

REVIEW

Use of ICT in education and generational diversity: a critical review of digital capabilities

Uso de las TIC en la educación y diversidad generacional: revisión crítica de las capacidades digitales

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ABSTRACT

The aim of this study was to carry out a critical and systematic review of the scientific literature on the use of Information and Communication Technologies (ICT) and its relationship with generational diversity of teachers; to analyze how digital competencies are developed in different educational contexts. The methodology was based on the PRISMA model, guaranteeing transparency and rigor in the phases of search, selection and documentary analysis. We reviewed 142 articles published between 2020 and 2025, of which 52 met the inclusion criteria, from databases such as Scopus, Web of Science and SciELO. The results showed that digital teaching competencies represent the main line of research, followed by generational diversity and educational innovation. In addition, a greater scientific production was identified in Europe, especially in Spain and Portugal, while Latin American studies, although growing, remain limited. It is concluded that the educational digital transformation requires sustainable policies, differentiated training programs and ethical and collaborative digital literacy that integrates generational diversity as a strategic resource for pedagogical innovation and professional strengthening.

Keywords: Information and Communication Technologies (ICT); Digital Competences; Generational Diversity; Intergenerational Learning; Educational Innovation.

RESUMEN

El presente estudio tuvo como objetivo realizar una revisión crítica y sistemática de la literatura científica sobre el uso de las Tecnologías de la Información y la Comunicación (TIC) y su relación con la diversidad generacional docente, con el propósito de analizar cómo se desarrollan las competencias digitales en los distintos contextos educativos. La metodología se basó en el modelo PRISMA, garantizando transparencia y rigor en las fases de búsqueda, selección y análisis documental. Se revisaron 142 artículos publicados entre 2020 y 2025, de los cuales 52 cumplieron con los criterios de inclusión, procedentes de bases de datos como Scopus, Web of Science y SciELO. Los resultados evidenciaron que las competencias digitales docentes representan la principal línea de investigación, seguidas por la diversidad generacional y la innovación educativa. Además, se identificó una mayor producción científica en Europa, especialmente en España y Portugal, mientras que los estudios latinoamericanos, aunque en crecimiento, siguen siendo limitados. Se concluye que la transformación digital educativa requiere políticas sostenibles, programas de formación diferenciados y una alfabetización digital ética y colaborativa que integre la diversidad generacional como un recurso estratégico para la innovación pedagógica y el fortalecimiento profesional.

Palabras clave: Tecnologías de la Información y la Comunicación (TIC); Competencias Digitales; Diversidad Generacional; Aprendizaje Intergeneracional; Innovación Educativa.

INTRODUCTION

In recent decades, the use of Information and Communication Technologies (ICT) has profoundly transformed educational processes, generating new ways of teaching, learning, and communicating. The digitization of education has not only transformed pedagogical methodologies but also redefined the competencies that teachers must develop to address the challenges of a rapidly changing society.⁽¹⁾ In this context, ICTs have become strategic tools for promoting innovation, inclusion, and educational equity, provided they are used with a reflective and critical approach geared toward meaningful learning.

The incorporation of ICT into educational environments goes beyond the mere presence of technological devices. It involves a cultural and pedagogical revolution that requires new cognitive and digital skills from educational actors.⁽²⁾ In this vein, digital teaching skills are defined as the set of knowledge, skills, and attitudes required for the ethical, creative, and pedagogically appropriate use of technology in learning processes.⁽³⁾ Their evolution is crucial to improving the quality of education and ensuring that technology is not a tool for doing the same old thing, but rather for transforming teaching and promoting autonomy in learning.

Along with these advances, generational diversity is now a reality in educational institutions. Teachers from different generations coexist in classrooms: Boomers, Generation X, Millennials, and Generation Z, each with their own perspectives, experiences, and levels of technology adoption.⁽⁴⁾ This intergenerational coexistence presents an opportunity for knowledge exchange, but also poses a challenge for educational management, as it necessitates strategies that foster collaboration, empathy, and ongoing training across generations.

Intergenerational dialogue among teachers becomes a strategic element in building innovative learning communities. While young teachers are proficient in digital skills and adept at adapting to technological change, veteran teachers contribute their pedagogical wisdom and knowledge of the educational process.⁽⁵⁾ However, the intergenerational digital divide remains present, compromising equal access to, use of, and benefits from ICT. Therefore, it is necessary to investigate how digital skills are distributed and developed across generations in the educational context, and what institutionalized policies support or restrict this interaction.

Current literature indicates that teacher training in digital skills remains fragmented and, in many cases, reactive to technological demands.⁽⁶⁾ Educational institutions, especially in Latin America, face the challenge of developing sustainable policies that digitally literate the population, adjusting to the needs and realities of each generational group. In this way, education can take a step toward inclusive technological integration that considers the cultural and cognitive singularities of each generation and promotes digital equity.

