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Digital competence of primary school teachers in Andalusia (Spain): A multidimensional analysis based on self-perceptions

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ABSTRACT

This study analyzes the self-perception of digital teaching competence (DTC) among primary education teachers in Andalusia, using an instrument based on the European DigCompEdu framework. Data were collected through a self-administered online questionnaire applied to a sample of 416 primary education teachers working in Andalusia. The study employed a mixed-methods design, combining quantitative analyses (descriptive, correlational, and comparative) with qualitative analysis of open-ended responses.

Employing a mixed-methods approach, the research assesses teachers' competence levels and examines differences according to professional experience, school ownership, teaching specialization, and territorial distribution. Results indicate that most teachers perceive themselves at intermediate levels of digital competence, with limited presence of advanced profiles. No statistically significant differences were found across professional or institutional variables, although descriptive trends emerge related to specialization, educational stage, and province. Personal factors—particularly professional confidence, beliefs regarding the usefulness of technology, and intrinsic motivation—emerge as the main facilitators of competence development, whereas time constraints, institutional support, and access to resources are identified as persistent barriers. The findings highlight the need to design personalized, sustained, and context-sensitive training strategies that address both personal and organizational dimensions to foster advanced pedagogical integration of digital technologies in the classroom.

1. Introduction

Digital technologies have become a central component of contemporary societies, shaping how individuals communicate, access information, work, and learn. In education, Information and Communication Technologies (ICT) have transformed teaching and learning environments by enabling new forms of interaction, personalization, and access to knowledge. However, their integration has also raised persistent challenges related to pedagogical coherence, equity, and meaningful use, reinforcing the idea that the educational value of ICT depends less on their availability than on how they are pedagogically integrated into teaching practice. While numerous studies report positive effects of digital tools and innovative methodologies on student motivation and engagement (e.g., Dočekal & Tulinská, 2015; Toma et al., 2023; Vouglanis, 2023), others highlight limited or inconsistent outcomes when

technology is introduced without adequate pedagogical planning (Karamti, 2016).

Within this debate, teachers' digital competence has emerged as a key factor mediating the effective integration of ICT in the classroom. Although a substantial body of research has examined the impact of specific technologies or digital resources on students' learning processes (e.g., Ardelean et al., 2023; Colomo-Magaña et al., 2020; Gan et al., 2015; Ladage et al., 2023), comparatively less attention has been paid to teachers' own digital competence, particularly in early childhood and primary education. This gap is especially relevant given that curricular initiatives aimed at developing students' digital skills are unlikely to succeed if teachers lack the competence required to implement digital technologies in pedagogically meaningful ways.

In response to this need, several frameworks have been developed to conceptualize and assess teachers' digital competence. Among them, the

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Technological Pedagogical Content Knowledge (TPACK) model (Koehler & Mishra, 2009), building on Shulman's (1987) work, highlights the interdependence of technological, pedagogical, and content knowledge. Complementing this approach, the European Framework for the Digital Competence of Educators (DigCompEdu) (Redecker & Punie, 2017) has become a widely adopted reference for assessing teachers' digital competence across educational systems. DigCompEdu conceptualizes digital teaching competence as a multidimensional construct encompassing professional engagement, digital resources, digital pedagogy, assessment, student empowerment, and the development of students' digital competence. While these frameworks have contributed to standardizing assessment criteria and guiding professional development, existing empirical evidence remains largely descriptive and frequently relies on single-method approaches. The importance of teachers' digital competence becomes particularly evident when considering its relationship with students' academic performance. Research consistently indicates that ICT can enhance learning outcomes, motivation, and engagement only when its use is pedagogically sound and supported by adequate teacher training (Addeo et al., 2021; Lawrence & Tar, 2018; Romero-Rodríguez et al., 2020; Veiga & Andrade, 2021). Consequently, insufficient digital competence among teachers may limit the transformative potential of ICT, underscoring the need for sustained professional development and supportive institutional conditions (Collado-Sánchez et al., 2023).

Despite growing international interest in teachers' digital competence, empirical evidence remains unevenly distributed across educational stages and contexts. Research focusing specifically on primary education is still relatively limited (Collado-Sánchez et al., 2023; Galindo-Domínguez & Bezanilla, 2021), and studies conducted in decentralized education systems are particularly scarce. In the Andalusian context, regional data indicate that more than 45% of teachers report beginner or basic levels of digital competence (Junta de Andalucía, 2021; Palacios-Rodríguez et al., 2020), raising concerns about the system's capacity to respond effectively to current digital demands. Taken together, existing research suggests that while ICT integration has been widely examined, less attention has been paid to teachers' self-perceived digital teaching competence as a multidimensional construct and to how such perceptions relate to professional experience, institutional conditions, and contextual factors—particularly in primary education and decentralized systems.

1.1. Study rationale

Taken together, prior research highlights the relevance of teachers' digital competence for the effective integration of ICT in educational practice, while also revealing persistent challenges related to training, institutional support, and pedagogical implementation. Although existing studies have provided valuable insights into digital competence frameworks and technology use in education, evidence remains fragmented and often limited to descriptive or single-method approaches. Moreover, the rapid pace of digital transformation in education, intensified by recent systemic changes, underscores the need for updated, context-sensitive analyses that examine teachers' digital competence in relation to both professional and contextual variables. In this context, a comprehensive and mixed-methods approach is required to better understand how teachers perceive their digital competence and which factors currently facilitate or hinder its development.

