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# El docente digital: influencia de la formación inicial y permanente en la competencia digital docente

## *The digital teacher: the influence of initial and in-service training on teachers' digital competence*

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**RESUMEN**

La escuela digital plantea importantes retos al profesorado que exigen el desarrollo de la Competencia Digital docente para introducir las tecnologías digitales de forma efectiva en el aula y en las distintas dimensiones del trabajo docente. Partiendo de esta realidad, el presente artículo sintetiza los principales resultados emergidos de un proyecto de I+D+i centrado en analizar el nivel de desarrollo de la Competencia Digital Docente del profesorado de las etapas de Educación Infantil y Primaria en la Comunitat Valenciana. El trabajo se ha desarrollado a partir de un enfoque cuantitativo no experimental de tipo *ex post facto* con diseño transversal, mediante la aplicación del cuestionario DigCompEdu Check-In a 331 docentes en ejercicio. Los resultados apuntan a que haber recibido formación inicial y/o formación permanente en materia tecnológica tienen una incidencia en el nivel de competencia digital docente en todas las dimensiones. Estos hallazgos inciden en



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la necesidad de potenciar este tipo de capacitación en los diferentes contextos del desarrollo profesional del profesorado.

**PALABRAS CLAVE**

Competencia digital; profesorado; formación inicial; formación permanente.

**ABSTRACT**

The digital school poses important challenges for teachers, which require the development of digital pedagogical competences in order to effectively introduce digital technologies in the classroom and in the different dimensions of teaching work. Based on this reality, this paper summarises the main results of an R&D&I project aimed at analysing the development of digital pedagogical competences of early childhood and primary school teachers in the Valencian Community (Spain). The work has used a quantitative, non-experimental, ex post facto approach, following a cross-sectional design, through the application of the DigCompEdu Check-In questionnaire to 331 in-service teachers. The results suggest that having received initial and/or in-service training in technology has an impact on the level of digital competence of teachers in all dimensions. These findings point to the need to promote this type of training in the different contexts of teachers' professional development.

**KEYWORDS**

Digital competence; teachers; initial training; in;service training.

## 1. INTRODUCTION

Digital technologies have drastically changed the different dimensions of life and society, triggering a true metamorphosis of the educational sphere (Area, 2017). This is not a static phenomenon, but one that is constantly changing and evolving in the face of increasingly sophisticated and advanced technologies. In this sense, today's schools are organisations that incorporate a wide range of technological artefacts, from equipment and digital infrastructure to digital platforms for personalising learning, programming, robotics and drones, or the latest generative artificial intelligence tools (Pardo-Baldoví et al., 2023).

As a result, new proposals and ways of teaching and learning are emerging, moving towards what Turienzo and Manzano (2021) define as 'omni-learning', alluding to the possibility of learning (but also teaching) at any time and from any place, whether physical or virtual.

These phenomena pose important challenges for education professionals, who must necessarily learn to use digital technologies and integrate them effectively into their daily work, whether for tasks related to school or classroom management, for communicating with different school actors, for promoting collaboration with other members of the teaching staff and, above all, for facilitating the didactic process and responding to the diversity of the classroom (García et al., 2020). This requires the development of new ways of acting and interacting, now mediated by digital technologies and their values and logic, but also new ways of thinking, learning and teaching.

Focusing on teaching and learning, the challenge for teachers is twofold. On the one hand, because teachers need to learn how to use the tools to optimise their daily work (Gabarda et al., 2021); on the other hand, because as digital educators (López & Bernal, 2018), they have the responsibility to train the younger generations in a more conscious, responsible and critical use of these artefacts (Martínez & Garcés, 2020).

Based on this scenario, proposals aimed at favouring and promoting digital teaching competence are becoming increasingly relevant, following the approaches of the European framework

DigCompEdu (Redecker & Punie, 2017), adapted in the Spanish context by the Common Digital Competence Framework for Teachers (INTEF, 2017). Both the different educational administrations and various organisations are currently offering proposals aimed at training teachers in digital teaching competence (Castañeda, 2024).

In this context, the Spanish national initiative (Ministry of Education and Vocational Training, 2022), subsequently reinterpreted and developed by the regional education administrations, to certify the digital competence of teachers stands out. This gives the field a formal and institutional status.