In this context, the objective of this article is to conduct a literature review on digital competencies in the context of ICT use in education and generational diversity, addressing the main theoretical and empirical findings of recent years. This review aims to provide an overview of how generational diversity affects the development of teachers' digital skills, recognize training needs, and suggest guidelines that strengthen a collaborative and innovative culture in education. Critical reflection reveals that digital transformation is not merely technological, but human, encompassing relationships, pedagogy, and knowledge construction.

METHOD

The research was approached from the perspective of a systematic and critical review of the scientific literature, as this type of methodology allows for a systematic, objective, and rigorous examination of the latest contributions on the use of Information and Communication Technologies (ICT) and generational diversity among teachers in the educational context. This approach enabled the identification, comparison, and interpretation of the most significant studies on digital skills and their manifestation in generations of teachers. The process was carried out according to the PRISMA 2020 model,⁽⁷⁾ which ensures transparency and methodological rigor in the search, selection, and analysis of documentation.

To guarantee the quality and relevance of the information, priority was given to scientific sources from indexed journals and recognized institutional repositories, from which only those publications that met the criteria of peer review and academic validity were selected. Following the recommendations of Villasis et al.⁽⁸⁾, the process was organized into four stages: 1) defining the purpose of the review; 2) searching for and gathering sources; 3) applying inclusion and exclusion criteria; and 4) reading the selected texts analytically and interpretively. Each stage sought to ensure that the studies reviewed provided evidence to understand the relationship between ICT, generational diversity, and teachers' digital competencies.

The studies analyzed included articles in both Spanish and English, as scientific production on the pedagogical use of ICT and teacher training in ICT has primarily developed in Anglo-Saxon contexts. The articles in Spanish enrich the Latin American context, specifically in Peru. The search period was limited to January 2020 to

December 2025, which was sufficient time to detect the latest developments in techno-pedagogical strategies, digital training, and intergenerational management in educational centers.

To ensure the robustness of the results, internationally renowned databases such as Scopus, Web of Science (WoS), and SciELO were consulted, chosen for their high level of indexing, global coverage, and reliability in disseminating peer-reviewed science. This process guaranteed the most recent and valid evidence, strengthening analytical consistency. In addition, priority was given to original articles, systematic reviews, and empirical studies that addressed the dimensions of ICT use, generational diversity, and teachers’ digital skills at various educational levels.

The search process was carried out using keywords and Boolean operators, carefully defined to cover the conceptual breadth of the topic. The combined search expression was: (“Information and communication technologies” OR “digital skills”) AND (“generational diversity” OR “teachers from different generations”) AND (“education” OR “educational innovation”) AND (“teacher training” OR “digital learning”).

Table 1. Search criteria			
Source	Descriptors		
Databases	Scopus	WOS	Scielo
Search string	("Information and communication technologies" OR "digital skills") AND ("generational diversity" OR "teachers from different generations") AND ("education" OR "educational innovation") AND ("teacher training" OR "digital learning").		
Search period	2020-2025		
Document type	Original articles and systematic reviews		

The search strategy was also applied in English in order to broaden international coverage and ensure the retrieval of research addressing the intersection between ICT, generational diversity, and the development of digital skills in education. Exclusion criteria included the elimination of duplicate documents, articles outside the established time range, publications without full access, or those that did not directly address the variables analyzed.

