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INTEGRATION OF ICT IN INITIAL TEACHER EDUCATION: PRE-SERVICE TEACHERS PERCEPTIONS

INTEGRAÇÃO DAS TICS NA FORMAÇÃO INICIAL DE PROFESSORES: PERCEPÇÕES DOS FUTUROS PROFESSORES

INTEGRACIÓN DE LAS TIC EN LA FORMACIÓN INICIAL DEL PROFESORADO: PERCEPCIONES DEL PROFESORADO EN FORMACIÓN

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ABSTRACT: This article presents a study on the integration of Information and Communication Technologies (ICT) in initial teacher education in Portugal. The aim was to examine, from the perspective of student teachers, whether ICT is embedded in the curriculum, in the institution's physical and digital infrastructure, and whether consideration is given to the European Framework for the Digital Competence of Educators (DigCompEdu). The methodology involved administering an online questionnaire to 182 students in the final years of their master's programmes in teaching. Data were analysed using a quantitative, cross-sectional descriptive approach. The results indicate that prospective teachers positively evaluate the ICT-related knowledge acquired and feel confident in applying it in their future teaching practice. With regard to DigCompEdu, participants perceive its presence in the curricula of their courses. It is concluded that, despite some weaknesses, initial teacher education in Portugal has been preparing future educators to engage in ICT-supported teaching and learning processes, in line with the DigCompEdu framework.

KEYWORDS: Digital competences. DigCompEdu. Initial teacher education. Information and communication technologies. ICT.

RESUMO: Este artigo apresenta um estudo sobre a integração das Tecnologias da Informação e Comunicação (TICS) na formação inicial de professores no Brasil. O objetivo foi analisar, a partir da percepção dos estudantes, se as TIC estão integradas ao currículo, à infraestrutura física e digital das instituições e se os cursos consideram o referencial europeu de competências digitais para educadores (DigCompEdu). A metodologia consistiu na aplicação de um questionário on-line a 182 estudantes dos últimos anos de cursos de mestrado em ensino. Os dados foram analisados por meio de uma abordagem quantitativa com delineamento descritivo transversal. Os resultados indicam que os futuros professores avaliam positivamente os conhecimentos adquiridos em TIC e demonstram confiança em sua aplicação na futura prática profissional. Em relação ao DigCompEdu, os participantes reconhecem sua presença nos currículos dos cursos que frequentam. Conclui-se que, apesar de algumas fragilidades, a formação inicial docente contribui para o desenvolvimento das competências digitais propostas pelo DigCompEdu.

PALAVRAS-CHAVE: Competências digitais. DigCompEdu. Formação inicial de professores. Tecnologias da informação e comunicação. TIC.

RESUMEN: Este artículo presenta un estudio sobre la integración de las Tecnologías de la Información y la Comunicación (TICs) en la formación inicial de profesores en Brasil. El objetivo fue analizar, desde la percepción de los estudiantes, si las TIC están integradas al currículo, a la infraestructura física y digital de las instituciones y si los cursos consideran el marco europeo de competencias digitales para educadores (DigCompEdu). La metodología consistió en la aplicación de un cuestionario en línea a 182 estudiantes de los últimos años de los programas de maestría en enseñanza. Los datos fueron analizados mediante un enfoque cuantitativo con un diseño transversal descriptivo. Los resultados indican que los futuros docentes evalúan positivamente los conocimientos adquiridos en TIC y muestran confianza en su aplicación en la futura práctica profesional. En relación con el DigCompEdu, los participantes reconocen su presencia en los currículos de los cursos que cursan. Se concluye que, a pesar de algunas debilidades, la formación inicial docente contribuye al desarrollo de las competencias digitales propuestas por el DigCompEdu.

PALABRAS CLAVE: Competencias digitales. DigCompEdu. Formación inicial del profesorado. Tecnologías de la información y la comunicación. TIC.

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INTRODUCTION

In recent years, international scientific research in the field of education has identified the limited preparation of future teachers regarding the digital teaching competencies required by contemporary society, particularly concerning their ability to develop teaching and learning processes supported by information and communication technologies (ICTs) (Almeida et al., 2020; Burrows et al., 2021; Espejo-Villar et al., 2022; Gallego-Arrufat et al., 2019; García-Lázaro et al., 2022; Graça et al., 2021; Gudmundsdottir & Hatlevik, 2018; Hennessy et al., 2022; Kožuh et al., 2021; Lucas & Bem-haja, 2021; Luik & Taimalu, 2021).