Despite the growing body of research on teachers' digital competence and the widespread adoption of the DigCompEdu framework, several relevant gaps remain. Existing studies have predominantly focused on either descriptive assessments of digital competence levels or on specific dimensions of competence in isolated contexts, often relying exclusively on quantitative approaches. Moreover, there is limited empirical evidence combining large-scale quantitative self-perception data with qualitative insights that explore how teachers themselves interpret the factors facilitating or hindering their digital competence development.

In addition, research examining digital teaching competence within decentralized education systems, such as the Andalusian context, remains scarce, particularly at the level of primary education. As a result, there is a need for multidimensional and mixed-methods studies that not only assess teachers' self-perceived digital competence, but also analyze its relationship with professional and contextual variables and identify perceived facilitators and barriers. The present study addresses these gaps by adopting a mixed-methods design grounded in the DigCompEdu framework to provide a comprehensive and context-sensitive analysis of primary education teachers' digital teaching competence in Andalusia.

The objectives of this study are threefold. First, the study aims to assess the level of self-perceived digital teaching competence among primary education teachers in Andalusia, using the DigCompEdu framework as a reference. Second, it seeks to examine whether significant differences in self-perceived digital teaching competence exist according to professional and contextual variables, such as years of experience, teaching specialization, type of educational institution, and educational stage. Third, the study aims to identify the personal and institutional factors that teachers perceive as facilitating or hindering the development of their digital teaching competence.

1.2. Study objectives and research questions

Building on the identified research gaps—namely, the predominance of single-method evidence, the limited integration of large-scale self-perception data with qualitative accounts, and the scarcity of empirical studies focused on decentralized primary education systems—this study articulates a set of objectives operationalized through three research questions.

The first research question (RQ1) addresses the need for updated, context-sensitive evidence on primary education teachers' self-perceived digital teaching competence, framed within the DigCompEdu model. The second research question (RQ2) responds to the limited and inconsistent findings regarding the influence of professional and contextual variables on digital competence development, particularly in decentralized education systems. Finally, the third research question (RQ3) seeks to complement the quantitative profile by incorporating teachers' own perspectives on the personal and institutional factors that facilitate or hinder the development of digital teaching competence, thereby addressing the scarcity of mixed-methods approaches in this field.

Although the present study is situated within the Andalusian context, its objectives are closely aligned with broader international debates on teachers' digital competence and professional development. By adopting the DigCompEdu framework—widely implemented across European and international education systems—this research contributes comparative evidence on teachers' digital competence perceptions in relation to pedagogical practice, professional engagement, and contextual conditions. Moreover, the analysis of professional and institutional variables, together with the identification of perceived facilitators and barriers, offers insights transferable to other decentralized or regional education systems facing similar challenges in the design and implementation of teacher training systems and digital education policies.

Based on these considerations, the present study seeks to answer the following research questions:

RQ1. Does the self-perception of Andalusian primary school teachers reflect a level of digital teaching competence in line with the demands of today's educational context?

RQ2. Are there significant differences in self-perceived digital teaching competence according to professional experience, teaching specialization, or institutional characteristics?

RQ3. What personal or institutional factors do teachers identify as facilitators or barriers in the development of their digital teaching competence?

1.3. Expected contributions of the study

Beyond its specific objectives, this study aims to make several contributions at theoretical, methodological, and practical levels. From a theoretical perspective, the research contributes to ongoing international debates on teachers' digital competence by providing empirical evidence grounded in the DigCompEdu framework and by reinforcing a multidimensional understanding of digital teaching competence that integrates pedagogical, professional, and contextual dimensions.

From a methodological perspective, the study advances existing DigCompEdu-based research by combining large-scale quantitative self-perception data with qualitative insights into teachers' own interpretations of facilitating factors and barriers. This mixed-methods design allows for a more nuanced analysis of digital competence development than approaches relying exclusively on descriptive or single-method evidence. Finally, from a practical and policy-oriented perspective, the findings offer transferable insights for teacher training and professional development in decentralized or regional education systems. By identifying both personal and institutional conditions associated with digital competence development, the study provides evidence that may inform the design of context-sensitive training strategies and digital education policies beyond the Andalusian context.

2. Materials and method

2.1. Participants and procedure

The target population of the study consists of active teachers who teach in public, semi-private, and private Primary Education centers in the autonomous community of Andalusia. The final sample size was 416 participants, who voluntarily completed a self-administered online questionnaire.

The selection procedure was carried out through non-probabilistic convenience sampling, using professional associations, teaching networks, educational forums, and institutional platforms as dissemination channels. Although the study was specifically aimed at teachers in Andalusia, the open distribution strategy allowed for the participation of teachers from other autonomous communities. In order to maintain consistency with the territorial objective of the study, only the data from participants who stated that they worked in institutions located in Andalusia were included in the main analysis. Responses from outside this community were considered solely for preliminary comparison and trend stability checks, without forming part of the core interpretation of the results.

The inclusion criteria were: (1) currently working as a teacher in Primary Education centers, (2) working in Andalusia, and (3) explicitly agreeing to participate in the study through informed consent at the beginning of the questionnaire. The exclusion criteria were: (1) working outside Andalusia, (2) performing teaching duties at educational stages other than Primary, and (3) submitting incomplete questionnaires or those with inconsistent responses.

Data collection was carried out using the Microsoft Forms tool, which is enabled for use in educational settings. The link to the questionnaire remained active for a period of four weeks.