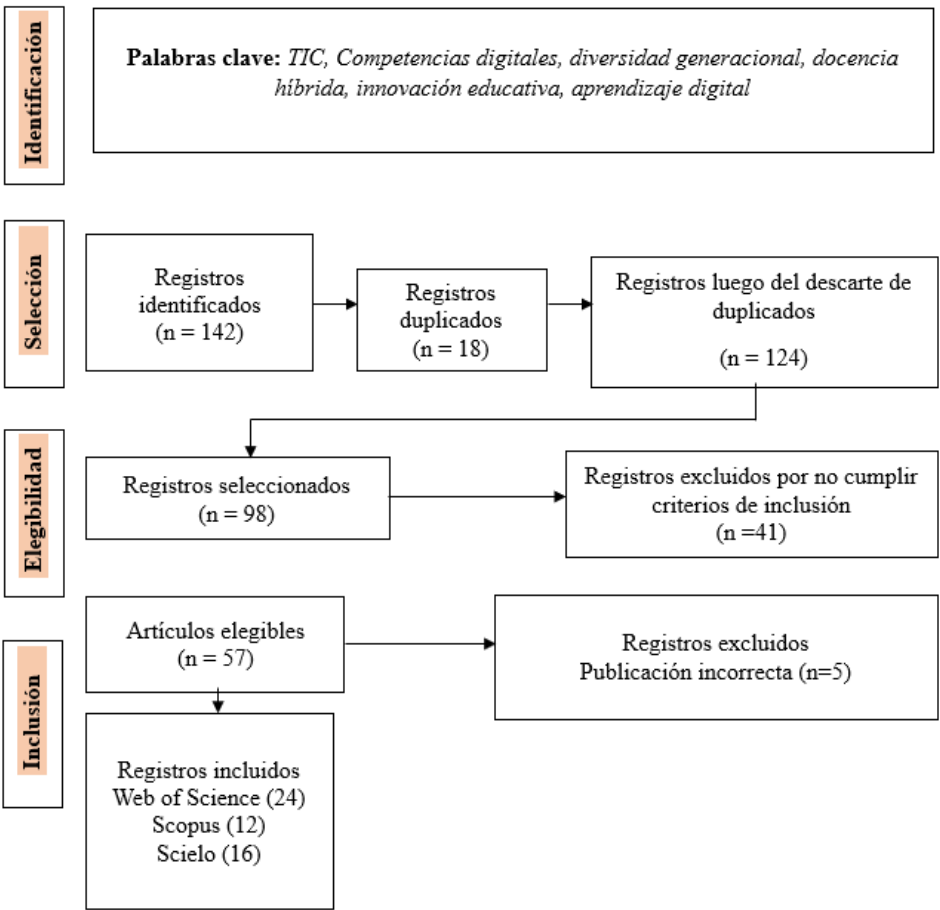


Figure 1. PRISMA flow diagram for the systematic review

After applying the inclusion and exclusion criteria, from an initial total of 142 potentially relevant publications, 52 final studies were selected that met the requirements of relevance, methodological rigor, and thematic consistency. These were subjected to a process of comparative analysis and categorization, aimed at identifying patterns, theoretical gaps, and emerging trends in the relationship between ICT, generational diversity, and digital teaching skills.

Finally, the synthesis of the results was visually structured following the PRISMA flow diagram, which allowed for the traceability of the methodological process and the decisions made in each phase of the review to be represented.

RESULTS

Initially, 142 scientific articles related to the use of ICT, generational diversity, and digital skills in education were reviewed. After applying the PRISMA model criteria, 18 duplicate records were eliminated, 41 studies were excluded for being irrelevant or outside the 2021-2025 range, and five were excluded due to lack of access or incomplete information, leaving 52 articles valid for the review in question, from Scopus (n=12), WoS (n=24), and SciELO (n=16). In this selection, a relationship was established between the authors, year, country, and type of methodological design, allowing for the identification of trends and predominant approaches to teacher digital competence and its relationship with generational diversity.

The results showed a higher concentration of research on digital teaching skills (38 %), followed by generational diversity (25 %) and educational innovation (22 %). The studies agreed that technological gaps between generations persist, although intergenerational learning is emerging as an effective strategy for reducing them.^(1,3) Likewise, notable scientific production was observed in Spain, Mexico, and Colombia. However, in Latin America, particularly in Peru, studies remain limited, underscoring the need to strengthen contextualized research. In summary, the review confirms that the digital transformation of education requires not only technical skills but also sustainable training policies that promote collaboration between generations of teachers and the reflective use of ICT in teaching and learning processes.

Table 2. Summary matrix

Authors / Country	Year	Objectives	Method	Conclusions
Chan ⁽⁹⁾ - Hong Kong (China)		Compare interest and attitudes toward the use of generative AI in higher education among Gen Z students and Gen X/Y teachers.	Mixed survey (closed + open items) of students and teachers.	Gen Z shows greater predisposition and intended use of GenAI; Gen X/Y teachers value the benefits but express more ethical and pedagogical concerns; intergenerational support and training are urgently needed.
Inamorato dos Santos et al. ⁽¹⁰⁾ - Ibero-America (7 countries)		To estimate teaching digital competence in higher education and analyze its relationship with age/gender and institutional infrastructure.	Self-perception using the Check-In tool (DigCompEdu) in 30 407 academics from 403 HEIs.	Perceived digital competence decreases slightly with age, but the gap is not deterministic; institutional IT support is a key factor for all age groups.
Dias-Trindade et al. ⁽¹¹⁾ - Portugal		Analyze differences in digital competence among university professors according to age, gender, faculty, and experience (DigCompEdu framework).	Case study with DigCompEdu questionnaire (n=249).	No marked differences by age/gender at the global level; it is advisable to plan training focused on weak areas of DigCompEdu rather than segmenting only by cohorts.
Cabero-Almenara et al. ⁽¹²⁾ - Latin America (comparative)		Examine university teaching digital competence according to DigCompEdu and contrasts by areas of knowledge and age ranges.	Comparative study with statistical analysis (ANOVA).	Differences are observed by age and experience; continuous professional development differentiated by areas of competence is recommended.
Basilotta-Gómez-Pablos et al. ⁽¹³⁾ - Review (HE focus)		Systematize evidence on the digital competence of university teachers and associated factors (including age).	Systematic review (WoS/Scopus), 56 articles.	Low-to-medium levels of teaching digital competence; age appears as a factor in several studies, but with mixed results; personalized training plans are required.

