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# Digital Competence of Training Teachers: Results of a Teaching Innovation Project

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**Abstract:** Today's society is characterised by the impact of technology in all areas of life, which is why promoting the development of digital competence in future preschool and primary school teachers is key to achieving a digitally competent population and promoting social progress from schools. This paper describes the implementation of a funded teaching innovation project developed with students of the Degrees in Preschool Education and Primary School Education at the University of Valencia, Spain. The main objective was the development of digital competence from a cross-cutting perspective. The analyses confirm the improvement of the participants in all areas of digital competence and the influence of gender on the results obtained. This highlights the impact of the intervention for the improvement of technological skills for future teachers.

**Keywords:** digital competence; initial training; teachers; innovative project

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## 1. Introduction

It is an indisputable fact that we live in a digital society where much of our daily lives are mediated by technology. Technology has progressively integrated into our personal relationships (modifying the way we socialise and communicate), into the way we develop our jobs and, clearly, also into the way we learn, immersing us in a social and cultural environment in the process of digitalisation.

So much so that educational institutions, in accordance with international and national regulations of various kinds and natures, have become largely responsible for ensuring that pupils (citizens) develop, in the school context, skills that enable them to function effectively in society.

The starting point of these guidelines is linked to the recognition by different supra-national organisations [1,2] that digital competence is one of the key competences that everyone should develop throughout their lives, on par with more traditional skills such as language learning or mathematical literacy.

This milestone helped many nations, including Spain, to start integrating digital competence as a key element of their education system, making contents on this subject more explicitly present in the regulation of the different educational stages, as well as in the training of future teachers.

In the case of teacher training, the creation of the European Higher Education Area and the reformulation of curricula provided a first opportunity to bring this area closer to technology. There has also been an international effort to identify the competences teachers require so they can keep providing an adequate service today. In recent years, this has led to the development of several frameworks such as the ISTE Standards for Educators: A Guide for Teachers and Other Professionals [3] or UNESCO's ICT Competency Framework for Teachers [4]. At the institutional level, the European Union has also worked along these lines, creating the European Digital Competence Framework for Educators (DigCompEdu) [5], and, in our country, leading to proposals such as the Common Digital Competence Framework for Teachers by the National Institute of Educational Technologies

and Teacher Training [6,7]. More recent regulations include the Resolution of 4 May 2022 of the Directorate-General for Territorial Evaluation and Cooperation, which publishes the Agreement of the Sectoral Conference on Education on the updating of the reference framework for digital competence in teaching.

However, all these initiatives have failed to materialise in an effective way if we consider them in the light of analyses of initial teacher training, which have shown that there has been a lower presence of digital content in recent years [8] and no effective inclusion of content and skills to promote digital competence due to a dispersion in the integration of ICT content in the curricula [9].

This reality clashes head-on with the advance of society towards a technological paradigm, which requires reflection on teacher training and the conditions in which teaching work is carried out [10]. This reflection should be aimed at promoting the digital competence of trainee teachers from a broad perspective (instrumental, pedagogical, and personal) to improve digital citizenship [11].

The concern regarding training and competences is not new, and there is a consensus about the importance of this area for the training of future teachers [12]. A number of previous studies have already analysed the level of digital competence of teacher trainees, highlighting that there are differences between their skills in different areas [13], proving that they have more extensive skills in the areas of communication and information [14] and greater difficulties in content creation [15], the creative use of technology [16], and the areas of safety and problem solving [17,18].

These studies have also revealed gender-related differences in the self-perception of competence. In this sense, recent studies [19–21] conclude that men have higher self-perceived technological skills than women, especially regarding safety and problem solving. There are also differences based on other variables such as age, with younger participants perceiving themselves as more competent [22,23].

We must bear in mind, however, that all these studies are based on self-perception, and that they may be merely idealisations [24] to be confirmed or refuted.

Under the consideration that digital competence is a multidimensional construct that encompasses the set of knowledge and skills necessary for a responsible use of technologies, we consider that the development of digital competence and the effective use of technology by future teachers as key due to the impact it has today on the organisational and educational functions associated with the teaching role in schools [25], as well as on specific issues such as attention to diversity [26,27].