In quantitative terms, the sample size obtained ($N = 416$) is considered adequate for descriptive studies such as this one. Based on Vallejo's (2012) criteria for a 95% confidence level ($z = 1.96$) and assuming maximum population variance ($p = q = 0.5$), a sample of 384 subjects allows for estimates with a $\pm 5\%$ margin of error. The collected sample exceeds this threshold, providing a sufficiently robust basis for generalizing the results within the defined territorial framework. Nevertheless, it is acknowledged that non-probabilistic sampling formally limits the statistical representativeness of the general population, so the conclusions should be interpreted with caution and directly in relation to the described sample profile.

2.2. Instrument

The design of the instrument used in this study was based on the adaptation of two widely recognized methodological benchmarks. On the one hand, elements from the questionnaire used by Carpenter et al. (2024) were incorporated, focusing on the contextual analysis of digital competence in the university setting. On the other hand, structural and conceptual principles from the European DigCompEdu framework (Redecker & Punie, 2017) were integrated, with the aim of ensuring both the epistemological and operational coherence of the construct "teachers' digital competence" within the educational environment. This combination enabled the development of a solid evaluative proposal, theoretically grounded and adapted to the objectives of the study.

The validation instrument for the questionnaire consisted of 13 main questions and 2 final questions of a global nature, which were evaluated based on clarity, relevance, and purpose. From this tripartite structure, 45 differentiated items were generated and submitted to the judgment of a panel of experts using a five-level Likert scale (1 = strongly disagree; 5 = strongly agree), selected for its ability to capture nuanced assessments in content validation contexts. The validation procedure was carried out between December 2024 and March 2025, following a purposive sampling strategy. Seventeen experts were invited, whose suitability was determined based on three fundamental criteria: more than five years of professional experience in the field of technologies applied to education; self-perceived competence to issue evaluative judgments on instruments related to digital teaching competence; and the successful completion of the assigned validation phase.

The validation of the questionnaire was carried out by a panel composed of 17 experts in educational technology from various Ibero-American countries, such as Spain, Ecuador, and Chile, affiliated with both public and private institutions. The group included 2 education professors, 14 university lecturers, and 1 master's level instructor in educational innovation. This diverse and specialized academic composition enabled a rigorous review of the instrument from pedagogical, methodological, and contextual perspectives, thus ensuring a solid content validity adapted to digital training environments in higher education.

The experts evaluated each item considering the three previously mentioned dimensions. Based on their responses, various quantitative analyses were carried out to assess the content validity of the instrument: calculation of the average per item, the Content Validity Index (I-CVI), the score (product of the mean and I-CVI), as well as Fleiss' Kappa coefficient, the latter aimed at identifying the degree of inter-rater agreement beyond chance. The analysis of the scores revealed that the item values ranged between an average (\bar{x}) of 3.76 and 4.88, with an overall mean of 4.47 out of 5, indicating a favorable perception of the proposed content (Table 1). For its part, the I-CVI was calculated following the criterion established by Hyrkás et al. (2003), considering as valid those items that received a score of 4 or 5 from at least 78% of the evaluators. In this regard, 36 items met the acceptance threshold, while 9 did not reach this criterion, which justifies their possible revision. The global validity index S-CVI/Ave reached a value of 0.861, indicating a high level of inter-rater agreement. On the other hand, the average score, resulting from the combination of the degree of agreement and the rating given, was 3.86 points out of 5, which confirms the overall adequacy of the instrument.

$$CVI = \frac{N \text{ of raters giving a rating of 4 or 5}}{N \text{ total of raters}}$$

Finally, the analysis of Fleiss' Kappa coefficient, calculated by grouping items by question and considering the three evaluated dimensions, yielded low values, close to zero. This trend is common in Likert-type scales with multiple levels, where slight variations between scores can be interpreted as a lack of consensus. Nevertheless, the complementarity between the results of the CVI, the score, and the average analysis supports the conclusion that there is an acceptable level

Table 1
Contingency table of expert judgment on the instrument.

Dimensions	\bar{X} Clarity	\bar{X} Relevance	\bar{X} Purpose	\bar{X} Total	CVI	Score
Professional profile and educational context of the teacher	4.49	4.65	4.67	4.60	0.87	4.04
Professional attitude towards digital transformation	4.35	4.41	4.41	4.39	0.80	3.53
Management and adaptation of digital resources	4.53	4.88	4.65	4.69	0.90	4.23
Pedagogical integration of digital tools	4.35	4.71	4.47	4.51	0.90	4.06
Digital assessment and formative feedback	4.35	4.82	4.59	4.59	0.88	4.06
Promoting digital autonomy among students	4.29	4.41	4.35	4.35	0.86	3.76
Promotion of digital skills among students	4.24	4.71	4.47	4.47	0.88	3.95
Personal and institutional conditions for digital teaching development	4.12	4.74	4.62	4.49	0.87	3.94

of agreement among the participating experts, thus consolidating the validity of the questionnaire as a diagnostic tool for the self-perception of digital teaching competence.

2.2.1. Structure and content of the instrument

The instrument used in this study was designed to assess teachers' self-perceived Digital Teaching Competence (DTC) in accordance with the European DigCompEdu framework (Redecker & Punie, 2017). It consists of 45 Likert-type items organized around the six DigCompEdu competence areas: (1) Professional engagement, (2) Digital resources, (3) Digital pedagogy, (4) Assessment and feedback, (5) Student empowerment, and (6) Facilitating students' digital competence development.

Each item was formulated to capture teachers' perceived competence in pedagogical, professional, and contextual aspects of digital technology integration, rather than purely technical skills. Items were answered on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). A detailed mapping of items to DigCompEdu dimensions is provided in Table 2 to ensure transparency and replicability.

