for Early Childhood Teachers. A Cross Sectional Study of Their Digital Competences

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Abstract: The scarce presence of technologies at the early childhood education level today is a cause for worry. This study aims to provide information on the training of future early childhood education teachers and their relationship with technologies. The work is based on a pretest–posttest methodology through a cross sectional descriptive study. The sample is made up of 535 4th year students of the Degree in Early Childhood Education at the University of Seville. Descriptive and contrast analyses were performed as well as contrast statistics and effect size. The results show that the training received by the students was a key element to improve self-perception of digital competence. There were statistically significant changes between before and after receiving the training. The changes produced always meant an improvement in the students' self-perception. In the study of their profiles, relevant changes were also identified. Whereas before training subjects were grouped into newcomer and explorer categories, after training they were grouped into the highest profiles: integrator, expert, and pioneer. For this reason, it is necessary to manage training plans to allow future teachers to position themselves at an expert level.

Keywords: higher education; early childhood education; ICT; digital competence; teacher training

1. Introduction

The importance of training future teachers of early childhood education (ECE) in information and communication technology (ICT) is one of the concerns that is recently leading researchers in the area to look for reasons that explain the reason for the low presence of technologies at this educational level. Since its appearance, technologies have been widely introduced in ECE programs with the aim of children learning and playing. However, the significant integration of technologies in early learning, and its implication in children's cognitive development, is not very evident. This is demonstrated by the few studies and research carried out in this regard.

Currently, children come with very large technological baggage from their homes. It is obvious that many of the children who attend early childhood and primary education centers have grown up in homes where multimedia and multimodal forms of expression are very common. Therefore, their experiences of using digital technologies can be really extensive [1,2]. Together, the exceptional situation that COVID-19 has caused has forced the use of technologies to be intensified as an alternative to face-to-face education. In this very specific and unusual context, schools show the digital deficiencies of the system, despite the large number of resources available on some occasions and the goodwill of teachers and students. That is why, during the suspension of classroom classes, students without classes will spend even more hours at home using computers, mobile devices, and consoles. It is important to point out that digital teaching competence is essential for the application of active methodologies and adapted to current students [3].

With this background, it is obvious that children in early childhood education do not understand why, when they arrive at school, their communication, play, and learning tools are not similar to those used in their family contexts. Against this background, early childhood education teachers have to rethink what they do in their classrooms and with what resources. They are the key and central axis to achieve and promote the integration of ICT in professional practices and developing guidelines for the use of ICT in educational spaces, under the support of administrations and study plans.

For this reason, there is no doubt that everything regarding the initial training of early childhood teachers in ICT is of interest. Furthermore, one must consider the premise that technologies are present in the daily lives of these children, from one to six years old. Therefore, for them, they have already become invisible tools in their environment. Even so, the issue of technologies for learning at early ages goes unnoticed in most studies and research, usually linked to primary education, forgetting the peculiarities of early childhood education. For this reason, it is more than evident that there is a problem that is not being adequately addressed.

This study aimed to provide information on the training of future teachers of early childhood education and its relationship with technologies. Specifically, it was about knowing the self-perceptions towards technologies before their university training in ICT and after having received it. Then, it was about knowing if these self-perceptions can evolve and change their conception when acting by incorporating ICT in their future curricular practice. Finally, we tried to understand how these self-perceptions can influence the way in which students perceive their own digital competence and their view about the presence of ICT in their classroom.

2. ICT Self-Perceptions of Early Childhood Teachers

The contributions and the trust that, little by little, the technologies are acquiring from educators, parents, and the students themselves have led to rethinking educational practice as a variety of resources are used and mastered in ECE classrooms [4,5]. However, the real integration of technologies for educational purposes in classroom practice has not been found in most of the studies carried out [6,7].

The integration of technologies in the curriculum has significant implications for teachers [8]. For them, the central problem is "change" [9]. Changes around the use of ICTs have a profound impact on teachers' work, such as the methods of instruction, the content of teaching, and their relationship with young children. All this has generated new expectations about their work and their roles to face digital challenges. This entails their incorporation into teaching practice. Multimodal digital forms of expression and communication offer a significant change in our culture and, therefore, in the challenges for educators [10].

Some of the studies carried out indicate that the factors that influence the integration of ICT in classrooms can be multiple and complex; others affirm that the effective use of ICT in education depends, to a large extent, on the way that teachers integrate it in teaching and learning [11,12]. In fact, the central role of teachers in the use of technologies indicates that a fundamental reason why they are not used, and are poorly integrated in the classroom, is directly related to the intentions and capacities of teachers to integrate them, more than with the lack of technology in the classroom [13,14].