Taking into account all these considerations, the aim of this study is to analyse the self-perception of students of the Degrees in Preschool Education and Primary School Education with respect to their actual digital competence, as well as their potential improvement in all digital competence areas after participating in a teaching innovation project, and the influence that variables such as gender and the year they are currently studying may have on these results.

## 2. Materials and Methods

### 2.1. Participants

To determine the sample (Figure 1), a pre-analysis of study potential was carried out using the G*Power 3.1 software to conduct a repeated measures ANOVA test with intra- and inter-subject interaction analysis for the three different years of degrees (first, second, and third year) and the two gender groups. The effect size was f(V) = 0.20 and the power was 1-β = 0.95, which indicated a sample of 102 subjects. A total of 198 observations were recorded from 99 subjects (21.7% were men and 78.3% were women) who were students of the Degree in Education (there were 44.4% first-year students; 48.5% second-year students, and 7.1% third-year students).

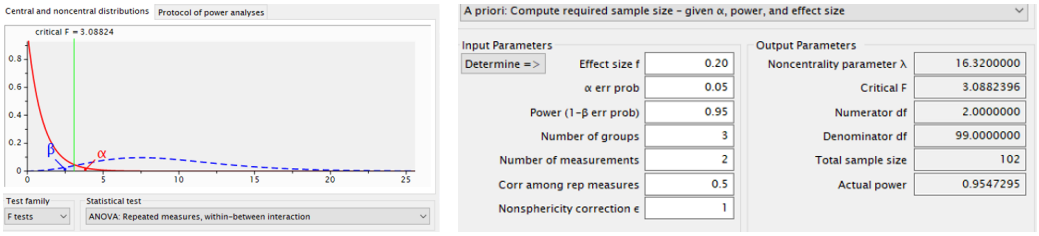



**Figure 1.** Sample calculation.

### *2.2. Instruments*

The instrument used was a questionnaire adapted from the DigComp project in the European Framework for the Digital Competence of Educators. The questionnaire was shared using Google Forms. The responses used a Likert scale. The form was divided into two parts, one focusing on the collection of socio-demographic information and another focusing on teachers' digital competence. After a brief introduction with an informed consent form and the request for socio-demographic data, there was a question about the students' prior self-perception of digital competence, followed by 21 questions grouped into the five areas of DCC (Table 1), and finally a question to reassess the students' self-perception after completing the questionnaire.

**Table 1.** Summary of the questionnaire structure.

| *PARTS* | BLOCKS | TOPIC |
|---|---|---|
| *1* | I | Socio-demographic data |
| *2* | II | Self-diagnosis of digital competence |
| | III | Areas of Digital Competence in Education<br>Area 1. Information and data literacy<br>Area 2. Communication and collaboration<br>Area 3. Digital content creation<br>Area 4. Safety<br>Area 5. Problem solving |
| | IV | Self-perception after completing the questionnaire |

### *2.3. Procedure*

This research project is divided in a total of six phases that took place over the academic year 2021–2022 (Figure 2).

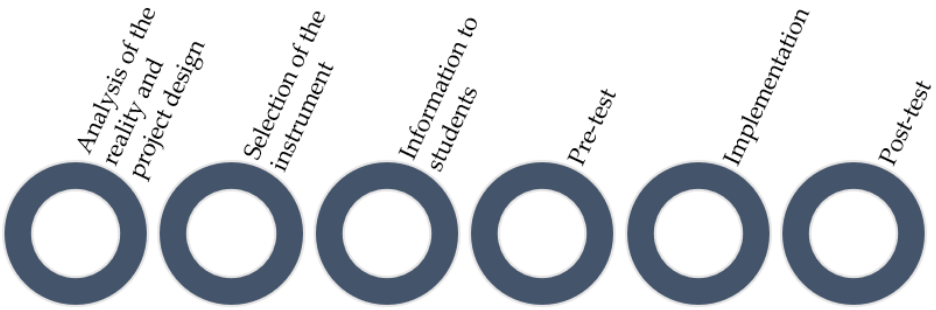



**Figure 2.** Phases of the process.

After prior reflection based both on the work carried out during previous years and on the educational needs arising from the situation caused by the COVID-19 pandemic, the first phase involved the design of a Teaching Innovation Project (TIP) that integrated resources, methodologies, and activities combining the principles of face-to-face training with digital competence and autonomous and collaborative student work.