For each participant, a global Digital Teaching Competence (DTC) score was calculated as the arithmetic mean of all item responses. In addition, mean scores were computed for each DigCompEdu competence area. To facilitate interpretability and ensure alignment with the DigCompEdu proficiency model, both overall and dimensional scores were classified into five competence levels using theoretically defined cut-off points based on the structure of the five-point Likert scale. Specifically, mean scores between 1.00 and 1.80 were classified as A1 (Beginner), indicating an initial or emerging level of digital competence. Scores ranging from 1.81 to 2.60 corresponded to A2 (Explorer), reflecting basic engagement with digital technologies. Mean values between 2.61 and 3.40 were categorized as B1 (Integrator), representing a moderate and functional integration of digital tools into teaching practice. Scores from 3.41 to 4.20 were classified as B2 (Expert), indicating advanced and confident pedagogical use of digital technologies. Finally, mean scores between 4.21 and 5.00 were assigned to C1 (Leader), reflecting a high level of digital teaching competence characterized by innovation, leadership, and strategic use of ICT.

Table 2
Mapping of questionnaire items to DigCompEdu competence areas.

DigCompEdu area	Item range	Conceptual focus
Professional engagement	Items 1–7	Use of digital tools for professional communication, collaboration, and continuous professional development
Digital resources	Items 8–14	Selection, creation, adaptation, and management of digital educational resources
Digital pedagogy	Items 15–22	Pedagogical integration of digital technologies to support active and collaborative learning
Assessment and feedback	Items 23–28	Use of digital tools for assessment, monitoring, and formative feedback
Student empowerment	Items 29–34	Personalization, inclusion, and support of students' autonomy through digital technologies
Facilitating students' digital competence	Items 35–45	Promotion of students' digital literacy, problem-solving, and responsible technology use

Note. Item numbering corresponds to the final validated version of the questionnaire. The full instrument is available as supplementary material to facilitate replication.

This classification approach has been widely used in DigCompEdu-based self-assessment studies and allows for consistent comparison across contexts while preserving the ordinal nature of the measurement scale. The internal consistency of the instrument was examined using Cronbach's alpha coefficient. The overall scale showed high internal reliability ($\alpha > .90$), indicating strong coherence among the items measuring digital teaching competence. Reliability indices for the six DigCompEdu dimensions ranged from acceptable to excellent levels ($\alpha > .70$), supporting the internal consistency of each subscale and the robustness of the instrument for research purposes.

2.3. Data analysis

The data analysis followed a mixed-methods approach, combining quantitative and qualitative techniques to provide a comprehensive understanding of teachers' self-perceived Digital Teaching Competence (DTC). Quantitative analyses included descriptive statistics to characterize the sample and to determine overall and dimensional levels of self-perceived digital teaching competence. Correlational analyses were conducted using Spearman's rho to examine the relationship between the global DTC score and the specific DigCompEdu competence areas, given the ordinal nature of the Likert-type data. Correlation coefficients were interpreted following the criteria proposed by Cohen (1988) and Dancy and Reidy (2007). Comparative analyses were performed to explore potential differences in DTC self-perception according to professional experience, type of educational institution, teaching specialization, educational stage, and territorial distribution. Prior to inferential analyses, assumptions of normality and homoscedasticity were examined. When parametric assumptions were met, analysis of variance (ANOVA) tests were applied. In cases where these assumptions were not met, non-parametric alternatives, specifically the Kruskal–Wallis test, were used. This decision-making process ensured the appropriate selection of statistical tests based on the characteristics of the data.

In addition to statistical significance testing, effect sizes were calculated to estimate the magnitude of observed differences. Eta squared (η^2) was reported for ANOVA analyses, and epsilon squared (ϵ^2) was used for Kruskal–Wallis tests, following recommended guidelines in educational research. Effect sizes were interpreted as negligible, small, moderate, or large according to conventional thresholds.

In parallel, a qualitative thematic content analysis was conducted on 277 open-ended responses included in the questionnaire. An inductive coding approach was adopted to identify recurring themes related to perceived facilitators and barriers in the development of digital teaching

competence. The coding process involved an initial open coding phase, followed by the grouping and refinement of categories to ensure conceptual coherence and analytical clarity. The qualitative analysis was conducted by a single researcher and was used to complement and enrich the quantitative findings by providing contextualized insights into teachers' perceptions and experiences. Although no formal inter-coder reliability indices were calculated, the systematic and transparent coding procedure enhances the credibility and interpretative value of the qualitative results.

3. Results

This section presents the results derived from the quantitative and qualitative analyses conducted using the structured questionnaire based on the European DigCompEdu framework. The analysis focuses on determining the level of self-perceived digital teaching competence (DTC) among primary education teachers in Andalusia, as well as exploring potential differences according to professional and contextual variables and identifying perceived facilitating factors and barriers.

3.1. Descriptive statistics of the sample

This subsection presents the descriptive characteristics of the sample in order to contextualize the results of the study and facilitate their interpretation. The final sample consisted of 416 teachers working in Primary Education in the Autonomous Community of Andalusia. The participants represent a broad range of professional and contextual profiles, encompassing different provinces, types of educational institutions, levels of professional experience, and teaching specializations.

As shown in Table 3, the sample includes teachers from diverse institutional contexts, including public, charter, and private schools, as well as professionals at different stages of their teaching careers. Years of teaching experience range from early-career teachers to those with extensive professional trajectories, providing a heterogeneous sample in

Table 3
Demographic and professional characteristics of the sample.