For this reason, it must be borne in mind that rather than blaming pedagogy, the knowledge, and skills that early childhood teachers have, one should point to those psychological factors such as their self-perceptions of use. This fact will directly influence their integration in the classroom.

The psychological context of teaching, especially teachers' perceptions, is crucial to understand their daily work with ICT [15]. Thus, those perceptions that teachers have about the use of ICTs can strongly influence their practices in the classroom [16]. That is why it is significant that, unless teachers perceive ICT as valuable, they will not be willing or able to use it in a way that is productive in the teaching and learning processes [12]. Quite different is the case that teachers perceive that ICT is useful; there is a high probability that they will adopt them without any difficulty [16,17].

These studies infer that teachers' perceptions are a direct influencing factor in guaranteeing the successful use of technologies in the classroom. Deferments studies [18] find a high correspondence between teachers' perceptions and pedagogical practices. Teachers' positive perceptions of the benefits of technologies influence the frequency of use of technologies in the classroom. Teachers' beliefs and perceptions are important as they provide the best indicators of the decisions individuals make throughout their lives. Therefore, they act as guides for thinking and behavior and positively influence individual work and learning practices [19].

The investigations cited above argue that teachers' self-perceptions of learning and teaching are the true propositions that a teacher considers. These propositions are developed during the years that teachers spend in school: first as students (during their initial training) and, later, as teachers. It is with time and use that these beliefs or propositions become solid and robust. In this sense, several large groups could be established: content mastery vs. student orientation; transmission of information by the teacher vs. learning by the student; and direct reception/transmission vs. constructivism.

Although it is true that the study of teachers' perceptions on the integration of technologies in classrooms has been a recurring theme for years, it should also be noted that this has been focused, almost exclusively, on the stages of primary, secondary, and university education. Therefore, in particular, research on the perceptions and utilization strategies of infant teachers related to ICT in ECE is much scarcer than at other educational levels, almost non-existent. It is a topic that, as has been already mentioned, parents and educators are very concerned about: the profound impact that technologies are having on experiences, in addition to the learning outcomes, of children in the first years of schooling [20].

This article pays full attention to the importance of knowing whether the self-perceptions that students in the early childhood education university degree program have about working with ICT throughout their initial training may constitute an influential factor in the integration of technologies in their future classrooms.

3. Initial Training of Early Childhood Teachers: Digital Competences

The training of future teachers in digital competences can be known through the different syllabi that are offered. In the specific context of this research, we looked at the Faculty of Education Sciences of the University of Seville (Spain). Despite the efforts and changes carried out in recent years, there are still great differences when it comes to equating the initial training offered to students from different European universities. These differences do not refer to elements of content and objectives, nor to their approach, since all universities offer technological literacy through the acquisition of basic knowledge about technological means, basic ICT skills, and knowledge of how to integrate the basic tools in the curriculum or in its methodology [21]. Ultimately, its purpose is to make students know how, where, and when to use ICT.

The big difference lies in how this subject is included in the different study plans. The Andalusian Community, in which our study university is located, is an example. Of the eight existing universities, in four it is a "basic subject", in two of them "optional", and in the other two it does not even exist, as such. This panorama does not offer clarity regarding the importance and role of technologies in the studies of the early childhood education degree. More specifically, it raises inequality of knowledge, competencies, and skills among the students of the different universities who acquire training in digital skills for incorporation into infant education classrooms [22].

Some studies show that the level of digital competence of early childhood students is not in line with the fact that they are "digital natives" [23]. This idea is questioned in a few scientific works [24–29]. It is possible that teachers are digitally competent in other types of activities or tasks carried out in moments of inactivity and free time or leisure [30]. However, most teachers do not have enough digital competence to use ICT in their professional careers [21].

Adequate digital initial training makes students better perceive themselves in their development of critical thinking, problem solving, and decision making, as well as the fact that it will increase their creative capacity and influence them to be more innovative, as demonstrated by the findings obtained in different studies [22]. However, these teachers not only need a technological "training", but also to strengthen and cultivate membership in learning communities where teachers, researchers, technology experts, and policy makers can meet to discuss and reflect on the pedagogical possibilities of integrating technologies into the classroom. They need communities where, as pointed out in other works [31], common values and interests can be shared and their primary objective is the acquisition of knowledge, learning, skills, and competencies of their participants.

4. Digital Teaching Competence and Pedagogical Knowledge

Leaving aside the differences found in the way of understanding the initial training of ECE teachers in technological competences, note that the digital competence of teachers is related to all those skills, attitudes, and knowledge required by teachers in a digitized world [32]. It is also related to the use of ICT from a didactic –pedagogical perspective in a professional educational context [31].