Subsequently, after a series of coordination meetings of the teachers involved in the project, the second phase consisted of the selection of the data collection instrument. In this case, a questionnaire was developed based on the Common Digital Competence Framework for Teachers (INTEF, 2017) to facilitate the initial assessment of the technological skills of students in the Degree in Primary School Education.

Thirdly, students were provided with information about the project they were participating in, detailing the main objectives, as well as the specific actions that would be carried out in the different subjects involved in the project. An explanation was provided in the first face-to-face classroom session, and the briefing was also posted in the Virtual Classroom.

The fourth phase was the pre-test evaluation. To this aim, the questionnaire—previously created in Google Forms and uploaded to the Virtual Classroom—was shared with the students in a face-to-face session. Filling in the questionnaire was completely voluntary. In addition, and to obtain more responses, a reminder was sent to them after a few days, in which they were encouraged to fill it in.

Then, in the fifth phase, which ran from September 2021 to May 2022, the training programme was implemented through a series of activities (detailed in Table 2).

**Table 2.** DC development activities.

| Digital Competence Area | Proposal | Activity |
| --- | --- | --- |
| Information and data literacy | Conceptual approach<br>Theoretical reinforcements | Bibliographic and press search.<br>Recommended reading and viewing of short videos. |
| Communication and collaboration | Construction of individual and collective meaning | Sharing through the blog "Promoting digital competence". |
| Digital content creation | Practical work<br>Webinar | Training seminar with experts on gamification and video games as inclusive educational resources.<br>Production of a visual resource (video, audio, drawing [visual thinking], presentation, etc.). |
| Safety | Webinar | Training seminar with experts on digital transformation in educational centres. |
| Problem solving | Practical work<br>Individual and group tutoring | Accompaniment and guidance in the teaching and learning processes via videoconferencing.<br>Resolution of practical cases. |

The first activity, linked to the area of information and media literacy, consisted of carrying out a bibliographic search to find out the state of the art and share interesting documents for the development of the subject. Some recommendations were provided on where to look for information (scientific databases), as well as search terms (descriptors), and search strategies (Boolean operators).

For the second activity, aimed at improving communication and collaboration, indications were given on how to access and participate in a blog created ad hoc for the innovation project. In this blog, resources created by both teachers and students themselves were incorporated, generating a space for the exchange and collaborative construction of knowledge.

In order to work deeper into the area of content creation, in the third activity, a seminar on gamification in attention to diversity was given by a teacher who was an expert in video games, and the creation of a resource by the students was proposed.

The fourth activity, focused on the area of security, consisted of a webinar on the digital transformation of educational centres and the implications of the secure use of information in them.

Finally, to address the area of problem solving, the fifth activity was developed through individual and group tutoring in order to facilitate the resolution of the practical cases proposed in the framework of the subjects.

The sixth phase concluded with the post-test evaluation, to validate the intervention and to identify the students' final level of digital competence.

### 2.4. Variables

The dependent variables analysed were:

1. The different types of digital competence were analysed based on the five areas (Table 2) and were named DC_Information, DC_Communication, DC_Creation, DC_Safety, and DC_Problem_solving.
2. Actual_DC_3: The average digital competence score for each area, measured on a scale from 1 to 3.
3. Actual_DC_6: The average digital competence score for each area, but adjusting Actual_DC_3 values to a scale from 1 to 6, so that Actual_DC_6= 1+ ((1- Actual_DC_3) *2.5).
4. PDC evolution: Intra-subject variable comparing pre-questionnaire PDC with post-questionnaire PDC, as well as before and after the pedagogical intervention.
5. PDC/DC match: Intra-subject variable comparing average pre-questionnaire PDC with DC, before and after the pedagogical intervention (DC-PDC).