Despite all these efforts, the research conducted by Mañas & González (2023) highlights that training in digital teaching competences is still lacking in quality and effectiveness. These findings are in line with those of Lores et al. (2019), who underline the eminently instrumental and theoretical nature of teacher training related to digital technologies. Their findings are complemented by the work of Andía et al. (2020), who point to the low level of digital teaching competence of Spanish teachers. In view of this, González-Rodríguez et al. (2022) argue that it is necessary to promote solid training actions and proposals to optimise the in-service training of teachers in relation to this competence, with the aim of promoting the didactic and effective use of digital technologies in the classroom.

Faced with this reality, we ask ourselves: what is the level of digital competence of ECE and PE teachers, and what influence do initial and in-service training have on the development of digital competence? To answer these questions, this paper summarises the main results of an R&D&I project (reference: CIGE/2022/072) funded by the Regional Department of Innovation, Universities, Science and Digital Society of the Valencian Government (Spain), which focused on studying and analysing the level of development of digital teaching competence of teachers of the aforementioned educational levels in the Valencian Community.

## 2. METHOD AND MATERIALS

### 1.1. Approach

We followed a quantitative, non-experimental, *ex post facto* approach with a cross-sectional design, using questionnaires. On the basis of the data obtained, we carried out descriptive analyses using measures of central tendency and dispersion, as well as inferential analyses, with the aim of determining the level of digital competence of early childhood and primary teachers, as well as the impact of previous training on these skills.

### 1.2. Sample

The sample consists of 331 practising teachers in the Valencian Community, working in early childhood education (82), primary education (180) or both (69). Specifically, 267 women and 64 men, aged between 26 and 65 years (average: 43.8 years).

### 1.3. Instrument

Data collection was based on the DigCompEdu Check-In questionnaire (Cabero-Almenara & Palacios-Rodríguez, 2020), which is the Spanish adaptation of the DigCompEdu instrument (Redecker & Punie, 2017). This questionnaire includes a total of 22 competences, grouped into six domains or dimensions (Table 1):

**Table 1. DigCompEdu dimensions**

| Code | Dimension | Explanation |
|---|---|---|
| PE_DIM | Professional engagement | Focused on the professional environment of teachers, integrating their ability to use technology both in their teaching role and in their interaction with the rest of the educational community. |
| DR_DIM | Digital resources | Linked to the teachers' selection, creation and distribution of digital resources for educational purposes. |
| TL_DIM | Teaching and learning | Related to the ability to design, plan, and implement technology in teaching and learning processes. |
| A_DIM | Assessment | Focused on the use of digital tools and strategies to improve the assessment, feedback, and quality of the learning process. |
| E_DIM | Empowering learners | Related to the ability to involve students in learning, to encourage their participation and to use technology to adapt the learning process. |
| F_DIM | Facilitating learners' digital competence | Linked to the development and promotion of students' digital skills, not only from an educational, but also from a civic dimension. |

*Note*: Created by the authors from the DigCompEdu Check-In questionnaire (Cabero-Almenara & Palacios-Rodríguez, 2020).

In addition to the items included in these dimensions, three variables are proposed to provide a more comprehensive picture of the technological skills of the teachers under study:

- Initial DC perception (Initial_per): the teachers' self-perceived level of digital competence prior to answering the DigCompEdu Check-In questions. Information is collected on an A1–C2 scale, which is recoded into values 1–6 for the analyses.
- Final DC perception (Final_per): the teachers' self-perceived level of digital competence after answering the questionnaire. Information is collected on an A1–C2 scale, which is recoded into values 1–6 for the analyses.
- DC score (DC_score): the actual level of digital competence extracted from the teachers' responses to the items in the questionnaire. It results in an overall score, which we coded according to Cabero-Almenara and Palacios-Rodriguez (2020): less than 20 points: novice (A1); 20–33 points: explorer (A2); 34–49 points: integrator (B1); 50–65 points: expert (B2); 66–80 points: leader (C1); and more than 80 points: pioneer (C2). We then recoded scale A1–C2 into values 1–6 for the analyses.

In addition to the items included in these dimensions, we propose a set of socio-demographic questions as independent variables for the analysis of teachers' digital competence.

For the present study, the following variables were analysed:

**Table 2. Variables to be analysed.**

| Variables | Categories of response |
|---|---|
| Initial studies | Diploma / Degree in Early Childhood Education (ECE) / Degree in Primary Education (PE) / Double degree / Bachelor's degree / Master's Degree in Secondary Education |
| ICT training in initial training | Yes / No |
| ICT training in in-service training | Yes / No |

## 1.4. Procedure

The data collection process was carried out in several stages:

Phase I. To be able to collect the appropriate data, the study population was identified, which in this case consisted of practising early childhood and primary teachers in the Valencian Community.