There are different institutions that define the indicators that describe the digital competence of teachers through proposals that establish models or frameworks of digital competence. In them, the competences that teachers must develop in the technological field are classified with different dimensions and descriptors. With the purpose of knowing how the student of the infant degree is perceived in digital competence before and after receiving training, this study uses the theoretical works of the International Society for Technology in Education (ISTE) and the European Commission's Joint Research Center (JRC).

The ISTE has become one of the most important international benchmarks worldwide [33]. The ISTE stands out in establishing standards of technological competences and skills for teachers. The ISTE Standards for Educators aim to help teachers become digitally empowered learners [34]. The six categories or dimensions referred to are below.

A. Creativity and innovation: creative thinking, knowledge construction, and development of innovative products and processes using ICT.
B. Communication and collaboration: use of digital media and environments to communicate and work collaboratively, even at a distance, to support individual learning and contribute to the learning of others.
C. Research and information management: use of digital tools to obtain, evaluate, and use information.
D. Critical thinking, problem solving, and decision making: using critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions, using appropriate digital tools and resources.
E. Digital citizenship: understanding of human, cultural, and social issues related to ICT and practicing legal and ethical behavior.
F. Functioning and concepts of ICT: adequate understanding of the concepts, systems, and operation of ICT.

At the end of 2017, the European Digital Competence Framework for Educators (DigCompEdu) [35] appears. It is the product of a series of congresses, workshops, debates, and deliberations with experts and professionals. At the same time, it is built after a bibliographic review and involves a synthesis of existing instruments at the local, national, European, and international levels [36,37]. The result assumes a consensus on the main areas and elements of digital teaching competence, following a progressive logic in each competence area [38]. It is a model of digital competence for trainers and its areas of competence are as follows.

A. Professional commitment: focuses on teachers' working environment. Teachers' digital competence is expressed in their ability to use digital technologies not only to improve teaching, but also to interact professionally with peers, students, family, and different agents in the educational community.

B. Digital resources: related to the sourcing, creation, and distribution of digital resources. One of the key skills that any teacher must develop is to identify good educational resources. In addition, you must be able to modify, create, and share them to fit your goals, students, and teaching style. At the same time, you must know how to responsibly use and manage digital content, respecting copyright rules and protecting personal data.

C. Digital pedagogy: the fundamental competence of the entire "DigCompEdu" framework is knowing how to design, plan, and implement the use of digital technologies at different stages of the teaching and learning process. In addition, a change in approaches and methodologies that are focused on students is advocated.

D. Evaluation and feedback: linked to the use of digital tools and strategies in the evaluation and improvement of teaching–learning processes. Digital technologies can enhance existing assessment strategies and lead to new and better assessment methods. Furthermore, by analyzing the large amount of (digital) data available on individual student actions, teachers can offer more specific feedback and support.

E. Empowering students: use of digital tools for student empowerment. One of the key strengths of digital technologies in education is their potential to promote the active participation of students in the learning process and their autonomy over it.

F. Facilitate the digital competence of the students: on how to develop and facilitate the digital citizen competence ("DigComp") of the students.

Taking these competences into account, six levels or progressive management profiles were established, identifying the level of digital competence of a teacher as a newcomer (A1), explorer (A2), integrator (B1), expert (B2), leader (C1), and pioneer (C2). These profiles were used in this study to know the level of self-perceived competence of the students of the ECE university degree program at the University of Seville.

In Table 1, these profiles are described according to the complexity of a task with ICT, teacher autonomy, and required cognitive domain.

These frameworks serve to develop the model for analyzing the digital skills of university students [39]. It was configured into 6 dimensions and 44 indicators. Figure 1 represents the broad categories corresponding to digital skills.

Figure 1. Digital competences of university student. Adapted from reference [38].

Table 1. Interpretation of European Digital Competence Framework for Educators (DigCompEdu) framework competence levels.

Profile	Level	Task Complexity	Autonomy	Cognitive Domain
Newcomer	A1	Simple task	Need for guidance	Remember
Explorer	A2	Well-defined routines and routine problems	Personal autonomy	Understand
Integrator	B1	Variety of tasks and problems	Guide others	Apply
Expert	B2	Most appropriate tasks to solve a problem	Adaptive capacity in complex contexts	Evaluate
Leader	C1	Solving complex problems with limited solutions	Integration into professional practice	Create
Pioneer	C2	Solving complex problems with a multiplicity of factors involved	Proposal of new ideas and processes	To question

5. Methodology

It was decided to carry out this cross sectional study to determine if there was an evolution after the specific training intervention in and with technology for teachers (subject of "Information Technology and Communication Applied to Early Childhood Education") with a duration of one semester, specifically October–January.