The independent variables were:

1. Effect of the intervention: Intra-subject variable comparing pre-intervention and post-intervention values.
2. DC area: The different types of digital competence were analysed based on the five areas (Table 2), and were named as DC_Information, DC_Communication, DC_Creation, DC_Safety, and DC_Problem_solving.
3. Gender: Two categories, men and women.
4. Degree year: Three categories, 1st-, 2nd-, and 3rd- year students.

### 2.5. Data Analysis

Data analysis was performed using the SPSS v28.0 software (IBM, Chicago, IL, USA). The mean and standard deviation were used as indicators. Tests for normality and homogeneity of variances were performed beforehand. To compare the effects of the intervention, gender, and studied year on the areas of digital competence, as well as the effect of the questionnaire on PDC and PDC-to-DC match, mixed ANOVA tests were conducted with the intra-subject intervention variable—two measurements (pre- and post-intervention)—and gender as an inter-subject variable, with two categories (men and women). Pairwise comparisons tests with Bonferroni significance correction were requested.

To compare the evolution of PDC for each gender and year, and to compare between the different types of DC, Friedman tests were performed with subsequent pairwise Wilcoxon tests, correcting for significance according to Bonferroni. Significance was adjusted for $p$-values < 0.05.

## 3. Results

### 3.1. Intervention

The intervention significantly improved all areas of digital competence (Table 3): DC_Information ($F_{40}$ = 15.1; $p$ <.001; eta = 0.28), DC_Communication ($F_{40}$ = 42.8; $p$ < 0.001; $\eta^2$ = 0.52), DC_Creation ($F_{40}$ = 26.0; $p$ < 0.001; $\eta^2$ = 0.4), DC_Safety ($F_{40}$ = 34.9; $p$ < 0.001; $\eta^2$ = 0.34), and Actual_DC ($F_{40}$ = 15.1; $p$ < 0.001; $\eta^2$ = 0.47), as well as Actual_DC_6 ($F_{40}$ = 38.4; $p$ < 0.001; $\eta^2$ = 0.50). The intervention changed the effect of completing the questionnaire PDC as well: there was a decrease between pre- and post-questionnaire PDC before the intervention; after the intervention, however, an increase was observed between pre- and post-questionnaire PDC scores (Table 3). Finally, the intervention significantly reduced the

difference between the post-questionnaire PDC and the Actual_DC_6 score measured in the questionnaire, resulting in a significantly better PDC_DC_match (Table 3).

**Table 3.** Effect of the intervention on the different areas of digital competence (DC), the effect of the questionnaire on the respondents' PDC, and the difference between perceived (PDC) and actual DC (Actual_DC_6).

| Variables | Moment | M | SD | Effect of the Intervention |
|---|---|---|---|---|
| DC_Information | Before<br>After | 1.61<br>1.98 | 0.42<br>0.35 | *** |
| DC_Communication | Before<br>After | 1.57<br>2.05 | 0.33<br>0.35 | *** |
| DC_Creation | Before<br>After | 1.44<br>1.9 | 0.34<br>0.44 | *** |
| DC_Safety | Before<br>After | 1.64<br>2.05 | 0.42<br>0.37 | *** |
| DC_Problem_solving | Before<br>After | 1.5<br>1.95 | 0.37<br>0.42 | *** |
| Actual_DC_6 | Before<br>After | 2.38<br>3.46 | 0.73<br>0.79 | *** |
| Questionnaire_PDC_effect | Before<br>After | −0.49<br>0.24 | 0.59<br>0.89 | *** |
| PDC_DC_match | Before<br>After | 0.67<br>0.44 | 0.68<br>0.63 | *** |

Note: *** $p < 0001$.

To analyse PDC evolution for each gender and year, Friedman tests were performed with subsequent pairwise Wilcoxon tests.