Indeed, studies such as Fonseca (2019) indicate that a large majority of teachers, even recent graduates, do not integrate ICTs into their teaching practice as a tool for facilitating meaningful learning, raising questions about what prevents teachers from using ICTs and what has been done in the curricula of teacher education institutions to address this issue. A scoping literature review conducted by Loução and Pedro (2023) also identified vulnerabilities in Initial Teacher Education (ITE) regarding the integration of technologies and the development of 21st-century competencies, despite their growing relevance. Silva and Costa (2022) had already corroborated this concern, justifying their analysis by noting that many teachers, even recent graduates, do not effectively integrate ICTs. Additionally, Vieira and Pedro (2023) found a low prevalence of technologies in the ITE curricula analyzed in Portugal, a situation they identified as common to several countries, emphasizing that the preparation of teachers for the digital society remains largely ineffective.

According to the European Commission, digital competence is defined as:

Digital competence involves the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society. It includes information and data literacy, communication and collaboration, media literacy, digital content creation (including programming), safety (including digital well-being and competences related to cybersecurity), intellectual property related questions, problem solving and critical thinking. (European Commission et al., 2019, p. 10)

The frequent and relevant attention of international policy agendas to the recognition of the expansion and significance of ICTs across various sectors of society has marked recent decades (European Commission, 2014; European Commission et al. 2020; OECD, 2019; UNESCO, 2016). Although several international policy agendas recommend the integration of ICTs at all educational levels, scientific research in this area remains limited, indicating insufficient attention to the topic (García-Lázaro et al. 2022).

At the same time, existing studies often involve geographically small samples, a condition that hinders large-scale inferences and, consequently, prevents nations from having sufficient scientific support to guide decision-making regarding changes to be implemented in their educational systems (Hennessy et al., 2022). Added to this scenario is the following problem: even when the recommendations of international policy agendas are reflected in ITE curricula, they do not point to a true digital transformation of the professional performance of future teachers, as the expected transformation cannot be considered merely the simple use of specific digital tools (Espejo-Villar et al., 2022). Indeed, the mere use of technologies, as observed during the COVID-19 pandemic, does not necessarily translate into knowledge and competencies for conscious, critical, and effective use, but rather reinforces the need for investment in digital and technological literacy (Loução & Pedro, 2023).

It is, therefore, to address these gaps in scientific research that this study seeks to contribute, aiming to analyze data collected from ITE students regarding their perceptions of ICTs integration in master's-level teacher education programs in the context of Portugal.

In the European context, according to a survey by the European Commission, a limiting factor in the full integration of ICTs in ITE is the broad autonomy of higher education institutions (HEIs) in designing ITE curricula. This autonomy leads to a lack of parity between curricula and makes it difficult to collect clear and comparable data and information that would allow identification of which digital teaching competencies are being taught to future teachers (European Commission, 2019). However, this scenario is gradually changing due to advances in aligning national legislation with European and international regulations. These documents guide HEIs to recognize the relevance of curricular integration of ICTs within ITE. Consequently, HEIs have been (re)designing the provision of curricular units (CUs), expanding knowledge on the educational use of ICTs, and promoting effective mechanisms to integrate digital technologies into teaching practice within primary and secondary education curricula (European Education and Culture Executive Agency & Eurydice, 2019). Nonetheless, as Fonseca (2019) points out, research highlights that future teachers face difficulties observing and experimenting with examples of technology use during their training, particularly in the context of supervised teaching practice, and that the beliefs and attitudes of teacher educators regarding the potential of technologies, as well as their own ICT training levels, are intrinsic factors that influence how future teachers use them. Vieira and Pedro (2023) add that weaknesses in the digital competencies of higher education teacher educators, particularly concerning learning assessment, represent a further challenge.

When future teachers are well-prepared in ITE, they become more capable of undertaking teaching and learning processes with ICTs and, thus, respond positively to such preparation (Günbaş, 2022; Kulaksız & Toran, 2022). As García et al. (2022) indicate, ICT knowledge must be ensured in ITE and should no longer be treated as a medium- or long-term goal,

with gradual improvement implemented only through continuous professional development. Ultimately, it should be established as a frequent, disciplinary, and transdisciplinary teaching practice provided by HEIs, as the teacher is recognized as the main agent promoting the social, technological, scientific, and educational changes demanded by contemporary society.