5.1. Objectives

The main objectives of this research were

- to discover the degree and type of self-perceived digital competence before and after taking the subject "Information and Communication Technologies Applied to Early Childhood Education" (O1);
- to determine if there were statistically significant differences in the self-perception of digital competence of the students of the Degree in Early Childhood Education at the University of Seville, after receiving a technological training (O2); and
- to show those profiles detected based on the perceived competence level (O3).

The work proposed a pretest–posttest methodology through a descriptive cross sectional study. This design did not modify the variables under study, but explored their nature and behavior in the participants who were part of the study [40].

5.2. Sample

The sample was made up of the students who were in the 4th year of the Degree in Early Childhood Education at the University of Seville during academic years 2016/2017, 2017/2018, and 2018/2019; there was a total of 535 students. The distribution was 184 from the 2016/2017 academic year, 242 from the 2017/2018 academic year, and 101 from the 2018/2019 academic year. For their selection, incidental or convenience criteria were chosen, according to their availability to answer the questionnaire [40]. Note that all groups, during the three academic years, received the same training by the same professor.

Most of the participants were women (93%). Regarding their technological profile, almost all had a personal computer (98.9%) and mobile devices (99.6%). Internet access and connection was almost generalized (99.8%). Most connect to the internet from anywhere (78%). Only some did it from home (18%), or exclusively at the university (3%). Finally, all the participants used the Internet daily, with connections of more than 10 h a week (66%), between 5 and 10 h (31%), and 1 h or less (3%).

5.3. The Instrument

The "Questionnaire for the Study of the Digital Competence of the Student of Higher Education" or CDAES [39] is used. This validated and designed ad-hoc questionnaire, with 10-interval Likert-type scaling, includes the following sections.

1. Sociodemographic characteristics and use of technologies: participants were asked about their gender and questions related to their experience of Internet use, access device, and frequency of use.
2. Forty-four items with Likert scaling to assess students' self-perception: they respond to six competency dimensions, as explained in previous paragraphs (Figure 1):

   A. Technological literacy: digital competence is knowing how to plan and implement the use of digital technologies in different contexts [41].
   B. Search and treatment of information: related to the sourcing, creation, and distribution of digital resources. Citizens must be able to modify, create, and share them [42].
   C. Critical thinking: analyze, understand, and evaluate to plan and conduct research, manage projects, and make informed decisions using appropriate digital tools and resources [43,44].
   D. Communication and collaboration: digital competence is related to the ability to use digital technologies to interact with friends, coworkers, students, and family [45,46]. Furthermore, this communication through technology allows individual professional development and collective and continuous innovation in any type of organization [37].
   E. Digital citizenship: related to knowing how to use and manage digital content responsibly, respecting copyright rules and protecting personal data [47]. In addition, any digital citizen is committed to their training throughout life [35].
   F. Creativity and innovation: use of innovative digital tools to modify existing elements in order to improve them [35]. Innovation with ICT is related to the exploration and use of emerging technologies [48], simulations [49], and problem solving methodology [36,46].

Regarding the reliability of the questionnaire for the sample under study, internal consistency was obtained using the Cronbach's alpha coefficient as a whole and by dimensions. The results indicated a very high level of reliability ($\alpha = 0.975$) globally [50]. In addition, the reliability that is obtained in the dimensions also has a high level: technological literacy ($\alpha = 0.910$), information search and treatment ($\alpha = 0.879$), critical thinking ($\alpha = 0.879$), communication and collaboration ($\alpha = 0.929$), digital citizenship ($\alpha = 0.888$), and creativity and innovation ($\alpha = 0.941$). These results coincide with those carried out in previous validation studies of the instrument [39].

5.4. Procedure and Data Analysis

The questionnaire was done in a digital format, through the "Google Forms" platform. Data collection was carried out in the subject at the beginning and at the end of the semester in which it took place (first semester, that is, from September to February, approximately). The aims of the study were explained by the responsible teacher, and the collaboration of the students was requested. At all times, the anonymity of the participants was assured.

Descriptive analyses based on central tendency and dispersion were performed (O1, O3). In addition, contrast statistics were applied to make a comparison of the scores obtained (O2, O3). Specifically, Mann–Whitney U test and Cohen's d effect size were used to assess the magnitude of the differences between the pretest and posttest (O2). The Kruskal–Wallis H test was also applied to compare the proposed competency profiles that were the object of study (O3). In parallel, it was verified that data was not normally distributed through the study of asymmetry and kurtosis. The Kolmogorov–Smirnov test confirmed this check, with significance (p-value) equal to 0.000 for all items (non-normal distribution). The data obtained were analyzed with SPSS software (v.23).