### 3.2. Comparison between DC Types

Comparing the values of the different areas of DC showed significant differences between before and after the intervention ($X_2 = 29.3$; $p < 0.001$). Thus, Area 1 (DC_Information) registered the highest values, and Area 3 (DC_Creation) registered the lowest. The comparison of these two areas was the most significant ($Z = -4.7$; $p < 0.001$). However, the improvements produced by the intervention in all areas (especially in these two) mean that there were no significant differences between the different areas after the intervention (Figure 3).

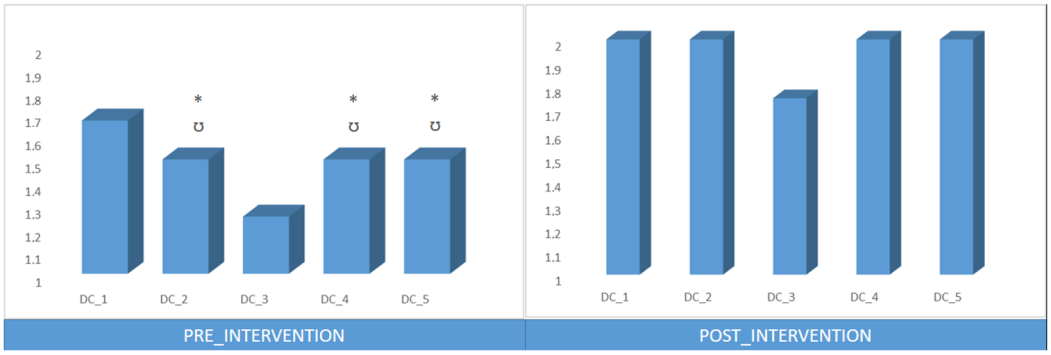



**Figure 3.** Comparison of areas DC_1 (DC_Information), DC_2 (DC_Communication), DC_3 (DC_Creation), DC_4 (DC_Safety), and DC_5 (DC_Problem_solving) before the intervention. Note: ∪ indicates significant differences with DC_1; * indicates significant differences with DC_3 ($p < 0.05$).

### 3.3. Gender

The analysis of gender in relation to the different areas of digital competence, the effect of the questionnaire, and the difference between perceived and actual digital competence, are shown in Table 4. Men recorded significantly higher Actual_DC after the intervention ($t(99) = 3.5$; $p < 0.006$; $d = 0.78$), higher DC_Communication scores before ($t(99) = 3.0$; $p < 0.001$; $d = 0.29$) and after ($t(99) = 3.5$; $p < 0.001$; $d = 0.38$) the intervention, and higher DC_Safety scores after the intervention ($t(99) = 3.2$; $p = 0.001$; $d = 0.41$).

**Table 4.** Effect of gender on the different areas of digital competence (DC), the effect of the questionnaire on the respondents' PDC, and the difference between perceived (PDC) and actual DC (Actual_DC_6).

| Variables | Moment | Female | | Male | | Gender Effect |
|---|---|---|---|---|---|---|
| | | M | SD | M | SD | |
| DC_Information | Before | 1.55 | 0.37 | 1.7 | 0.47 | |
| | After | 1.99 | 0.4 | 1.98 | 0.29 | |
| DC_Communication | Before | 1.45 | 0.27 | 1.74 | 0.32 | *** |
| | After | 1.99 | 0.37 | 2.13 | 0.33 | ** |
| DC_Creation | Before | 1.41 | 0.31 | 1.47 | 0.37 | |
| | After | 1.88 | 0.46 | 1.92 | 0.42 | |
| DC_Safety | Before | 1.62 | 0.46 | 1.67 | 0.38 | |
| | After | 1.98 | 0.4 | 2.15 | 0.31 | ** |
| DC_Problem_solving | Before | 1.47 | 0.36 | 1.54 | 0.39 | |
| | After | 1.91 | 0.5 | 1.99 | 0.3 | |
| Actual_DC_6 | Before | 2.25 | 0.72 | 2.56 | 0.73 | |
| | After | 3.37 | 0.86 | 3.58 | 0.68 | ** |
| Questionnaire effect | Before | −0.6 | 0.65 | −0.33 | 0.49 | |
| | After | 0.22 | 0.95 | 0.28 | 0.83 | |
| PDC_DC_match | Before | 0.75 | 0.79 | 0.55 | 0.65 | |
| | After | 0.63 | 0.71 | 0.19 | 0.08 | ** |

Note: *** $p < 0.001$; ** $p < 0.01$.