According to Burrows et al. (2021), one possible strategy to achieve effective curricular integration of ICTs in ITE lies in fostering collaborative work between teacher educators and students (future teachers), whereby teacher educators encourage students to explore, appropriate, and experiment with pedagogical processes using ICTs according to their area of training. Luik and Taimalu (2021) complement this recommendation by stating that ITE teacher educators should act as models of digital proficiency for future teachers, being capable of exemplifying teaching and learning processes mediated by ICTs.

Politically and economically, Portugal shares the same educational ambitions as the European bloc and currently maintains two national plans that constitute the country's agenda to promote and stimulate ICT integration at all levels of the Portuguese education system. In 2020, the Digital Transition Action Plan for Portugal was launched, encompassing three major objectives: consolidating digital education as a Portuguese reality; improving teacher training and professional qualification; and guiding ICT integration in education through the promotion of inclusion and digital literacy (Governo da República Portuguesa, 2020). The second plan, entitled *National Digital Competences Initiative e.2030* (INCoDe.2030), launched in 2018 and updated in 2021, aimed to promote essential 21st-century digital competencies, covering basic education, digital inclusion, and research, with the goal of preparing citizens for the digital age and fostering the country's economic and social development (Conselho de Ministros, 2018, 2021).

Beyond national goals and plans, Portugal also seeks to align with policies established by the European Union, including the adoption of the *European Framework for the Digital Competence of Educators (DigCompEdu)* (European Commission et al., 2017). Additionally, during the pandemic, the European Commission published the *Digital Education Action Plan 2021-2027* (European Commission, 2020), which constitutes a political measure to promote the digitalization of education systems in member states. Among the plan's priorities are the creation of a digital education ecosystem and the promotion/enhancement of the digital competencies of the educational community. The plan also aimed to identify emerging needs to achieve its objectives, considering that education systems in member countries should: a) improve connectivity quality and provide accessible and adequate digital tools; b) reform teacher education by equipping educators with knowledge and tools to enhance their engagement with digital technologies; and c) develop citizens' digital competencies, recognized as transversal in the *Key Competences for Lifelong Learning Framework* (European Commission, 2019).

In the context of ICT integration, according to the perceptions of ITE students in Portugal, they report that they frequently apply ICT knowledge in their training through autonomous learning, stimulated by the activities they undertake in curricular units (CUs); however, they indicate a lack of learning activities with ICTs that could be developed in the classroom, where interaction with peers and support from teacher educators is available (Monteiro & Leite, 2021). The gap perceived by students in Portuguese ITE is corroborated by a similar study conducted in Finland, which indicates that the successful integration of ICTs in ITE—and the consequent teaching of these future teachers with ICT support—results from a formative framework that includes: collaborative and autonomous peer work; time for active experimentation with ICTs alongside teacher educators; and physical infrastructure, hardware, and software, which must be available both in the HEIs where they are trained and in the schools where they carry out internship activities (Vilppola et al. 2022).

Research in the field shows increased commitment by HEIs to improve the digital competencies of future teachers through more effective ITE with regard to digital integration, as current social demands to promote knowledge through ICTs are urgent and require constant reflection, planning, and action. At the same time, future teachers consider highly positive the pedagogical knowledge of ICTs acquired during ITE and report that such knowledge fosters positive beliefs about how to professionally engage in teaching and learning processes mediated by ICTs (Günbaş, 2022; Kulaksız & Toran, 2022).

The last decades have been marked by the presence of specialists advocating ICT integration in ITE programs through a pedagogical and didactic approach intentionally designed to promote the connection between digital technologies and their effective use in professional teaching practice contexts (Dale, 2000; Espejo-Villar et al., 2022; Graça et al. 2021; Martinez et al., 2015; Simões & Faustino, 2019). These experts emphasize that HEI curricula should integrate specific content, pedagogical practices, and the organization and planning of teaching-learning activities, with particular attention to the educational, innovative, and transformative potential inherent in ICTs (Günbaş, 2022).