6. Results

Following the objectives of the study set out, we offer those data that show the degree and type of self-perceived digital competence before and after completing the subject "Information and Communication Technologies Applied to Early Childhood Education" (O1).

Data indicate that students had a medium-high perception of their digital skills in all the areas that were included in the study, although the areas of communication and collaboration ($\bar{x}$ = 6.04; σ = 7.62) and critical thinking ($\bar{x}$ = 6.22; σ = 1.79) received the lowest scores. Digital citizenship ($\bar{x}$ = 7.62; σ = 1.67) and search and treatment of information ($\bar{x}$ = 7.00; σ = 1.54) were the areas with the highest scores. In relation to the data obtained after completing the subject (posttest), an increase was observed in all areas of competence. In other words, the students' self-perception improved, leaving all of them above 7 points. Compared to the pretest, Digital citizenship was the area that increased to a lesser extent, with a 0.52 point difference. At the same time, the area of communication and collaboration had the highest increase compared to the pretest, with a 0.98 point difference. Figure 2 visually shows the scores obtained for the pretest and posttest, as well as the growth in self-assessment.

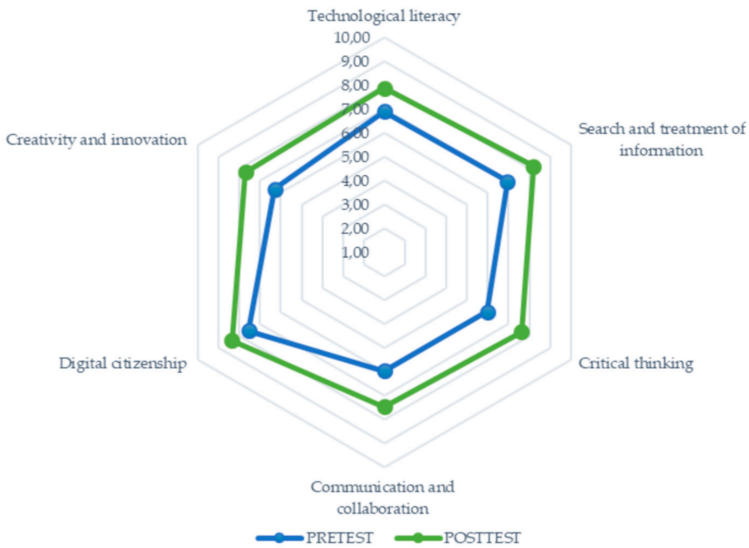


Figure 2. Self-perception of digital competence by dimensions.

Table 2 shows the data obtained from the self-perception of digital competence before and after taking the ICT subject applied to early childhood education, broken down by each academic year that was studied.

As can be seen, there were no major differences from the global data. The areas of communication and collaboration, along with critical thinking, received the lowest score. At the same time, the area of digital citizenship was the most valued during the three academic years. During the academic year 2018/2019, greater growth was observed in each area. Even so, there were no major differences compared to the 2016/2017 and 2017/2018 courses. These data were expanded and nuanced in the results obtained in the contrast tests.

To answer whether there were statistically significant changes between the students' self-perception of digital competences before and after taking the ICT subject (pretest–posttest), as well as to discover if there were significant differences taking the academic year (O2) as a contrast variable, Mann–Whitney U non-parametric contrast tests were applied with Cohen's d calculation for more than two related samples (Table 3) and Kruskal–Wallis (Table 4).

According to the data obtained, the training received by students (ICT) was an important element to improve self-perception of their digital skills. All the areas of competence listed had a significance level of less than 0.05; we can confirm with a confidence level of 99% that there were statistically significant changes between before and after completing the subject. Considering the value of d, the magnitude of these differences can be considered moderate.

If Table 4 is observed, where the average ranges are shown, the changes produced always meant an improvement in the students' self-perception; that is, the students perceived that they improved in all the areas that make up digital competence.

Table 2. Self-perception of digital competence by dimensions and academic year.