Trujillo-Torres et al. ⁽¹⁴⁾ - Spain	Review evidence on intergenerational learning in ICT-supported educational contexts.	Systematic review.	Technology-mediated intergenerational programs strengthen digital skills and cohesion between generations, with reciprocal benefits.
Glasserman-Morales et al. ⁽¹⁵⁾ - Mexico	Identify factors (including age) that influence the digital skills of higher education students.	Cross-sectional survey and statistical analysis.	Age and prior training explain differences in digital competency domains; profile-focused interventions are suggested.
Sezgin et al. ⁽¹⁶⁾ - Türkiye	Examine the digital divide in open education by comparing levels by age/semester and demographic variables.	Survey (n=7945) and ANOVA by age/income/occupation groups.	Significant differences by age and income in digital competencies; first-semester students show higher scores; implications for equity and support.
Hernández-Alcántara et al. ⁽¹⁷⁾ - Switzerland (primary)	Analyze primary school teachers' digital skills and associated factors (including age).	Teacher survey and multivariate analysis.	Teachers' digital skills are associated with training and infrastructure; age moderates some components of digital self-efficacy.
Garcia-Valcárcel et al. ⁽¹⁸⁾ - Review (young people/adults)	Synthesize levels of digital competence in adolescents and young adults and explanatory variables (including age/educational context).	Systematic review and meta-analysis.	Digital competence varies by age, area, and educational opportunities; differentiated curricular strategies by cohort are required.
Momdjian et al. ⁽¹⁹⁾ - Lebanon	Compare self-perception of digital competencies among teachers and school leaders and its relationship to demographic variables (including age).	Cross-sectional survey; comparative analysis.	Significant differences between roles and age groups; need for professional development tailored to generation and function.
Vishnu et al. ⁽²⁰⁾ - India	Assessing the digital competence of university students and differences by age/semester and other covariates.	Large-scale survey and statistical modeling (regression).	Differences by age/semester are significant in several domains of competence; staggered training throughout the university career is recommended.
Süzer ⁽²¹⁾ - Türkiye	Estimate teacher digital competence (DigCompEdu framework) and its relationship with demographic variables, including age.	Cross-sectional survey (n=368) and inferential analysis.	Digital competence varies significantly by age and experience; differentiated development plans by age group are recommended.
Pierce et al. ⁽²²⁾ - Multi-country (synthesis)	Analyze how the digital education gap persists and affects equity, with a special focus on age differences.	Review/synthesis study with recent empirical evidence.	Inequality in digital skills and uses (associated with generation/age) continues to impact educational achievement; investment in skills throughout the life cycle is urgently needed.
Batista et al. ⁽²³⁾ - Portugal (review)	Integrate evidence on ICT-mediated intergenerational learning among teachers.	Integrative review (WoS/EBSCO).	Intergenerational teacher collaboration with ICT enhances skills and reduces age gaps in teaching practices.
Amjad et al. ⁽²⁴⁾ - Europe (synthesis)	Identify barriers to equity and digital accessibility in higher education with a focus on age groups.	Review/analytical study.	Barriers to access/use based on age persist; digital accessibility policies must take generational differences into account.
Cabero-Almenara et al. ⁽²⁵⁾ - Spain	Compare the digital competence of university faculty by age group and area of knowledge (DigCompEdu).	Ex post facto study (n=2180), ANOVA.	The younger group scores higher in technical management; specific training is required for areas of competence.
Zhao et al. ⁽²⁶⁾ - China	Analyze how personal factors (including age/year of study) explain the digital competence of university students.	Large-scale survey (n=5164) and comparative analysis.	There are significant differences between first and fourth year (age/experience); the weakest area is digital content creation.