### 3.4. Degree Year

The studied year (Table 5) had no significant effect on any DC are, nor on the effect of the questionnaire on PDC, or the difference between PDC and Actual_DC. However, students in the second year had the highest scores for all DC areas and, consequently, the highest Actual_DC_6 value. Third year students showed the greatest decrease in PDC after the first questionnaire, before the intervention, and were the only ones who reduced their PDC after the questionnaire. The PDC_PC_match for all three years showed that their PDC was an overestimation, but 3rd-year students had the best match (the smallest difference between PDC and DC).

### 3.5. PDC Evolution

The respondents' PDC was registered 4 times in total (Figure 4), twice before the intervention and twice again after the intervention.

In terms of gender, PDC evolved significantly in both women ($X_2{}^3 = 12.2$; $p = 0.007$) and men ($X_2{}^3 = 12.2$; $p = 0.007$) (Figure 5 left). Median PDC values decreased significantly between the two values recorded before the intervention (PDC_1 and PDC_2) in women ($Z = -3.4$; $p < 0.001$) and in men ($Z = -2.5$; $p < 0.014$), and then significantly increased between the second (PDC_2) and the last PDC values (PDC_4) in women ($Z = -2.6$; $p = 0.008$) and in men ($Z = -2.7$; $p < 0.007$). There were no significant differences between men and women in any of the PDC values (Figure 5 left).

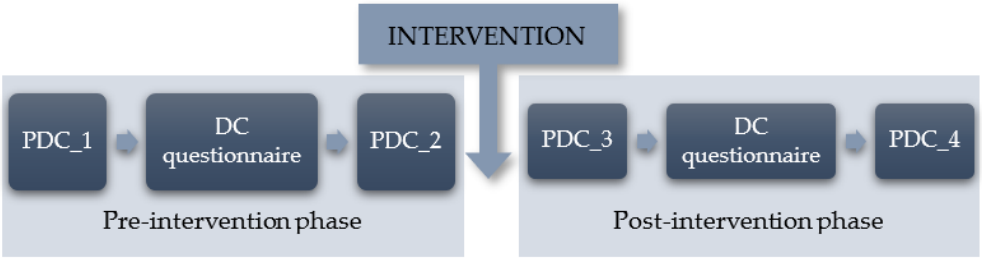



**Figure 4.** Perceived digital competence (PDC) scores and evolution before and after the intervention process.

**Table 5.** Effect of studied year on the different areas of digital competence (DC), the effect of the questionnaire on the respondents' PDC, and the difference between perceived (PDC) and actual DC (Actual_DC_6).

| Variables | Moment | First | | Second | | Third | |
|---|---|---|---|---|---|---|---|
| | | M | SD | M | SD | M | SD |
| DC_Information | Before | 1.53 | 0.35 | 1.71 | 0.57 | 1.67 | 0.19 |
| | After | 1.89 | 0.32 | 2.12 | 0.43 | 2 | 0 |
| DC_Communication | Before | 1.57 | 0.28 | 1.56 | 0.41 | 1.6 | 0.32 |
| | After | 1.96 | 0.38 | 2.17 | 0.35 | 2.1 | 0.15 |
| DC_Creation | Before | 1.42 | 0.35 | 1.43 | 0.36 | 1.5 | 0.29 |
| | After | 1.8 | 0.43 | 2.09 | 0.4 | 1.8 | 0.48 |
| DC_Safety | Before | 1.63 | 0.44 | 1.63 | 0.42 | 1.71 | 0.42 |
| | After | 2.01 | 0.37 | 2.16 | 0.37 | 1.95 | 0.33 |
| DC_Problem_solving | Before | 1.55 | 0.35 | 1.48 | 0.42 | 1.39 | 0.32 |
| | After | 1.84 | 0.43 | 2.14 | 0.32 | 1.85 | 0.55 |
| Actual_DC_6 | Before | 2.34 | 0.69 | 2.4 | 0.93 | 2.43 | 0.47 |
| | After | 3.25 | 0.8 | 3.84 | 0.71 | 3.35 | 0.68 |
| Questionnaire effect | Before | −0.36 | 0.58 | −0.57 | 0.65 | −0.71 | 0.49 |
| | After | 0.41 | 1.01 | 0.21 | 0.7 | −0.4 | 0.55 |
| PDC_DC_match | Before | 0.56 | 0.56 | 0.74 | 0.85 | 0.85 | 0.83 |
| | After | 0.48 | 0.56 | 0.45 | 0.27 | 0.25 | 0.33 |