Phase II. The contact details of all the training centres were collected using the guide to centres on the website of the Regional Departments of Education, Universities and Employment.

Phase III. The digital questionnaire was sent through the general accounts of the centres.

Phase IV. Once the responses were received, the following analysis was carried out.

## 1.5. Analysis

The statistical analyses carried out using SPSS v, 28.0 software were as follows:

1. In order to determine the level of digital competence of the teachers, we carried out a descriptive analysis of the scores obtained in relation to the dimensions and items of the instrument, as well as the initial and final perceptions of DC and the actual DC score obtained.
2. In order to test whether there were significant differences in digital competence according to studies, initial and continuing training, we carried out inferential analyses. First, we tested the normality of the data (dimensions, items, initial/final perceptions and total score) using the Kolmogorov–Smirnov test. The results showed that the distribution was not normal (KS= p. ≤.05), so we performed non-parametric tests.

   a) The Mann–Whitney U test was performed on the variables "ICT in initial training" (yes/no) and "ICT in in-service training" (yes/no), calculating the effects with the Rosenthal r equivalent (Rosenthal, 1994), and the values of 0.2, 0.5 and 0.8 were set as small, medium or large effect.

   b) The Kruskal–Wallis H-test was used for the variable "Initial studies" to determine the existence of differences within the group. In significant cases (p. <.05), multiple comparisons were made for each pair of levels of the variable (Mann–Whitney U test), again calculating the effects with Rosenthal r.

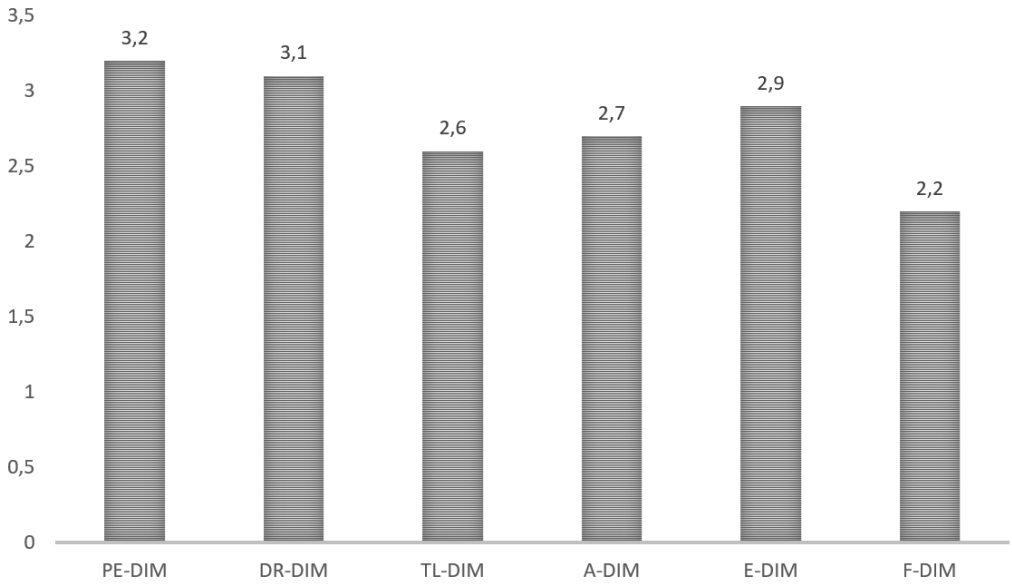
## 2. RESULTS

The results of this study are described in terms of the level of digital competence of teachers, calculated as the direct score of the questionnaire and their perceived level of competence. In addition to the overall score, the level in each of the dimensions and the effect of initial and in-service training are also analysed.

## 2.1. Level of digital competence

Looking first at the level of digital competence of the participating teachers, we find intermediate values, with not too many differences between the different dimensions (Figure 1):

**Figure 1. Mean scores per dimension.**




The data show that the dimension in which teachers are most proficient is Professional engagement (3.2), followed by Digital resources (3.1). Meanwhile, the area in which they are most deficient is Facilitating learners' digital competence (2.2), the only area in which they score below average.

## 2.2. Contrast between self-perceived level of competence and actual digital competence score

On the other hand, if we look at the teachers' perceptions of their own skills before starting the questionnaire, after completing it, and the actual skills extracted from their answers, we observe a rather remarkable difference (Table 3).