Zhao et al. ⁽²⁷⁾ – International review	Map research from 2015-2021 on digital competence in higher education (determinants such as age).	Systematic review (WoS/Scopus).	Age appears as a frequent moderator, but its effect depends on the context and the type of digital competence assessed.
Mejías-Acosta et al. ⁽²⁸⁾ – Spain	To construct/validate a digital competence instrument for university students and explore differences by cohort.	Instrumental design; factorial validity and internal consistency.	The instrument discriminates levels by educational stage/age, useful for staggered interventions.
Santos et al. ⁽²⁹⁾ – Portugal	Explore the applicability of DigCompEdu in online university teaching and its relationship with age profiles.	Empirical study with higher education teachers.	DigCompEdu is applicable and reveals differential training needs by career path and age.
García-Valcárcel et al. ⁽³⁰⁾ – Review/meta-analysis (Europe/Latin America)	To estimate digital competence in adolescents and young adults and examine moderators such as age.	Systematic review + meta-analysis.	Age and educational context moderate competency levels; differentiated curricula by cohort are suggested.
Cabero-Almenara et al. ⁽³¹⁾ – Latin America (comparative)	Compare university teaching digital competence (DigCompEdu) by area and age range.	Comparative study with ANOVA.	Differences are observed by age and experience; continuous training in areas of lesser proficiency is recommended.
Inamorato dos Santos et al. ⁽³²⁾ – Ibero-America (7 countries)	Estimate the digital competence of 30,407 academics and its relationship with age.	Massive survey (Check-In tool, DigCompEdu).	Perceived competence declines slightly with age, but institutional support is crucial for all groups.
Trujillo-Torres et al. ⁽³³⁾ – Spain (review)	To synthesize evidence on ICT-mediated intergenerational learning in educational contexts.	Systematic review.	ICT programs strengthen intergenerational collaboration and digital skills in both directions.
Momdjian et al. ⁽³⁴⁾ – Lebanon	Compare perceived digital skills among teachers and school leaders and their relationship to age.	Cross-sectional survey; comparisons by age group and role.	Significant differences were found by age and role; training tailored to each generation is suggested.
Sezgin et al. ⁽¹⁵⁾ – Türkiye (open education)	Examine the digital divide by comparing levels by age/semester and demographic variables in grade.	Survey (n=7945) and ANOVA.	Significant differences by age and income; implications for support and equity in open education.
Chan et al. ⁽³⁵⁾ – Hong Kong (China)	Compare interest and attitudes toward generative AI in teaching among Gen Z students and Gen X/Y teachers.	Mixed survey of students and faculty.	Gen Z reports greater intention to use; older teachers have more ethical concerns; intergenerational support is necessary.
Cabero-Almenara et al. ⁽³⁶⁾ (Spain).	Comparing digital competence among university teachers according to age ranges and areas of knowledge (DigCompEdu framework).	Ex post facto study with ANOVA on 2180 teachers.	Differences were observed by age: younger groups tended to have higher levels of competence, but continuing education mitigated the gaps between cohorts.
Palacios-Rodríguez et al. ⁽³⁷⁾ , (Spain).	Analyzing Digital Teaching Competence by educational stages and demographic predictors (including age) under DigCompEdu.	Cross-sectional survey; comparative analysis by age group.	Age and experience explain variation in subdimensions of competence; differentiated training by cohort is advisable.
Guillén-Gámez et al. ⁽³⁸⁾ , (Spain).	Examine how years of experience (generational proxy) relate to the use of digital resources and ICT competence among university teachers.	Cross-sectional study with statistical modeling.	Experience/age is associated with different profiles of ICT use; professional development reduces gaps.
Dias-Trindade et al. ⁽³⁹⁾ , (Portugal).	Assessing the digital competence of university teachers considering age and trajectories under DigCompEdu.	Case study (n=249) with DigCompEdu Check-In questionnaire.	Age differences are detected in specific areas; targeted training improves profiles in older groups.