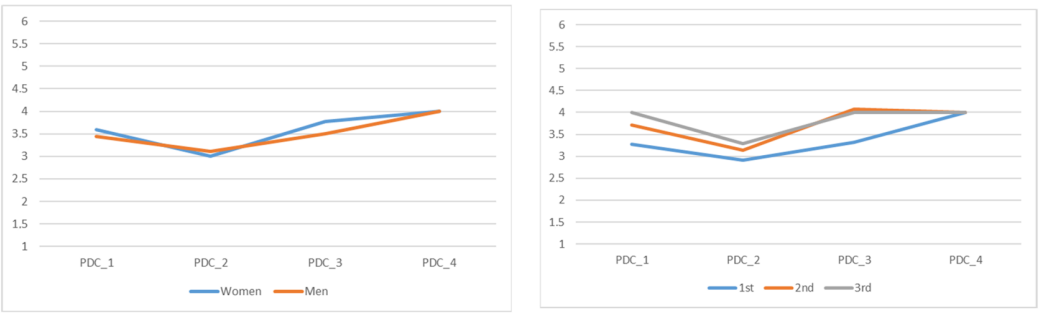



**Figure 5.** Perceived digital competence (PDC) scores and evolution before and after the intervention process, taking into account the participants' gender and studied year.

As for the year of the degree, PDC evolved significantly in 1st- ($X_2^3 = 12.5$; $p = 0.006$) and 2nd-year students ($X_2^3 = 9.5$; $p = 0.024$), but not in 3rd-year students (Figure 5 right). Among 1st-year students, the main differences were the lower ($Z = -2.5$; $p < 0.011$) PDC value in the second measurement, and the increase ($Z = -2.6$; $p < 0.009$) from the second to the fourth measurement. Similarly, among 2nd-year students, the main differences were the lower ($Z = -2.5$; $p < 0.011$) PDC value in the second measurement, and the increase ($Z = -2.4$; $p < 0.016$) from the second to the fourth measurement (Figure 5 right).

## 4. Discussion

The results obtained in this study are based on a teaching innovation project developed with future educators in the classrooms of the University of Valencia. There are previous experiences, such as in [28], which focused only on the Degree in Primary School Education and on searching, selecting, and providing a critical analysis of data (to elaborate an academic text), as well as on identifying fake news; however, the aim of the present project was to cover the different areas of digital competence for a more comprehensive development of the participants.

In line with other works such as [14,29], or previous studies such as [30], this research is committed to a cross-cutting perspective on digital competence. The main reason for this is that the current curricula for teacher training do not include a compulsory subject on technologies in education [9].

After analysing recent literature, we can state that the results regarding future teachers' perceptions of their general digital competence are quite different. There are works, such as [31], that found that students perceived their level of digital competence as close to that of a beginner user (level A1–A2), and others, such as [32], that conclude that future teachers participating in the study felt technologically competent, although with some exceptions: despite recognising their possibilities, they found it difficult to integrate digital technologies in the classroom. In the case of [33], its participants considered their digital competence to be average, and perceived a mismatch between their technical and pedagogical mastery, along the lines of the previous study. This paper finds that the perception of overall digital competence is high and highlights the improvement of participants in all five areas.