**Table 3. Initial perception, final perception and digital competence score.**

| | Mean | St. dev. |
|---|---|---|
| Initial_per | 2.89 | 1.063 |
| Final_per | 2.92 | 1.007 |
| DC_score | 4.07 | .941 |

Thus, although the initial and final perceptions are not too far apart (with means of 2.89 and 2.92 respectively), the responses to the different items show that actual competence exceeds 4 points (4.07). Teachers therefore underestimate their own competence compared to the actual competence derived from the responses.

## 2.3. Contrasts according to qualifying studies

In order to qualify to teach, most participants reported that they had obteained a Diploma (n=229), a Degree in Early Childhood Education (n=28), a Degree in Primary Education (n=51), a Double Degree in Early Childhood and Primary Education (n=6), a Bachelor's Degree (n=14) or a Master's Degree in Secondary Education (n=3).

As can be seen in Table 4, teachers with a Degree in Primary Education have higher skills in all dimensions and are also those who score highest in initial perception, final perception and actual digital competence.

**Table 4. Mean score per dimension according to the qualifying training.**

| Dimension | Diploma | Degree ECE | Degree PE | Double degree | Bachelor's degree | Master's degree |
|---|---|---|---|---|---|---|
| PE_DIM | 3.1856 | 3.0268 | 3.2990 | 2.8333 | 2.8393 | 2.6667 |
| DR_DIM | 2.9985 | 2.8929 | 3.5294 | 2.6667 | 2.9524 | 3.7778 |
| TL_DIM | 2.5721 | 1.9018 | 3.1029 | 2.5833 | 2.1786 | 1.9167 |
| A_DIM | 2.6929 | 2.4048 | 3.1634 | 2.7222 | 2.5714 | 3.1111 |
| E_DIM | 2.8821 | 2.5714 | 3.3922 | 3.0556 | 2.7619 | 2.5556 |
| F_DIM | 2.1659 | 1.4071 | 2.5882 | 1.8333 | 2.1571 | 1.8667 |
| Initial_per | 2.83 | 2.50 | 3.51 | 3.17 | 2.21 | 3.00 |
| Final_per | 2.86 | 2.71 | 3.49 | 3.00 | 2.29 | 2.67 |
| DC_score | 4.04 | 3.57 | 4,55 | 3.83 | 4.07 | 3.67 |

Conversely, the results suggest that teachers with a Degree in Early Childhood Education are those who are generally less competent on most dimensions and have lower actual DC scores. The exceptions are those with a double degree, who score lowest on DC and the DR dimension, and those with a Bachelor's Degree, who perceive themselves as the least competent, both before and after completing the questionnaire.

These differences are significant in all dimensions between those who have a Degree in Early Childhood Education and those who have a Degree in Primary Education, and between those who have the latter compared to those who have a Bachelor's Degree. In the remaining cases, the differences are either not significant or occur only occasionally in one of the dimensions.

## 2.4. Contrasts according to whether or not they received ICT training as part of their initial training

When asked whether ICT content was included in their initial training, 34.4% of the sample (n=114) answered in the affirmative and 65.6% (n=217) said that they had not received such training. When comparing the level of digital competence of the two groups, those who had received ICT training show higher technological competence than those who had not, on all dimensions (Table 5).

**Table 5. Mean digital competence by dimension according to whether or not they received ICT training during their initial training.**

| Dimension | Did receive ICT training | Did not receive ICT training |
|---|---|---|
| PE_DIM | 3.2982 | 3.0933 |
| DR_DIM | 3.2544 | 2.9739 |
| TL_DIM | 2.8311 | 2.4401 |
| A_DIM | 2.9152 | 2.6482 |
| E_DIM | 3.1550 | 2.8111 |
| F_DIM | 2.3579 | 2.0525 |
| Initial_per | 3.18 | 2.74 |
| Final_per | 3.18 | 2.78 |
| DC_score | 4.31 | 3.95 |

Similarly, as can be seen, teachers who had received ICT training as part of their initial training have a better perception of their own skills, both before and after answering the questionnaire, and obtain a higher score in actual digital competence (4.31 compared to 3.95 for those who had not received training).

Moreover, this variable shows significant differences in all dimensions in favour of those who had received ICT training as part of their initial education, although the effect is small for all of them (r=0.14569-0.1975), as shown in Table 6.