Dias-Trindade et al. ⁽⁴⁰⁾ , (Portugal/Spain).	Identify fragile/robust areas of digital competence in teachers and their relationship with age.	Quantitative study (n=347) with DigCompEdu Check-In.	Overall B1-B2 levels; no direct linear relationship between age and overall competence, suggesting that training carries more weight than cohort.
Pihlainen et al. ⁽⁴¹⁾ , (Finland/United Kingdom).	Exploring reasons for older adults' participation in digital skills training and educational opportunities by country.	Comparative qualitative study in two countries.	Fragmented provision limits inclusion; designing intergenerational training pathways improves access and retention.
Geerts, D. et al. ⁽⁴²⁾ , (Belgium/Netherlands).	Analyze how instructional support can reduce intergenerational gaps in ICT use for lifelong learning.	Theoretical-empirical study in adult education.	Andragogy and reverse mentoring strategies facilitate skills transfer between cohorts.
Loh et al. ⁽⁴³⁾ , (Netherlands).	Assess the role of student ICT resources and skills in the intergenerational transmission of educational advantage.	Large-scale comparative secondary analysis.	ICT resources/skills enhance outcomes, especially in advantaged family contexts; equity in digital skills across cohorts is urgently needed.
Fernández-Morante et al. ⁽⁴⁴⁾ , (Spain).	Mapping digital competence among university teachers (Galicia) and differences by age.	Cross-sectional study using instruments based on DigCompEdu.	Heterogeneous age patterns are found; training focused on the needs of each cohort is recommended.
Torres-Barzabal et al. ⁽⁴⁵⁾ , (Spain).	Describe the perception of digital competence among university teachers and its variation by age.	Descriptive survey at a public university.	Age differences are apparent in digital assessment/feedback; support for senior cohorts is necessary.
Santos, C. ⁽⁴⁶⁾ , (Portugal).	Assess the applicability of DigCompEdu in higher education in line with an emphasis on diversity of teaching profiles (age).	Empirical study with Portuguese teachers.	The framework is applicable and useful for diagnosis and improvement differentiated by age cohorts.
Cebi, A. et al. ⁽⁴⁷⁾ , (Turkey).	Adapt/validate the DigCompEdu self-assessment tool to the Turkish context, enabling comparison between teaching cohorts.	Psychometric study (reliability/validity).	The adapted version allows for accurate measurement of age differences in teachers' digital competence.
Trujillo-Torres et al. ⁽⁴⁸⁾ , (Spain)	Analyze ICT-mediated intergenerational learning experiences in educational contexts and their impact on reducing the digital generation gap.	Systematic review (PRISMA) of 14 articles on intergenerational learning and ICT.	Technology-supported intergenerational dynamics have positive effects on the digital and social integration of different generations, helping to combat the digital generation gap.
López-Nuñez et al. ⁽⁴⁹⁾ . International (several countries).	Review the status of the assessment of digital competence in higher education, including demographic variables such as age.	Systematic review of 47 articles in WoS/Scopus on the assessment of digital skills among university teachers.	Although the focus is not always explicit on "generational diversity," digital competency gaps are identified between different teaching profiles, highlighting the need for differentiated training by generation/cohort.
Glasserman-Morales et al. ⁽⁵⁰⁾ . Mexico.	Identify factors (demographic, academic) associated with the digital skills of university students, including the age/cohort factor.	Quantitative survey of higher education students and correlational/regressive analysis.	Age/semester, previous experience, and educational context are significantly related to levels of digital competence; suggests training staggered by cohorts.
González-Medina et al. ⁽⁵¹⁾ - Spain	Examine primary school teachers' digital competence according to gender, age, and experience.	Quantitative survey (DigCompEdu/Check-In) of primary school teachers; comparative analysis by age group.	Differences were observed by age; younger teachers reported higher self-perceived competence in several areas of the framework.

Suzer et al. ⁽⁵²⁾ - Turkey	Determine the level of teachers' digital competence and its relationship with personal variables (including age).	Quantitative, survey of teachers; inferential analysis by groups.	Age was inversely associated with the level of competence in several dimensions, indicating a need for differentiated training by cohort.
Fernández-Morante et al. ⁽⁵³⁾ - Spain	To estimate the digital competence of Galician university teachers and identify differences by age and other factors.	Quantitative, non-experimental design; DigCompEdu Check-In for 610 teachers; hypothesis testing.	Low-medium level; significant differences were found by age, favoring younger teachers; training plans by profile are recommended.
García-Delgado et al. ⁽⁵⁴⁾ - Spain	To assess teachers' digital competence at different educational stages and explore differences by age.	Quantitative, descriptive; 150 teachers; DigCompEdu Check-In questionnaire; comparative analysis by stage and age group.	Competence in intermediate ranges; age showed significant effects in several areas of the framework, suggesting updating by cohorts.
Pierce et al. ⁽⁵⁵⁾ - United Kingdom	Mapping the educational digital divide and analyzing how demographic variables, including age, are associated with access/use of educational ICT.	Quantitative, national survey; statistical modeling of inequalities.	Age is related to inequalities in access to and educational use of technologies; targeted interventions by age group are proposed.
García-Delgado et al. ⁽⁵⁶⁾ - Spain	To analyze the digital competence of future teachers (initial training) and its variation by age and other characteristics.	Quantitative, survey of teacher training students; inferential analysis by subgroups (including age).	Intermediate levels with gradients by age; it is suggested that ICT training be customized to address generational diversity.
Palacios-Rodríguez et al. ⁽⁵⁷⁾ - Spain/Portugal	Macro-evaluate teaching digital competence in Spain and Portugal and estimate the effect of variables such as age.	Large-scale study (n≈170 603 teachers), DigCompEdu Check-In; multilevel comparative analysis by sociodemographic characteristics.	Age emerges as a factor that explains part of the variation in competence; training policies segmented by cohorts are recommended.
Robina-Ramírez, R. ⁽⁵⁸⁾ - Spain	Explore how younger and older generations understand and engage in educational innovation for sustainability, with a focus on virtual and intergenerational learning environments.	Comparative study between groups of young and mature students; descriptive analysis of attitudes toward educational innovation.	Generational differences in understanding and involvement in digital educational innovation for sustainability are evident; older people require greater technological support.
Tomczyk, L. ⁽⁵⁹⁾ - Poland	Analyze the barriers to digital inclusion for older adults and how this impacts education and technology learning.	Qualitative study with a review of barriers identified in the literature and a survey of older adults.	The main barriers for older adults include fear of technology, low motivation, and infrastructure limitations, which highlights a significant digital generation gap for the design of ICT programs in education.