Year	Type	Technological Literacy		Search and Treatment of Information		Critical Thinking		Communication and Collaboration		Digital Citizenship		Creativity and Innovation		Total	
		x̄	σ	x̄	σ	x̄	σ	x̄	σ	x̄	σ	x̄	σ	x̄	σ
Global	Posttest	7.56	1.99	7.88	1.60	7.10	2.25	7.02	2.31	8.14	1.75	7.34	2.03	7.51	1.78
	Pretest	6.98	1.89	7.00	1.54	6.22	1.79	6.04	2.26	7.62	1.67	6.5	1.96	6.73	1.49
2016–2017	Pretest	7.16	1.55	7.05	1.52	6.65	1.38	6.21	1.88	7.67	1.46	6.82	1.91	6.93	1.26
	Posttest	8.06	1.50	8.76	1.26	8.35	1.28	8.00	1.60	8.71	1.61	8.35	1.16	8.37	1.29
2017–2018	Pretest	6.59	2.35	7.10	1.46	5.75	2.19	5.82	2.85	7.72	1.83	6.16	1.82	6.52	1.70
	Posttest	7.24	2.08	7.60	1.64	6.60	2.41	6.62	2.49	7.93	1.86	7.02	2.16	7.17	1.87
2018–2019	Pretest	6.95	2.11	6.68	1.67	5.52	1.98	5.82	2.39	7.31	2.04	5.96	2.16	6.37	1.73
	Posttest	8.30	1.72	8.20	1.42	7.92	1.56	7.70	1.72	8.46	1.31	7.75	1.74	8.06	1.39

Table 3. Mann–Whitney U test with pretest–posttest grouping variable.

	Technological Literacy	Search and Treatment of Information	Critical Thinking	Communication and Collaboration	Digital Citizenship	Creativity and Innovation	Total
U Mann–Whitney	27,979.000	23,939.500	24,533.500	25,459.000	27,723.500	26,088.000	24,550.500
D Cohen	0.299	0.560	0.433	0.429	0.304	0.421	0.316
Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 4. Average ranges by dimensions.

Dimension	Pretest/Postest	Average Range	Sum of Ranges
Technological literacy	pretest posttest	238.58 289.71	63,224.00 75,904.00
Search and treatment of information	pretest posttest	223.34 305.13	59,184.50 79,943.50
Critical thinking	pretest posttest	225.58 302.86	59,778.50 79,349.50
Communication and collaboration	pretest posttest	229.07 299.33	60,704.00 78,424.00
Digital citizenship	pretest posttest	237.62 290.69	62,968.50 76,159.50
Creativity and innovation	pretest posttest	231.45 296.93	61,333.00 77,795.00

To check if there were differences between the academic years and the level of self-perception of digital competence, the Kruskal–Wallis H test was applied. Table 5 shows the results obtained.

Table 5. Kruskal–Wallis results test academic year.

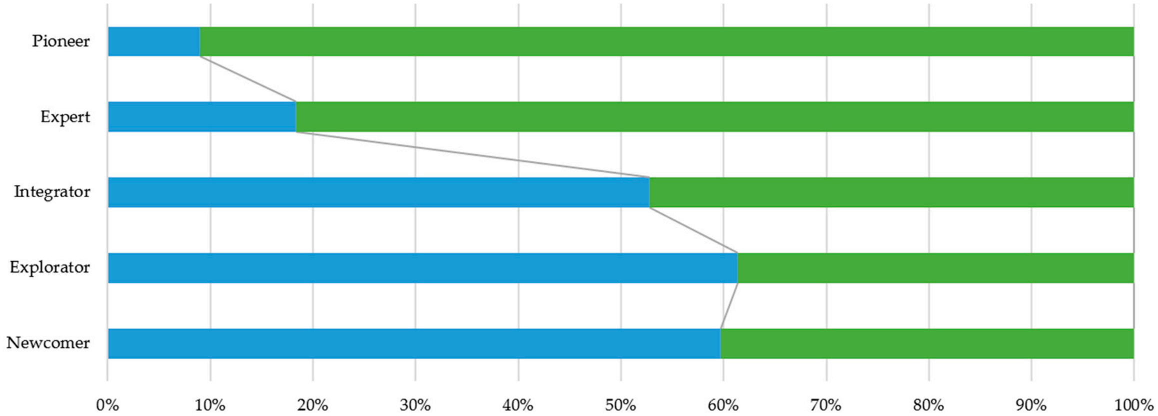
	Technological Literacy	Search and Treatment of Information	Critical Thinking	Communication and Collaboration	Digital Citizenship	Creativity and Innovation
Chi squared	8.144	0.680	5.316	2.632	0.813	3.613
gl	2	2	2	2	2	2
Sig.	0.070	0.712	0.070	0.268	0.666	0.164

The data obtained indicated that no statistically significant differences were obtained in the students' self-perception of their digital skills between the different academic courses under study. The results of the KW test for all the variables, the Chi-square value, presented a significance level greater than 0.05 ($p > 0.05$). The average range analysis (Table 6) indicated that the values obtained in the three courses under study did not demonstrate large differences, although higher values were observed in the academic year 2018/2019.

Table 6. Average ranges in academic year.