Finally, it is important to highlight that Portugal is neither isolated nor at a disadvantage regarding ICT integration in ITE; similar issues can be identified in countries such as Spain and Norway (Gallego-Arrufat et al., 2019; Gudmundsdottir & Hatlevik, 2018). Nevertheless, even with efforts to improve ICT integration in master's programs in Portugal, the country still faces challenges in achieving the necessary effectiveness to address some of these issues.

Objectives

This study assumes the following objectives (OB): (OB1) Evaluate, from the students' perspective, the level of ICT integration in the curricular units of master's programs related to

the training of future Portuguese teachers; ((OB2) Assess the extent to which students consider that they are provided with preparation to develop teaching and learning processes mediated by ICTs; (OB3) Analyze the ICT knowledge offered to students; (OB4) Identify the extent to which students consider that HEIs provide physical and digital infrastructure for the development of ICT competencies; (OB5) Analyze the extent to which students consider that they have developed the competencies recommended by the European DigCompEdu framework.

METHODOLOGY

The study was developed based on a cross-sectional descriptive research methodology, with a quantitative approach (Creswell & Creswell, 2021). The data collection strategy employed was an online questionnaire. An email was sent to 78 coordinators of master's programs in teaching operating in mainland Portugal during the 2019/2020 academic year, requesting that they forward the link to the online questionnaire to students in the final years of their respective programs. The study had previously been presented to the invited HEIs and obtained approval from the Ethics Committee of the authors' host institution. Student responses were collected between December 2020 and April 2021. The collected data were processed using statistical analysis conducted with SPSS 29.

Instrument and data collection

The questionnaire consists of four sections totaling 28 items (Pedro et al., 2025), organized as follows: the first section includes four items aimed at characterizing respondents (gender, age, HEI, and program); the second section (10 items) collects data regarding the integration of ICT in the curriculum of the attended master's programs; the third section (8 items) gathers information on the ICT knowledge offered to students by the HEIs; the fourth section (6 items) seeks to collect data on how the programs prepare students to develop the digital competencies recommended in the DigCompEdu framework; in this study, the six core areas of this framework were considered.

Validation

The questionnaire was validated in two stages. The first involved content validation by specialists, who assessed the clarity, relevance, and adequacy of the items, resulting in slight adjustments for greater precision in wording. The second stage involved statistical validation, analyzing properties such as the internal consistency of the instrument.

Specialists

The questionnaire was developed based on the literature and submitted for evaluation to two specialists in ICT in education, with a focus on ITE. These specialists analyzed the clarity, relevance, and coherence of the items, proposing suggestions and adjustments to improve the precision of four items in the instrument. The indicated modifications were incorporated, ensuring greater alignment with the research objectives. After this stage, the revised questionnaire was considered suitable for the subsequent data collection phase.

Statistics

Statistical validation was conducted through reliability analysis. Cronbach's alpha coefficient was calculated for the questionnaire as a whole and for each of its four sections, aiming to verify the consistency of responses within each dimension analyzed. Hinton et al. (2014) suggest that an alpha greater than 0.9 indicates excellent reliability; between 0.7 and 0.9, high reliability; between 0.5 and 0.7, moderate reliability; and below 0.5, low reliability. Corrected item-total correlation was calculated to examine each item's contribution to the overall construct. According to Field (2024), in a reliable scale, all items should show a positive correlation with the total, not less than 0.3, ensuring that items correlate well with the entire scale. Cronbach's alpha if the item is deleted was also calculated (Pedro et al., 2025), assessing the impact of removing each item on the internal consistency of the questionnaire.

Considering internal consistency (Pedro et al., 2025), the instrument demonstrated excellent reliability ($\alpha = 0.901$). Sections 2 ($\alpha = 0.815$) and 4 ($\alpha = 0.852$) showed high reliability, while section 3 ($\alpha = 0.674$) demonstrated moderate reliability. Regarding the corrected item-total correlation analysis, all items indicated suitability for measuring the overall construct (> 0.3). For Cronbach's alpha, if *the item is deleted*, the removal of only one of the 24 items (3.1) would slightly increase the value from 0.901 to 0.903. Given this minimal variation, item removal is not justified, as retaining it preserves the instrument's validity without compromising internal consistency.