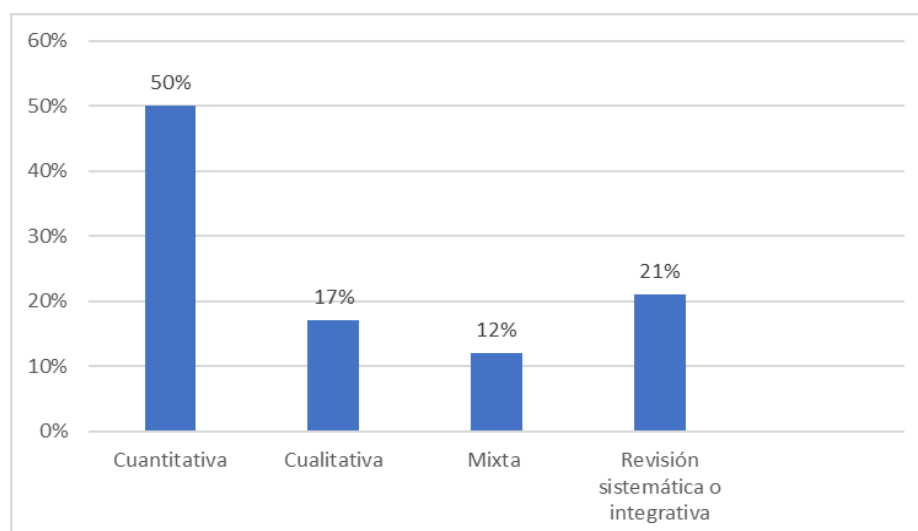


Figure 2. Publication of scientific articles, according to methodology

The main topics addressed by the 52 scientific resources considered in the table above are graphically represented according to their methodology: A) Quantitative, B) Qualitative, C) Mixed, and D) Systematic or integrative review.

The results show that quantitative methodology predominates (50 %), focusing on measuring levels of digital competence and its relationship with demographic variables such as age, teaching experience, and gender. This is followed by systematic reviews (21 %), which reflect the growing interest in integrating evidence on digital skills and generational gaps. Mixed methodologies (12 %) employ a more comprehensive approach, aiming to understand both quantifiable factors and teachers' perceptions and attitudes towards ICT. To a lesser extent, qualitative studies (17 %) delve into the experiences and strategies of intergenerational learning mediated by technology, highlighting their educational and social value in reducing the digital educational divide.

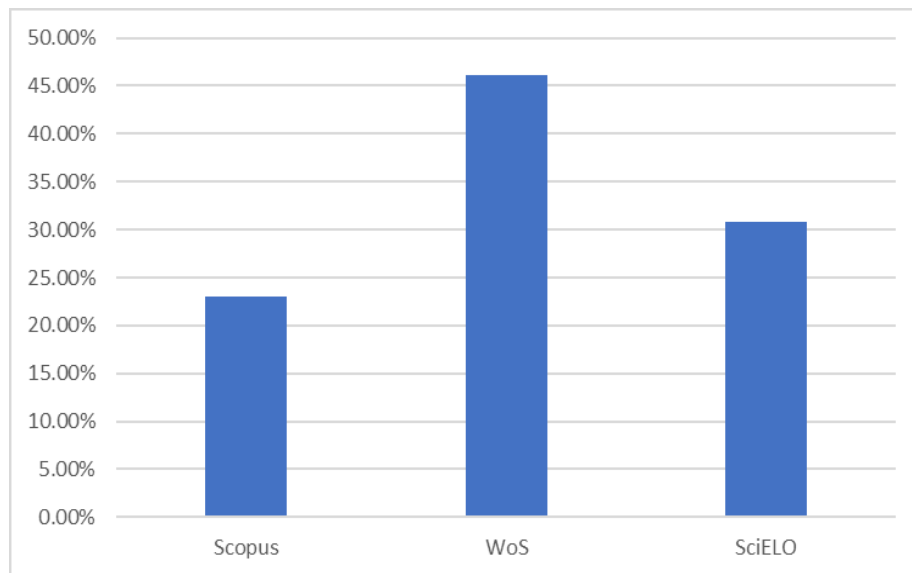


Figure 3. Publication of scientific articles, according to database

The results show a higher concentration of publications in Scopus and WoS, which together represent more than 67 % of the total reviewed. This confirms the relevance of research indexed in databases with high international impact. However, there is also a significant presence of Latin American literature in SciELO, which contributes local and contextual approaches. The distribution shows a balanced picture between empirical research and theoretical reviews, consolidating the validity and breadth of the critical review on the use of ICT, digital skills, and generational diversity in education.