Dimension	Year	Average Range
Technological literacy	2016/2017 2017/2018 2018/2019	259.43 251.74 301.71
Search and treatment of information	2016/2017 2017/2018 2018/2019	258.71 263.79 274.15
Critical thinking	2016/2017 2017/2018 2018/2019	278.26 247.47 277.64
Communication and collaboration	2016/2017 2017/2018 2018/2019	255.65 261.49 285.23
Digital citizenship	2016/2017 2017/2018 2018/2019	255.99 267.56 270.07
Creativity and innovation	2016/2017 2017/2018 2018/2019	280.10 251.92 263.60

To respond to the third objective of the study (O3), profiles were identified based on the perceived level of competence, following the nomenclature used in the DigCompEdu Digital Teaching Competence Framework presented in the theoretical framework of this article (Table 1). They established five different profiles according to the domain of digital competence: newcomer (0 to 4.9 points), explorer (5 to 6.9 points), integrator (7 to 8.9 points), expert (9 to 9.49 points), and pioneer (9.5 to 10). For this, an analysis was performed according to the total score obtained (Figure 3).



	Newcomer	Explorator	Integrator	Expert	Pioneer
PRETEST	13.58	38.87	42.64	3.77	1.13
POSTTEST	9.16	24.43	38.17	16.79	11.45

Figure 3. Percentage of students in each profile.

In the pretest, the subjects were grouped around the lowest profiles: novice (13.58%) and explorer (38.87%). In the posttest, most of the subjects are grouped around the highest profiles: integrator (38.17%), expert (16.79%), and pioneer (11.45%). The results were repeated if the answers are broken down by academic year.

To check if these differences were statistically significant, a Kruskal–Wallis H test was performed (Table 7).

It can be said with 99% confidence that there were statistically significant differences ($p = 0.000 < 0.01$) between the pretest and posttest results in the different profiles. The average range analysis indicated that the main differences occurred between the newcomer and pioneer profile (in favor of the pioneer profile). A pioneer is one who questions contemporary digital and pedagogical practices, of which they are experts. They lead innovation with ICT and are a role model for other teachers.

In the following table (Table 8), the scores obtained by each profile in the different dimensions and globally can be observed.

In the posttest, all profiles gave lower scores to the areas of "communication and collaboration" and “critical thinking”. In contrast, the “information search and treatment areas” and “digital citizenship” always received the highest score. The “novice” profile also stood out in the area of information search and treatment.

Table 7. Kruskal–Wallis profile test results.

	Technological Literacy		Search and Treatment of Information		Critical Thinking		Communication and Collaboration		Digital Citizenship		Creativity and Innovation		Total	
	Pret	Post	Pret	Post	Pret	Post	Pret	Post	Pret	Post	Pret	Post	Pret	Post
Chi squared	157.886	197.894	162.581	194.142	149.220	201.796	160.741	201.572	105.967	172.506	154.865	204.889	227.492	241.053
Sig.	0.000		0.000		0.000		0.000		0.000		0.000		0.000	

Table 8. Score obtained by competence profile.

		Technological Literacy		Search and Treatment of Information		Critical Thinking		Communication and Collaboration		Digital Citizenship		Creativity and Innovation		Total	
		x̄	σ	x̄	σ	x̄	σ	x̄	σ	x̄	σ	x̄	σ	x̄	σ
Newcomer	Pre	4.13	1.64	5.40	1.22	3.65	1.59	3.01	1.59	5.90	1.82	3.81	1.33	4.32	0.71
	Pos	3.96	1.55	5.25	1.26	2.90	1.33	2.38	1.17	5.21	1.39	3.60	1.60	3.88	0.57
Explorator	Pre	6.40	1.31	6.19	1.19	5.61	1.13	5.11	1.59	6.98	1.42	5.75	1.59	6.01	0.58
	Pos	5.98	1.20	6.63	1.02	5.38	1.49	5.33	1.46	6.77	1.26	5.70	1.01	5.97	0.53
Integrator	Pre	8.11	0.99	7.97	0.86	7.33	1.09	7.44	1.28	8.51	1.04	7.73	0.98	7.85	0.56
	Pos	8.02	0.98	8.04	0.83	7.60	1.11	7.58	0.94	8.57	0.98	7.80	0.93	7.93	0.55
Expert	Pre	9.60	0.52	9.20	0.54	8.10	1.07	9.60	0.52	9.60	0.39	9.10	0.70	9.20	0.18
	Pos	9.25	0.61	9.43	0.48	9.05	0.52	8.93	0.79	9.55	0.85	9.07	0.70	9.22	0.14
Pioneer	Pre	9.67	0.58	10.00	0.00	9.67	0.58	10.00	0.00	10.00	0.00	9.67	0.29	9.83	0.14
	Pos	9.83	0.38	9.83	0.36	9.58	0.47	9.70	0.47	9.90	0.24	9.78	0.36	9.77	0.20

7. Discussion and Conclusion

There is a dilemma that worries the university teachers responsible for training their students in information and communication technology (ICT) at the university degree of early childhood education level: knowing and coming to understand what reasons explain the low presence of technologies and its didactic–curricular applications at this educational level. It is here where our study focused, based fundamentally on two variables that, as other previous studies demonstrate, were considered determinants to answer the questions asked.