Variable	Category	n	%
Years of teaching experience	Less than 5 years	64	15.38
	6–15 years	107	25.72
	16–25 years	129	31.01
	More than 26 years	84	20.19
Type of educational institution	Other/not specified	6	1.44
	Public	386	92.79
	Charter	20	4.81
Teaching specialization	Private	5	1.20
	Other/not specified	5	1.20
	Primary Education (generalist)	155	37.26
	Secondary Education	132	31.73
	Early Childhood Education	35	8.41
	Therapeutic Pedagogy/Hearing and Language	19	4.57
	Physical Education	11	2.64
Territorial distribution	English	9	2.16
	Music	7	1.68
	Other specializations	43	10.34
	Almería	78	18.75
	Córdoba	49	11.78
	Málaga	37	8.89
	Granada	35	8.41
	Cádiz	30	7.21
	Huelva	24	5.77
	Sevilla	24	5.77
Jaén	23	5.53	
Other provinces	96	23.08	

Note. Percentages may not total 100 due to rounding. Teaching specializations were recoded and grouped for analytical purposes.

terms of accumulated teaching experience. Likewise, a variety of teaching specializations are represented, reflecting the diversity of roles and responsibilities within primary education settings. Table 3 summarizes the main demographic and professional characteristics of the participants, including years of teaching experience, type of educational institution, teaching specialization, and territorial distribution across Andalusian provinces. Frequencies and percentages are reported to provide a clear and systematic overview of the composition of the sample and to support the interpretation of the subsequent analyses.

3.2. Level of self-perception of digital teaching competence among Andalusian teachers (RQ1)

The results allow for the identification of a general profile of self-perceived digital teaching competence among primary education teachers in Andalusia. Based on responses to the overall assessment scale aligned with the DigCompEdu levels, a higher concentration is observed at intermediate levels. Specifically, 25.95% of participants are positioned at level B1, followed by 22.78% at level A2 and 21.52% at level B2. At the lower end, 16.46% of teachers report a basic level (A1), while 13.29% reach level C1, corresponding to advanced competence.

The overall average of self-perception is 3.17 out of 5, which suggests a moderately positive assessment. Nevertheless, these data should be interpreted with caution, as they reflect subjective perceptions rather than an objective evaluation of competence. To examine the relationship between overall DTC self-perception and its specific dimensions, a Spearman correlation analysis was conducted between the global assessment score and five core areas of the DigCompEdu framework. Table 4 presents the correlation coefficients and significance levels.

3.3. Differences in self-perception of digital competence according to experience, employment status, and teaching speciality (RQ2)

To examine potential differences in teachers' self-perception of digital teaching competence (DTC) across professional and contextual variables, comparative analyses were conducted considering years of professional experience, type of educational institution, teaching specialization, employment status, educational stage, and territorial distribution. Table 5 summarizes the mean self-perceived DTC scores for each category, together with the statistical tests applied and corresponding p-values. Regarding professional experience, descriptive differences were observed across groups, with higher mean scores reported by teachers with fewer than five years of experience and progressively lower mean values among teachers with longer professional trajectories. However, the analysis of variance (ANOVA) did not reveal statistically significant differences between experience groups, indicating a relatively homogeneous perception of digital competence across different stages of professional experience (see Table 5).

Similarly, no statistically significant differences were found according to the type of educational institution (public, charter, or private). Although teachers working in charter and private schools reported slightly higher mean self-perception scores than those working in public institutions, these differences did not reach statistical significance, as shown in Table 5. Differences were also examined across teaching

Table 4
Spearman correlations between the overall perception of Digital Teaching Competence (DTC) and its specific dimensions.

Dimension	ρ with general DTC	p	Interpretation
Digital resources	0.73	<0.001	High
Development of the DTC in students	0.61	<0.001	Moderate
Professional commitment	0.61	<0.001	Moderate
Evaluation and feedback	0.58	<0.001	Moderate
Student empowerment	0.54	<0.001	Moderate

Table 5
Differences in self-perceived Digital Teaching Competence (DTC) according to professional and contextual variables (RQ2).

Variable	Category	M	Statistical test	p-value
Years of teaching experience	Less than 5 years	3.31	ANOVA	0.78
	6–15 years	3.25		
	16–25 years	3.07		
	More than 26 years	3.02		
Type of educational institution	Public	3.15	ANOVA	0.25
	Charter	3.31		
Teaching specialization	Private	3.31	Kruskal–Wallis	0.82
	Physical Education	≥3.35		
	Music	≥3.35		
Employment status	Generalist	~3.10	Descriptive	n.s.
	Tenured	3.15		
Educational stage	Substitute	3.27	Descriptive	n.s.
	Early Childhood	2.95–3.10		
	Primary (1st cycle)	2.95–3.10		
	Primary (3rd cycle)	>3.30		
Territorial distribution	Seville	3.67	Descriptive	n.s.
	Málaga	3.15		
	Granada	3.14		
	Cádiz	2.67		
	Almería	2.91		

Note. M = mean; n.s. = not statistically significant. ANOVA and Kruskal–Wallis tests were applied where assumptions were met. Descriptive comparisons are reported when inferential testing was not conducted.

specializations. Higher mean scores were observed in areas such as Physical Education and Music, whereas generalist profiles showed more moderate average values. Nevertheless, the Kruskal–Wallis test confirmed that these differences were not statistically significant, suggesting that self-perceived digital competence does not vary substantially across areas of specialization (Table 5). With respect to employment status, substitute teachers reported slightly higher mean self-perception scores than tenured teachers. These differences are reported descriptively, as no inferential testing was conducted for this variable (Table 5). Analysis by educational stage revealed higher mean self-perception scores among teachers working in the third cycle of primary education, while lower mean values were observed in early childhood education and in the first cycle of primary education. These differences are presented descriptively in Table 5. From a territorial perspective, differences were observed among Andalusian provinces. Teachers in Seville obtained the highest mean self-perception score, followed by Málaga and Granada, whereas lower mean values were reported in Cádiz and Almería. These territorial differences are reported descriptively, without inferring statistical significance (Table 5).