Characterization of respondents

Data from 182 respondents from 35 master's programs in teaching were considered valid, representing 19.45% of the total estimated population of 936 students. The questionnaire items were optional, resulting in variation in the number of responses per question. While the total sample comprised 182 respondents, some questions had fewer responses, with a minimum of 137 respondents.

The students from the teaching master's programs who completed the questionnaire had an average age of 27 years (standard deviation = 5.6 years) and were enrolled in the programs listed in Table 1.

Table 1. *Percentage Distribution of Respondents According to Attended Master's Programs*

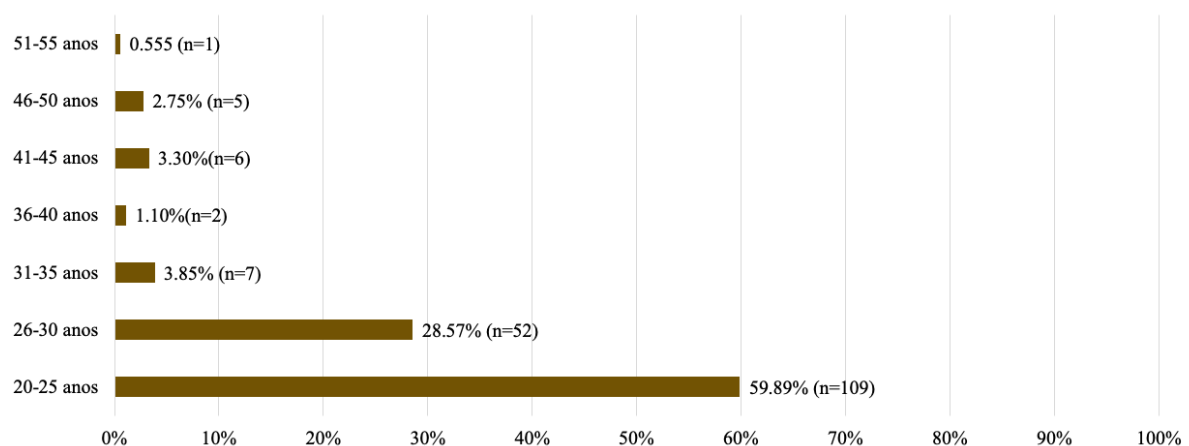
Program (n=35)	Respondents n= (%)
Master's in Early Childhood Education and Teaching of 1st CEB	57 (31.3)
Master's in Physical Education Teaching in Basic and Secondary Education	32 (17.6)
Master's in Teaching 1st CEB and Mathematics and Natural Sciences in 2nd CEB	32 (17.6)
Master's in Early Childhood Education	27 (14.8)
Master's in Teaching 1st CEB and Portuguese and History and Geography of Portugal in 2nd CEB	27 (14.8)
Master's in English Teaching in 1st CEB	6 (3.3)
Master's in Music Teaching	1 (0.5)

Source: author's elaboration.

Regarding gender, 86.3% of participants identified as female, confirming studies that indicate the feminization of the teaching profession (Santos, 2022); 13.2% identified as male, and 0.5% chose not to disclose their gender. The geographical coverage achieved across the 18 districts of mainland Portugal was 77.8% (14 districts).

Figure 1 presents the distribution of respondents by age group in ascending order. It can be observed that 88.5% are between 20 and 30 years old, while only one participant is in the 51–55 age range. The minimum age is 23 years, and the maximum age is 55 years.

Figura 1. *Age profile of respondents*



Source: author's elaboration.

Categorization scale

Sections 2, 3, and 4 consist of 24 items designed to measure respondents' perceptions using a five-point agreement scale, where a score of 1 corresponds to "strongly disagree"; 2 to "partially disagree"; 3 to "neither agree nor disagree"; 4 to "partially agree"; and 5 to "strongly agree." Respondents were also given the option to indicate "don't know/don't want to answer," with such responses scored as 0 points.

To enable a structured and interpretable analysis of the results obtained from participants' responses, a categorization scale was established based on the mean scores calculated for sections 2, 3, and 4 of the questionnaire. This classification was defined according to the following intervals: ≤ 2.5 (low), 2.6–3.0 (acceptable), 3.1–3.5 (good), 3.6–4.0 (very good), and ≥ 4.1 (excellent). The assignment of these categories is based on the statistical distribution of the mean scores, allowing a comparative and qualitative evaluation of respondents' perceptions. This approach facilitates the identification of trends, supporting the analysis of ICT integration in the curriculum, the availability of infrastructure, and the preparation provided by institutions for the development of teachers' digital competencies.