**Table 6. Significant differences by dimension according to initial ICT training.**

| | PE_DIM | DR_DIM | TL_DIM | A_DIM | E_DIM | F_DIM |
|---|---|---|---|---|---|---|
| Mann–Whitney U | 10382.000 | 9849.000 | 9451.500 | 9867.000 | 9889.500 | 10251.000 |
| Significance | .016 | .002 | .000 | .002 | .003 | .010 |
| Rosenthal r equivalent | 0.14569 | 0.1837 | 0.1975 | 0.180868 | 0.173496 | 0.1567 |

## 2.5. Contrasts according to whether or not they received ICT training as part of their in-service training

Of the total number of participants (n=331), 262 (79.2%) indicated that they had received in-service training on digital content. This training is most often provided by the national or regional education administration (62.6%), followed by the workplace itself (30.9%) and other institutions (6.5%).

Analysing the scores according to this variable, it can be seen that teachers who have received technological training as part of their in-service training score higher on all dimensions (Table 7).

**Table 7. Mean scores per dimension according to ICT training in in-service learning.**

| Dimension | Did receive ICT training | Did not receive ICT training |
|---|---|---|
| PE_DIM | 3.2939 | 2.7200 |
| DR_DIM | 3.1680 | 2.7378 |
| TL_DIM | 2.7002 | 2.1467 |
| A_DIM | 2.8203 | 2.4667 |
| E_DIM | 3.0117 | 2.6489 |
| F_DIM | 2.2898 | 1.7067 |
| Initial_per | 2.98 | 2.56 |
| Final_per | 3.02 | 2.57 |
| DC_score | 4.22 | 3.57 |

It can also be observed that teachers who have received training in this area perceive themselves as more competent, both before and after completing the questionnaire, and generally show a higher level of actual digital competence. These differences are also significant in all dimensions of the analysis (Table 8), with different effect sizes. Thus, the effect is medium in all dimensions (with the highest values in dimensions PE and F), except for dimension E, where it is small.

**Table 8. Significant differences by dimension according to in-service ICT training.**

| | PE_DIM | DR_DIM | TL_DIM | A_DIM | E_DIM | F_DIM |
|---|---|---|---|---|---|---|
| Mann–Whitney U | 5301.500 | 6379.000 | 6511.500 | 6906.000 | 7549.500 | 6181.000 |
| Sig. | .000 | .000 | .000 | .000 | .005 | .000 |
| Rosenthal r equivalent | 0.399 | 0.293 | 0.2985 | 0.264 | 0.1903 | 0.3185 |

## 3. DISCUSSION

Firstly, the results of this study show an intermediate level of digital competence, following the conclusions of other studies with practising teachers, such as that of Palacios & Martín (2021), which highlighted instrumental competence in the use of technological resources, the one in which García et al. (2020) demonstrated limitations in the use of technology for diversity and in the safety dimension, or a study by Fuentes et al. (2019), in which limitations in content creation skills proved to be an obstacle to achieving higher scores. In the same vein, the study by Gabarda et al. (2021), in which the sample was made up of future teachers in the same two stages in the Valencian Community, also concluded that the level of digital competence of trainee teachers was medium. The results of this study differ from those of previous studies, such as Girón-Escudero et al. (2019), in which the self-perception of digital competence of future primary teachers was at a beginner level.

Secondly, a detailed analysis by dimension shows that the score was above average in all but one dimension. The lowest scores were found in the dimension related to the development of

students' digital competence. As stated by Gabarda et al. (2021), the role of the teacher is key in the development of students' digital competence, but it is essential that teachers themselves have the necessary training to enable this, as they are not only citizens but also digital educators (López & Bernal, 2018) and key agents in the process (Martínez & Garcés, 2020).

Furthermore, a small difference was found between the initial and final perceptions of digital competence, with the latter being slightly higher. In other words, the scores are similar after completing the questionnaire, which implies that the knowledge assessed within each dimension is correct and that there is an adjusted assessment of what each dimension measures, as found in previous studies with university teachers (Ferrando et al., 2023).

On another note, the scores measured by the questionnaire and the self-perceived ones provided by the participants are significantly different: teachers' self-perceived competence is significantly lower, both before and after completing the questionnaire. In this study, participants underestimate their own competence when compared to the actual score obtained in the questionnaire, independent of other variables such as gender and age (Gabarda et al., 2023) and, in this case, any initial or in-service training received in relation to technology. This discrepancy has been found in previous studies focusing on teachers and prospective teachers at other levels of education. However, the initial and final perceptions of competence are not always lower than the actual scores obtained through the questionnaire. Some studies with future teachers (Marín et al., 2023) have demonstrated the phenomenon of competence idealisation (Cabero et al., 2020), contrary to what we observed in the current study.