Finally, given that the assumptions of normality and homoscedasticity required for parametric testing were not met in all cases, complementary non-parametric analyses were conducted using the Kruskal–Wallis test. The results of these analyses confirmed the absence of statistically significant differences according to years of experience, type of educational institution, and teaching specialization. Overall, although descriptive differences in self-perceived digital competence are observed across professional and contextual variables, these differences do not translate into statistically significant effects.

In addition to statistical significance testing, the magnitude of observed group differences was examined using effect size indicators. Consistent with the non-significant results obtained in both parametric and non-parametric analyses, effect sizes were small across all professional and contextual variables, suggesting negligible practical

Table 6
Spearman correlations between the general perception of DTC and factors perceived as facilitators or barriers.

Perceived factor	ρ with general DTC	Interpretation
Professional confidence (combined average)	0.51	Moderate-high
Personal beliefs	0.42	Moderate
Institutional integration	0.37	Low-moderate
Access to digital resources	0.29	Low

Note: All correlations were statistically significant ($p < .001$). Interpretation according to Cohen (1988): low (<0.30), moderate (≥ 0.40), high (≥ 0.70).

differences in self-perceived digital teaching competence between groups. Given the exploratory nature of the study and the absence of statistically significant effects, effect size information is reported to support the interpretation that observed variations reflect limited practical relevance rather than meaningful group disparities.

3.4. Facilitating factors and barriers in the development of digital teaching competence (RQ3)

This section presents the results related to the factors perceived by teachers as facilitators or barriers in the development of their digital teaching competence (DTC). These results are derived from a combined analysis of quantitative ratings collected through structured questionnaire items and qualitative data obtained from open-ended responses. The analysis provides an overview of the relative weight assigned by teachers to different personal and institutional factors, as well as the frequency with which these factors emerge in teachers' own accounts.

Teachers assessed a set of personal and institutional factors using a five-point ordinal scale. The highest mean scores correspond to personal factors, particularly beliefs regarding the usefulness of technology for teaching and learning ($M = 3.72$, $SD = 0.97$) and professional confidence in the use of digital tools ($M = 3.71$, $SD = 0.94$; $M = 3.69$, $SD = 1.03$). Access to digital resources also received relatively high ratings ($M = 3.61$, $SD = 1.04$). In contrast, lower mean values were observed for institutional factors such as the integration of ICT at the institutional level ($M = 3.32$, $SD = 1.05$), the availability of time for professional development ($M = 3.30$, $SD = 1.12$), and the provision of technical support ($M = 3.28$, $SD = 1.14$).

To examine the relationship between these factors and overall self-perceived DTC, Spearman correlation analyses were conducted. As shown in Table 6, all analyzed factors are positively and significantly correlated with overall DTC perception ($p < .001$). Professional confidence shows the strongest association ($\rho = 0.51$), followed by personal beliefs about technology ($\rho = 0.42$), institutional integration of ICT ($\rho = 0.37$), and access to digital resources ($\rho = 0.29$).

In addition to the quantitative analysis, a qualitative thematic content analysis was conducted on 277 open-ended responses provided by participants. An inductive coding process led to the identification of ten main categories related to facilitating factors and barriers in the development of digital competence. The most frequently mentioned categories include ongoing teacher training, lack of time, access to technological resources, and professional confidence. Fig. 1 presents the frequency distribution of these categories. For a deeper understanding of these categories, as well as the discursive nuances associated with each, a supplementary table with representative direct quotes and a visualization of the relative occurrence by category have been included as open-access materials.¹

To enhance clarity and provide an integrated overview of the main results, Table 7 summarizes the key findings corresponding to each

¹ Ábalos-Aguilera, F. (2025). *Categorization of qualitative responses on factors that influence DTC* [Data set]. Zenodo. <https://doi.org/10.5281/zenodo.15740727>.

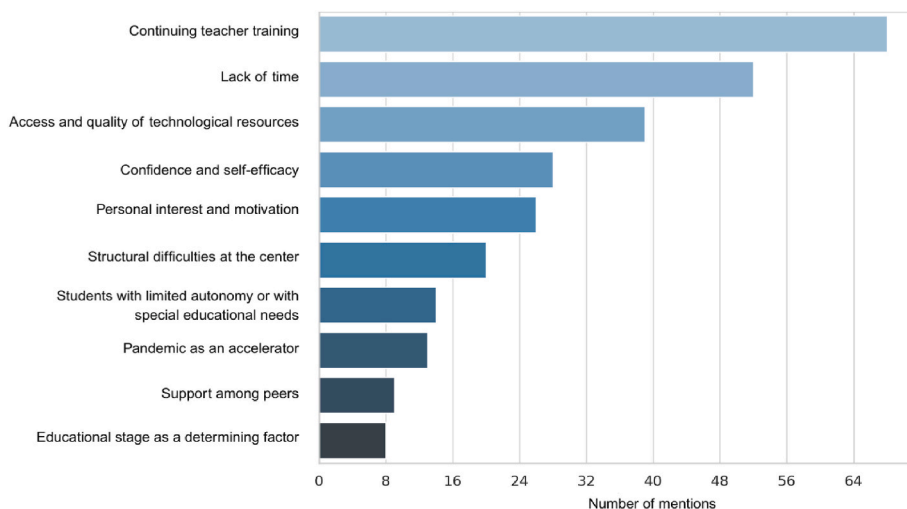


Fig. 1. Factors perceived as determinants of DTC.

research question, together with the analytical procedures used. This synthesis facilitates the interpretation of results and supports the transition to the discussion of their theoretical and practical implications.