Data collection and analysis

The data collection instrument was incorporated into an online form made available through Google Forms via an institutional account (edu.ulisboa.pt). The data collected through the online form were exported and subsequently imported into SPSS version 29, where they underwent statistical processing and analysis. This process enabled the systematic organization and exploration of the data, ensuring the integrity and reliability of the information obtained.

RESULTS AND DISCUSSION

Integration of ICT in ITE

Table 2 presents the mean and standard deviation values of the responses obtained from the application of the questionnaire to students enrolled in the investigated master's programs (with response values ranging from 1 to 5 points).

Table 2. Mean values and standard deviation for section 2

Instrument item	Mean (standard deviation)
2,1	3,52 (1,493)
2,2	3,44 (1,203)
2,3	3,44 (1,204)
2,4	3,65 (1,205)
2,5	4,01 (1,008)
2,6	4,36 (0,829)
2,7	3,56 (1,348)
2,8	3,13 (1,151)
2,9	3,64 (1,116)

Source: author's elaboration.

The mean scores for items 2.5 and 2.6, rated qualitatively as “very good” and “excellent,” respectively, indicate that, according to the perception of the master's students surveyed, there is a high level of confidence and preparation to undertake future teaching and learning processes mediated by ICT. It is also observed that these students are highly aware that ICT will be required as a component of their future professional practice. These data confirm that ICT knowledge acquired in ITE provides prospective teachers with positive beliefs regarding how they should conduct teaching and learning processes supported by ICT (Günbaş, 2022; Kulaksız & Toran, 2022).

These results corroborate data reported by the European Commission, Directorate-General for Education, Youth, Sport and Culture (2020), which indicate that, among Portuguese teachers who reported having received ICT training in ITE, 72% were trained in the last five years (2015–2019). Thus, it can be inferred that teachers in Portugal with less professional experience possess greater knowledge regarding the pedagogical applicability of ICT in teaching practice.

The scores for items 2.1, 2.2, 2.3, 2.7, and 2.8 represent the lowest scores in Section 2, although they still achieved a qualitative score considered “good.” These results are not necessarily negative; however, two points of attention should be noted. The first concerns item 2.1, whose score almost reaches the qualitative rating of “very good” but exhibits the highest standard deviation in the section, revealing a lack of consensus among students regarding the existence of a specific ICT course in the master's programs. The second point refers to item 2.8, in which a significant number of students ($n = 49$) chose not to respond; this item also presented the lowest quantitative score in the section, indicating some uncertainty among students as to whether the master's program they are attending, in terms of ICT-based learning, is equivalent to programs in other European countries.

The lack of consensus regarding a specific ICT course unit (item 2.1) is noteworthy when compared with the data presented by Silva and Costa (2022), which show significant variations in the provision of specific ICT courses among the Portuguese universities analyzed (16.66% at the University of Lisbon; 58.33% at the University of Minho; and 37.50% at Nova University of Lisbon). Loução and Pedro (2023) also suggest that ICT should not be confined to a single, isolated course unit but rather should benefit from being integrated into other subjects. The uncertainty concerning equivalence with other European countries (item 2.8) may reflect the lack of large-scale comparative studies, as pointed out by Hennessy et al. (2022) and Vieira and Pedro (2023).

With a higher average score, rated qualitatively as “very good,” items 2.4, 2.9, and 2.10 reveal positive perceptions among students regarding the programs they attend, indicating that the ICT preparation provided by the investigated ITE institutions is considered satisfactory by the students.

Knowledge and infrastructure for the development of digital competencies in ITE

Table 3 presents the mean and standard deviation values for the eight questions answered by students enrolled in the master's programs in teaching within this section of the questionnaire.

Table 3. Mean values and standard deviation for section 3

Instrument item	Mean (standard deviation)
3,1	4,31 (0,863)
3,2	3,80 (1,001)
3,3	3,45 (1,123)
3,4	3,60 (1,114)
3,5	3,46 (1,285)
3,6	3,49 (1,371)
3,7	3,12 (1,385)
3,8	3,15 (1,414)
2,9	3,64 (1,116)

Source: author's elaboration.