Regarding the differences in the level of digital competence based on initial training, in this study primary school teachers obtained the best results, as found by Pozo et al. (2020). Moreover, according to Larrañaga et al. (2023), primary school teachers are the ones who most value the pedagogical opportunities of technologies for communication, collaboration and innovation. These differences in favour of primary school graduates are significant and are found in all dimensions of digital literacy. On the other hand, with regard to ICT training in initial teacher training, more than half of the participants indicated that they had not received it. This may be due to the introduction of digital competence from a cross-cutting perspective, which has already been identified as a possible shortcoming, because it blurs the responsibility for teaching it (Marín et al., 2019). This may be due to the fact that the curricula for the Degree in Primary Education does include a minor in ICT, but this is not the case for the Degree in Early Childhood Education or in Master's Degree in Secondary Education (Peirats et al., 2018).

The same is true when analysing the differences in digital competence between those who receive training related to technology and digitalisation and those who do not. Significant differences were found across all dimensions. The data therefore support the idea that there is a direct relationship between the level of technological training and the level of digital competence (Pozo et al., 2020). Therefore, it is important to invest efforts in the design of training actions that allow teachers at all levels of education to develop their digital competence, so that they can make pedagogical and innovative use of technology and exploit its potential for improving students' digital competence.

Technological training is a challenge and a necessity (Castañeda, 2024; Targino et al., 2022), both in initial training and throughout a teacher's professional life.

## 4. CONCLUSIONS

The aim of this study was to determine the level of digital competence of early childhood and primary school teachers in the Valencian Community and to analyse the influence of initial and in-service teacher training on their digital competence.

We believe that it is essential to design training actions for the development of teachers' digital competence, so that they can use technological tools and resources in their daily teaching practice. Their training must go beyond technical issues (Andía et al., 2020), so that they can put

what they have learned into practice and introduce active techniques for developing technological skills (Romero et al., 2020), as well as gamification (Cuevas et al., 2021) or flipped classroom methodologies (Colomo et al., 2020).

For in-service training, the contributions of INTEF, the trade unions and the CEFIRE centres in the Valencian Community are fundamental (Gabarda et al., 2021). However, it is necessary to rethink teacher training policies on the premise that the current offer is insufficient to respond to the needs of schools, families, students and citizens in the midst of the technological revolution. A high percentage of teachers are self-taught (Lores et al., 2019) and there is a gap between technical knowledge and pedagogical uses of technology in the classroom (Mañas & González, 2023). These uses involve the organisation and management of centres and require communication with families and collaboration with other professionals (Pardo & San Martín, 2020).

The limitations of this study include the size of the sample, which makes it difficult to extrapolate the results to all teachers. Furthermore, despite the use of a validated questionnaire, which provides greater methodological support, the information obtained is limited and could be complemented by combining it with other tools such as focus groups or semi-structured interviews. These approaches would allow us to understand qualitative issues such as motivations, strategies or resistance to developing digital competence.

In short, there is a need for extensive further research into the development of teachers' digital competence. Interesting lines of future research include longitudinal studies to analyse how digital competence develops throughout the professional careers of prospective and current teachers, and to make proposals that can provide insights for modifying university curricula and improving the level of training of graduates. From a methodological point of view, it would be interesting to analyse other variables that may influence the level of development of teachers' digital competence and to carry out other studies that combine qualitative and quantitative designs in order to get a closer and more in-depth view of this reality.

## AUTHORS' CONTRIBUTION

Concept, M.I.P. and M.S.; Method, V.G.; Software, V.G. and D.M.; Validation, D.M.; Formal analysis, V.G.; Research, V.G., D.M., M.I.P. and M.S.; Writing, V.G., D.M., M.I.P. and M.S.; Preparation of the manuscript, V.G., D.M., M.I.P. and M.S.; Writing: proofreading and revision, V.G., D.M., M.I.P. and M.S.; Visualisation, V.G., D.M., M.I.P. and M.S.; Supervision, V.G. and D.M. All authors have read and accepted the published version of the manuscript.

## DATA ACCESSIBILITY STATEMENT

The data underlying the results presented in this study are available from the Zenodo repository [*https://zenodo.org/records/14039735*]. While the dataset is publicly accessible, users are required to contact the corresponding author.

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