4. Discussion

The present study provides a comprehensive overview of primary education teachers’ self-perceived digital teaching competence (DTC) in Andalusia, framed within the European DigCompEdu framework. Overall, the findings indicate that teachers tend to position themselves at intermediate levels of digital competence, with a smaller proportion reaching advanced stages. This profile reflects a functional but still developing level of digital competence, suggesting that although teachers are able to integrate digital technologies into their professional practice, there remains considerable room for growth toward more advanced, critical, and transformative uses of technology in educational contexts.

The results related to the first research question confirm the multi-dimensional nature of teachers’ self-perceived digital competence. Strong associations between the overall DTC score and several DigCompEdu dimensions—particularly the pedagogical use of digital resources, professional engagement, and the development of students’ digital competence—indicate that teachers’ global self-assessments are

Table 7 Summary of main findings by research question.

Research Question	Key Findings	Evidence Source
RQ1	Teachers’ self-perceived Digital Teaching Competence (DTC) is situated at an intermediate level, corresponding mainly to B1–B2 levels in the DigCompEdu framework.	Descriptive statistics (overall mean DTC score)
RQ2	No statistically significant differences were found in self-perceived DTC according to professional experience, type of institution, teaching specialization, employment status, educational stage, or territorial distribution.	ANOVA and Kruskal–Wallis tests ($p > .05$); Table 5
RQ3	Teachers identified professional training, collaboration, and institutional support as main facilitators of DTC development, while lack of time, workload, and limited resources emerged as the main barriers.	Qualitative thematic analysis of open-ended responses

constructed through consistent judgments across interconnected domains. This finding supports previous research that conceptualizes digital competence as an integrated construct combining pedagogical, professional, and learner-oriented components rather than isolated technical skills. With respect to the second research question, the absence of statistically significant differences across most professional and contextual variables points to a relatively homogeneous perception of digital competence among Andalusian teachers. Although descriptive variations were observed according to years of experience, type of educational institution, teaching specialization, employment status, educational stage, and territorial distribution, these differences did not translate into robust inferential effects. This result aligns with prior studies suggesting that digital teaching competence is not primarily determined by structural or career-related variables, such as seniority or institutional ownership, but rather by a combination of contextual conditions, access to training, and individual attitudes toward technology.

The analysis of facilitating factors and barriers (RQ3) provides additional insight into the mechanisms underlying teachers’ digital competence development. Personal factors—particularly professional confidence and positive beliefs about the pedagogical value of technology—emerged as the strongest correlates of overall DTC self-perception. Institutional factors, such as access to digital resources, ICT integration at the school level, and availability of time for professional development, also play a relevant role, although their influence appears more moderate. Together, these findings reinforce the importance of addressing both individual and organizational dimensions when promoting teachers’ digital competence.

This study presents several methodological strengths that enhance the robustness and relevance of its findings. First, it is grounded in the DigCompEdu framework, a well-established and internationally recognized model for assessing teachers’ digital competence, which ensures conceptual rigor and facilitates comparison with prior and future research across different educational systems. Second, the study is based on a large sample of primary education teachers, providing a solid empirical basis for identifying patterns in self-perceived digital teaching competence within the studied context. Third, the adoption of a mixed-methods design constitutes a key strength, as the integration of quantitative analyses with qualitative thematic exploration allows for a more comprehensive and nuanced understanding of teachers’ digital competence, capturing not only competence levels but also the personal and institutional factors that shape their development. Together, these methodological features strengthen the validity of the study and support the interpretative depth of the results.

4.1. Theoretical contribution and practical implications

From a theoretical perspective, this study contributes to the growing body of research that recognizes the DigCompEdu framework as a robust and conceptually sound reference for examining teachers' digital competence from a multidimensional perspective. This perspective is consistent with recent research emphasizing the relevance of emerging pedagogical approaches and digital experiences in education, particularly those that explore innovative and game-informed learning environments as part of broader digital competence frameworks (Abbas & Mahrishi, 2025). The findings support an understanding of digital competence as a complex and integrated construct that extends beyond technical proficiency to encompass pedagogical decision-making, professional engagement, and responsiveness to contextual conditions. By combining quantitative self-assessment data with qualitative insights, the study offers a more nuanced interpretation of teachers' perceptions, highlighting how self-perceived competence is constructed through the interaction of individual beliefs, professional practices, and institutional environments. In this sense, the results reinforce the value of self-perception measures as a meaningful, albeit partial, analytical lens for exploring digital competence, particularly when triangulated with qualitative evidence that captures teachers' experiences and interpretations in their own terms.