According to the students' perception, the master's programs in teaching satisfactorily provide digital tools that enable the development of teaching competencies with ICT (item 3.4). Likewise, students positively self-assessed their prior knowledge of ICT for educational application, even before enrolling in the master's programs (item 3.2). In both cases, the mean scores were rated qualitatively as “very good,” with item 3.2 standing out for its highest level

of participation (responses from all students) and evidencing their confidence in their ability to develop teaching and learning processes mediated by ICT. It is worth noting that this perception of confidence had already been identified in item 2.5 of the previous section, establishing a trend in students' perceptions within this study. Additionally, item 3.1 achieved the highest score in this section, further reinforcing students' confidence in relation to ICT, which may partly be attributed to a generational factor, considering that 60% of the respondents are aged between 20 and 25 years.

On the other end of the results for Section 3 are items 3.3, 3.5, 3.6, 3.7, and 3.8, which, although achieving a qualitative score considered "good," reveal some deficiencies in the provision of physical and digital ICT infrastructure by the institutions offering the master's programs. Particular attention should be given to the availability of digital infrastructure (software), as reflected in students' responses to items 3.7 and 3.8, both of which recorded the lowest mean scores. These data indicate limited attention by the programs in providing knowledge, preparation, and digital infrastructure concerning the educational use of digital platforms and applications. In this context, it is important to emphasize that digital transformation and strong ICT performance among future teachers should not be limited merely to the consumption of digital technological tools (Espejo-Villar et al., 2022). Furthermore, a greater curricular alignment in ITE is defensible, allowing for a clearer assessment of the digital competencies being taught to future teachers (Comissão Europeia, 2019).

Development of teachers' digital competencies based on the DigCompEdu framework

Table 4 presents the mean and standard deviation values for the six questions answered by students enrolled in the master's programs in teaching in this section of the questionnaire, derived from the aforementioned framework.

Table 4. Mean values and standard deviation for section 4

Instrument Item / DigCompEdu Area	Mean (standard Deviation)
4.1 (Area 1 – Professional Engagement)	3.16 (1.298)
4.2 (Area 2 – Digital Resources)	3.87 (0.959)
4.3 (Area 3 – Teaching and Learning)	3.70 (1.046)
4.4 (Area 4 – Assessment)	3.65 (1.088)
4.5 (Area 5 – Empowering Learners)	3.39 (1.233)
4.4.6 (Area 6 – Facilitating Learners' Digital Competence)	4.25 (0.867)

Source: author's elaboration.

The six items in this section yielded results that were relatively close to each other, with each item addressing one of the six areas/dimensions of knowledge outlined by DigCompEdu.

According to the students' perceptions, the scores of the responses fell qualitatively within the following classifications: "good" (items 4.1 – Professional Engagement and 4.5 – Empowering Learners), "very good" (items 4.2 – Digital Resources, 4.3 – Teaching and Learning, and 4.4 – Assessment), and "excellent" (item 4.6 – Facilitating Learners' Digital Competence).

In Area 6 of DigCompEdu, investigated in item 4.6 (Facilitating Learners' Digital Competence), the highest score in this section was achieved according to the students' perceptions. This reinforces the trend already identified in the previous sections regarding the positive belief of future teachers in their ability to develop teaching and learning processes with ICT in their future professional practice. Based on this finding, it is reasonable to infer that the efforts undertaken over the past decades and the recommendations of experts have borne fruit in promoting the integration of digital technologies and their effective use in the professional practice contexts of future teachers (Dale, 2000; Espejo-Villar et al., 2022; Graça et al. 2021; Martinez et al., 2015; Simões & Faustino, 2019).

Two areas of DigCompEdu, according to students' perceptions, proved to be more fragile and obtained the lowest scores in Section 4: Area 1 (item 4.1), which refers to teachers' digital knowledge for interaction with school teams, and Area 5 (item 4.5), which addresses educators' digital competencies in selecting, applying, and developing digital educational resources for student activities. The score of Area 5 reinforces the weakness already identified in Section 3, item 3.8, which also recorded a low score and investigated the same topic. Therefore, it is noteworthy that in the training provision of the investigated HEIs, little attention is given to preparing future teachers to acquire competencies related to the selection, operation/handling, and development of technological applications for educational purposes.