An idea that confirms this work is the studies carried out on the need to include in the initial training of these future professionals a specific training to develop digital competence [51–53]. Specifically, a study [54] focused on the analysis of the situation of educational technology in the degrees of education offered by Spanish universities after the implementation of the European Higher Education Area (EHEA) concluded that the presence of educational technology had not increased compared to previous study plans. It should also be considered, reference [55] suggests, that the problem of the quality of university studies does not lie so much in the curricula, but in the professors of teaching careers, as it is the origin of the training cascade. There are great professors in the universities; these issues should not be ignored. Three problems that affect initial teacher training are (1) the pedagogical inconsistency that often occurs in terms of teaching planning and didactic communication; (2) the culture of credit cakes, which contribute to student and school forgetfulness and skews the curricular offer of universities; and (3) the crisis of educational originality of an important part of texts intended for training, all the more so if they have been written by researchers who have not worked in non-university teaching long enough.

It is necessary to promote changes in the current curricula for education degrees, as the subjects remain very similar to those in previous plans [56–59].

It has been demonstrated, and thus one of the main objectives set out in the study, once the post-test data was obtained, an increase could be observed by students in all areas of competence, throughout the different years. This indicates that, from a formative point of view, the students of the Early Childhood Education degree who took the subject of “Information and Communication Technologies Applied to Early Childhood Education” presented a moderate increase in the self-perception of the different informational competences linked to the integration of ICT in the curriculum of children, such as creativity and innovation.

On the other hand, one of the great challenges of teacher training today is the one that is intended to identify the different proficiency profiles of the teacher, as demonstrated by a multitude of studies and research carried out [32,48,60]. Although with regard to the educational stage of early childhood education, we can conclude that, due to the evolution experienced in the three academic years, the profile (level) of the student body went from a low profile to a medium-high profile once the adequate training to develop digital skills through the subject of ICT in early childhood education. In other words, students identified themselves with a “newcomer” and “explorer” profile before receiving the training action and, once completed, they perceived themselves as “integrator” and “expert”.

All this reaffirms the importance of and need for university degrees to be carried out when promoting and offering adequate training to ensure that the student perceives he or she is sufficiently trained to incorporate technologies in a professional future, in the day-to-day in the early childhood education classrooms. As mentioned above, it is not only necessary to manage training plans sufficiently to allow them to position themselves at an expert level, but also that said training be given by committed and trained teachers.

In a study aimed at defining the most valuable dimensions on which initial training of Early Childhood Education teachers is based, it concluded that digital competence was the least relevant. Along the same lines, reference [61] evaluate the digital skills necessary for undergraduate students in early childhood education to become professionals in education. This research reports the students’ skills were below expectations and this continues to demonstrate that training is crucial for good self-perception.

These results on their competences also coincide with those obtained in other investigations on a low-level self-perception of the students [62], which leads them to believe that they are not prepared to adapt digital resources due to their low level in the creation of digital materials [63]. Furthermore, as other research points out, most ECE students manifest a low use of ICT tools to put them into practice in the creation and adaptation of digital content [64]. Taking into account the results obtained, ICT training is a crucial requirement in the initial training of early childhood education teachers, and it is necessary to analyze the influencing factors in the level of digital competence of the teachers to understand the problems they encounter in their teaching practice [65].

Therefore, the deficiencies regarding the use of the technologies found in children's classrooms are determined by these major factors: study plans and training of trainers. It is necessary to reinforce the dimension of pedagogical knowledge of technology to know, understand, and apply its didactic and methodological use in teaching–learning processes. It should not be forgotten that in this educational stage the presence of technologies is still scarce and, in most cases, those teachers who venture to incorporate them use their own resources.

This work presents a series of limitations when it comes to providing generalizations. This is due to limiting a specific Faculty of Education, as well as the sample size. For this reason, attempts have been made to correct them by carrying out the cross sectional study through the three academic years. These findings support the need for studies and research related to this topic. In addition, according to the section "Sustainable Education and Approaches", this topic is integrated into its line of interest, which is related to education, culture, and economic and social sustainability.

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