The findings regarding the perception of competence in the different areas of digital competence are consistent. At the University of Valencia, [34] concluded that future preschool and primary school teachers perceive higher levels of self-efficacy in the information and communication areas, as opposed to safety and problem solving, especially in relation to knowledge about copyright, the design of collaborative network projects, or ICT problem solving, which obtained the lowest scores. In the same vein, [17,22] also conclude that self-efficacy in each of the digital competence areas is uneven and that prospective teachers consider themselves competent in all areas except safety and problem solving. This contrasts with the work of [35], which focuses on the area of digital safety. They concluded that students recently enrolled in the Degree in Primary School Education perceive themselves as competent in this area. Others such as [14] also claim that prospective teachers perform better in relation to the communicative area of digital competence, as well as in attitudes and expectations towards ICTs. As for the fifth area, problem solving, studies such as [36] state that men provide higher self-perception values; they consider themselves more competent and feel more confident than women when faced with problems related to digital devices. These results coincide with those of [37] but disagree with [38]. It is, therefore, necessary to analyse whether self-perception falls in line with reality or, as pointed out in [20,24], it is an idealisation, i.e., their confidence in their own competence is greater than their actual skills, as we have indeed observed in this study.

As for the variables that may influence digital competence results, there are references in the current literature to gender, age, or the amount of prior training. In line with the results of the present study, other authors detect significant gender differences in higher education [39] and vocational training teachers [40]. In the case of primary school teachers, studies such as [41] conclude that women perceive themselves to be more knowledgeable than men about educational websites and blogs, show higher self-efficacy scores, and are more capable of using such tools. According to [20,23], women also have better digital content creation skills. On the other hand, [42] found that the lowest digital competence scores belonged to female primary school teachers and [43] observed more competence in the use of digital devices and educational applications by men. Along the same lines, [44] concludes that positive perceptions of the level of digital competence are also obtained in the case of trainee teachers, with significant differences in favour of men. Concerning age or, in this case, the year of the degree, it has not been a significant variable, although previous

studies have found statistically significant differences among active teachers. According to [41,45], older people are less digitally competent than younger people.

## 5. Conclusions

According to [46], we cannot claim that digital natives [47] are more digitally competent generations, but rather that the cross-sectional training provided in the TIP has led to these results.

Educational curricula need to change and integrate educational technology in its technological and didactic aspects [32], which will make it easier to use it functionally and educationally in the classroom, and to have professionals who are competent in the use of technology [17], which what the goal of this intervention.

Many previous research projects and their implementation tend to focus only on the technical capabilities of digital resources, rather than on fostering critical thinking [48]. Therefore, in accordance with [49], this work proposed to increase the experimentation with the applied and insightful practical component of teacher training, focusing on a conscious, effective, and feasible use of technologies, to contribute to the improvement of the different areas of digital competence and, thus, successfully addressing the challenges posed by the introduction of ICTs in the classroom. The key to achieving this, according to [17], is the development of comprehensive digital literacy among students of the Degrees in Preschool and Primary School Education, through the promotion of collaborative learning, authorship, ethics, and digital citizenship. To this end, they suggest introducing some proposals, with which we wholeheartedly agree, such as the modification of the syllabus for future teachers, including specific compulsory DCC training, as previously contemplated in the Degree in Education at the University of Valencia, with the subject *New technologies applied to education*. Other ideas that emerge in relation with the research of [50] are to restructure the Primary School curriculum to include a subject that educates students in technology, or to work these contents across the curriculum so that students are able, from an early age, to move in digital contexts and make a more correct and responsible use of the Internet and other technologies.

Regarding the limitations of the study, two main ones stand out. The first is related to the selection of the sample and was deliberate: all participants were students involved in the TIP. The second refers to the duration of the implementation phase, which was limited to one term and to basic six-credit subjects in the Degrees in Preschool Education and Primary School Education at the University of Valencia.

Finally, as a future line of research, it would be interesting in future projects to extend the intervention time and activities, based on the present experience and results, placing a greater emphasis on those dimensions with the worst results, as well as increasing the number of participants among students from both degrees. On the other hand, it would be very interesting to analyse the students' attitudes towards technology, because of the impact they might have on their teaching practices.

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