CONCLUSIONS

The questionnaire used demonstrated adequate validity and reliability for the proposed research, with a consistent structure and items well aligned with the construct studied. Therefore, the instrument is considered valid for capturing students' perceptions regarding the integration of ICT in ITE, allowing for the collection of reliable and relevant data.

Among the main results achieved by this study, the following can be highlighted: (1) it was identified that students exhibit a high level of positive belief that promotes the confidence of future teachers regarding their professional practice in teaching and learning processes mediated by ICT, as well as a high level of awareness that ICT will be valued as a component of their future professional practice; (2) students demonstrate satisfaction with the level of digital preparation provided by their HEIs, while also showing the ability to positively self-assess their prior ICT knowledge for educational application, even before entering the master's programs

they are currently attending; (3) the high level of belief and confidence students have in their ability to engage in teaching and learning processes supported by ICT.

Another quite evident finding was the weakness in Area 5 of the DigCompEdu, which refers to educators' digital competencies in selecting, applying, and developing digital educational resources for use in student learning activities; this weakness was further reinforced by evidence in item 3.8, which also obtained a low score and addressed the same theme of teaching competencies. Thus, this training deficit is highlighted as a point requiring particular attention and targeted improvement in the training offerings provided by the investigated HEIs.

These results, based on students' perceptions, provide an important counterpoint to studies analyzing curricula and trainers' perspectives. While students demonstrate confidence, Loução and Pedro (2023) and Fonseca (2019) point to trainers' insecurity and to the lack of preparation and low self-confidence of future teachers identified in other studies. Vieira and Pedro (2023) and Silva and Costa (2022) show that, although there is some integration of ICT and the DigCompEdu in curricula, this is often "timid" or uneven across institutions.

Similarly, despite the positive results demonstrated by students' perceptions, the current situation of Portuguese teachers working in basic education has indicated low proficiency in the following DigCompEdu areas/dimensions: 3 – Teaching and Learning (related to item 4.3 mentioned above), 4 – Assessment, and 6 – Facilitating Learners' Digital Competence (Lucas & Bem-haja, 2021). Therefore, according to recent literature in the field, if the DigCompEdu dimensions are being well addressed in ITE, future teachers will certainly respond positively in their future teaching practice, as this knowledge positively shapes their beliefs about teaching with ICT (Günbaş, 2022; Kulaksız & Toran, 2022) and, with more positive beliefs about how to teach with ICT, teachers will be more likely to act as key agents of educational change with technologies alongside their future students (García et al., 2022).

In the context of this investigation, the most prominent result, which was positively present in all three sections analyzing the students' perceptions, is associated with the level of confidence these future teachers demonstrated in their responses when assessing their preparation to engage in teaching and learning processes supported by ICT. The results were among the highest scores in all sections of the questionnaire; therefore, a positive belief among students regarding the educational use of ICT and its importance for the development of their future professional careers was revealed.

Regarding the objectives established in this study, according to the participants' perceptions: the course units adequately integrate ICT into ITE (OB1 and OB2); except for some weaknesses identified in the master's programs, the knowledge and teaching and learning processes mediated by ICT are provided in a way that meets the demands of contemporary society (OB3); the physical and digital infrastructure of the HEIs is adequate to prepare future

teachers with ICT competencies (OB4); and the European framework of digital competencies for educators is properly integrated into ITE (OB6).

As a limiting factor of the study, it is taken into consideration that all perceptions expressed in the questionnaire responses are shaped by the subjectivity of each respondent; therefore, the results indicate a trend rather than necessarily ensuring the actual reality.

Finally, the study highlights the importance of research, international initiatives, and national measures that have been guiding the integration of ICT in ITE, as only through recognizing the importance of investigating, improving knowledge, and developing mechanisms and tools to achieve this purpose (Kožuh, 2021) will nations, through education, be able to raise their populations' level of knowledge regarding ICT (Kolade & Owoseni, 2022). ITE plays an important role in promoting the informed, critical, and responsible use of technologies by future teachers. The systemic and systematic integration of technologies into teaching practices and training curricula is essential for future teachers to understand their importance, usefulness, risks, and benefits.

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