From a practical perspective, the results yield important implications for educational policy, school leadership, and teacher professional development. In this regard, the findings align with broader discussions on the social implications of digital transformation in educational contexts, highlighting the need to consider digital competence not only as a technical skill set but also as a factor influencing social development and participation (Youssef et al., 2024). The predominance of intermediate levels of digital competence suggests that many teachers have developed functional capacities to use digital technologies, yet may lack the pedagogical depth or confidence required to implement more transformative and innovative practices. This finding points to the need for sustained and coherent professional development pathways that move beyond short-term, tool-oriented training initiatives. Effective professional development should emphasize pedagogical integration, critical reflection on digital practice, and the strengthening of teachers' professional agency and confidence in technology use. Moreover, in decentralized education systems such as the Andalusian context, the findings underscore the importance of designing context-sensitive strategies that consider institutional conditions, access to resources, and local professional cultures. Such strategies are essential to support equitable and meaningful digital transformation processes that respond to both systemic priorities and the specific needs of educational communities.

4.2. Limitations and future directions

Several limitations of the present study should be acknowledged. First, the sample was obtained through a non-probabilistic convenience sampling strategy, which limits the external validity of the findings. Although the sample includes teachers from different provinces, educational stages, and institutional contexts within Andalusia, it cannot be considered statistically representative of the entire population of primary education teachers. Consequently, the results should be interpreted with caution and should not be generalized beyond the specific context studied.

In this regard, the statistical analyses conducted in this study are intended to identify patterns, tendencies, and associations within the sample rather than to establish population-level causal effects. The use of inferential statistics serves an exploratory and descriptive purpose, allowing for the examination of relationships between variables and the detection of potential differences across professional and contextual groups, but not for drawing definitive conclusions about the broader population.

Future research would benefit from probabilistic sampling designs and larger, more diverse samples that allow for stronger generalization and cross-regional comparisons. Longitudinal and multi-site studies could also help to confirm whether the patterns observed in this study are stable across different educational systems and policy contexts.

5. Conclusions

This study examined primary education teachers' self-perceived Digital Teaching Competence (DTC) in Andalusia through a mixed-methods approach grounded in the DigCompEdu framework. Overall, the findings indicate that teachers' self-perceived DTC is situated at an intermediate level, corresponding mainly to the B1–B2 proficiency levels of the DigCompEdu model. This conclusion is supported by the descriptive statistics of the global DTC score and the dimension-level means, which consistently reflect moderate and functional integration of digital technologies into teaching practice rather than advanced or leadership-oriented use. Regarding professional and contextual variables, the results show that self-perceived DTC does not differ significantly according to years of teaching experience, type of educational institution, teaching specialization, employment status, educational stage, or territorial distribution. Comparative analyses using ANOVA and Kruskal–Wallis tests did not yield statistically significant differences ($p > .05$) across any of the examined variables. In addition, effect size estimates were consistently small, indicating negligible practical differences between groups. These findings suggest a relatively homogeneous perception of digital teaching competence within the sample, regardless of teachers' professional trajectories or institutional contexts.

The qualitative findings provide complementary insights that help explain this quantitative homogeneity. The thematic analysis of open-ended responses revealed that teachers consistently identified professional training opportunities, peer collaboration, and institutional support as the main facilitators of digital teaching competence development. Conversely, lack of time, excessive workload, and limited access to resources emerged as the most frequently reported barriers. These themes were recurrent across different professional profiles, reinforcing the quantitative evidence that contextual and institutional constraints are perceived in similar ways by teachers, independently of their background characteristics.

Taken together, the results suggest that variations in self-perceived digital teaching competence are less associated with individual or contextual variables and more closely related to systemic and organizational conditions affecting teachers' opportunities to develop and apply digital skills. The absence of statistically significant differences across groups, combined with small effect sizes, indicates that perceived disparities in DTC are limited in magnitude and should be interpreted cautiously. Rather than pointing to structural inequalities between professional subgroups, the findings highlight shared challenges and common needs within the teaching population. Although the study is situated within the Andalusian context, its conclusions have broader implications for international debates on teachers' digital competence. The use of the DigCompEdu framework enables comparison with evidence from other educational systems, particularly those characterized by decentralized governance structures. The results underscore the importance of coherent institutional strategies, sustained professional development, and supportive organizational environments as key levers for enhancing digital teaching competence beyond individual-level interventions.

Finally, the study's conclusions must be interpreted in light of its methodological limitations. The use of non-probabilistic convenience sampling restricts the generalizability of the findings beyond the study sample. Accordingly, the statistical analyses are intended to identify patterns and associations within the participating group rather than to infer population-level causal effects. Future research would benefit from probabilistic sampling designs and longitudinal approaches to further examine how digital teaching competence evolves over time and how

targeted policy and training initiatives may influence its development.

CRedit authorship contribution statement

Francisco Ábalos-Aguilera: Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Luis M. Romero-Rodríguez:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Conceptualization. **Bárbara Castillo-Abdul:** Writing – review & editing, Writing – original draft, Resources, Project administration, Conceptualization.

Ethics statement

This study was reviewed and approved by the Ethics Advisory Board of the Rey Juan Carlos University with the approval number: (URJC Code: 220520243262024).

Declaration of the use of AI assisted technologies

None of the authors are native English speakers. Therefore, we used AI-assisted language-editing tools solely for English grammar, spelling, and style correction of the manuscript. Specifically, we used Paperpal and Grammarly for linguistic refinement. No AI tool was used to generate scientific content, conduct analyses, interpret results, or produce original ideas, and the authors take full responsibility for the integrity and accuracy of the work.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssaho.2026.102555>.

Data availability statement

The database used for this research is located in the Zenodo repository: [Abalos Aguilera et al. \(2025\). Categorization of qualitative responses on factors that influence DTC. Zenodo. https://doi.org/10.5281/zenodo.15740727](https://doi.org/10.5281/zenodo.15740727).

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