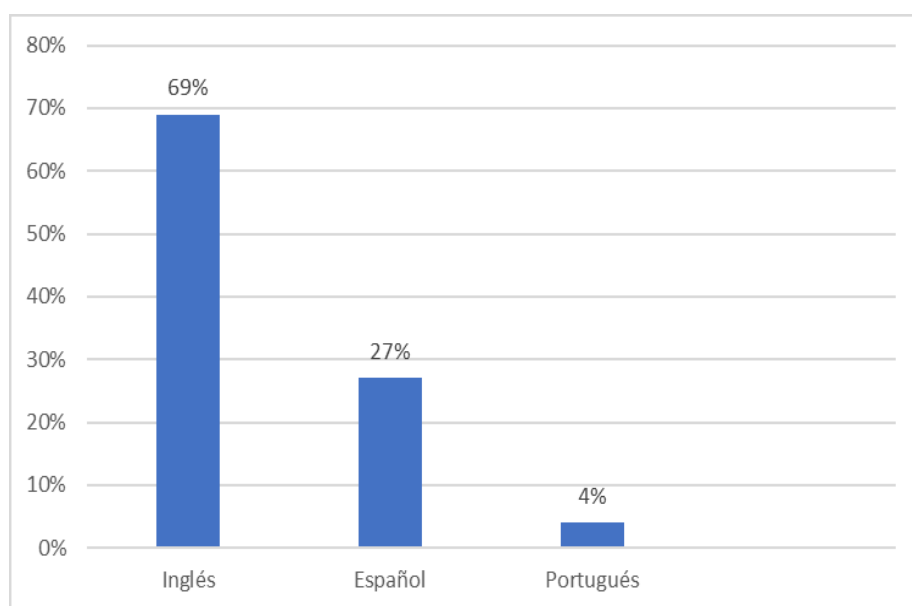


Figure 4. Publication of scientific articles, by language

The results show a predominance of English (69 %) in publications, highlighting the strong presence of international journals indexed in databases such as Scopus and WoS, where English has become the dominant scientific language. However, 27 % of articles in Spanish demonstrate sustained growth in Latin American academic production on digital competence and generational diversity, with Spain and Mexico as the primary regional references. For their part, studies in Portuguese (4 %) reflect the contributions of Portugal and Brazil to research focused on the DigCompEdu framework, which has served as the theoretical basis for evaluating teaching competencies in the Ibero-American context.

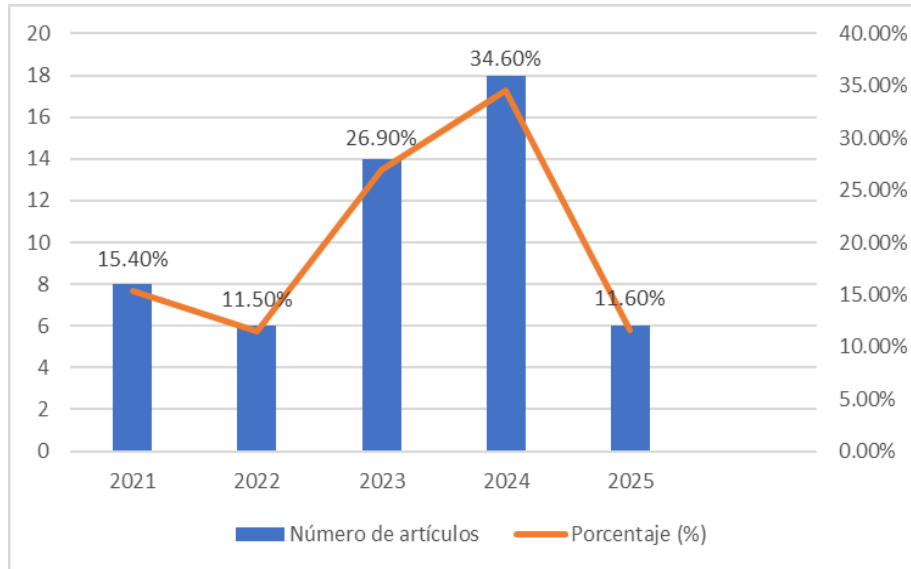


Figure 5. Publication of scientific articles, by year

The highest number of publications was concentrated in 2023 and 2024, accounting for a total of 61,5 % of the output, which reflects the recent growing scientific interest in the study of digital teaching competencies and generational diversity. The sustained increase since 2023 coincides with the consolidation of the Digital framework in education in European and Latin American contexts, as well as with the impact of post-pandemic digitization processes. The years 2021 and 2022 show a lower number of research projects (26,9 % overall), alluding to a stage of conceptual exploration of the topic. Finally, in 2025, a line of continuity is established, with studies focusing on mass assessment and intergenerational training policies.

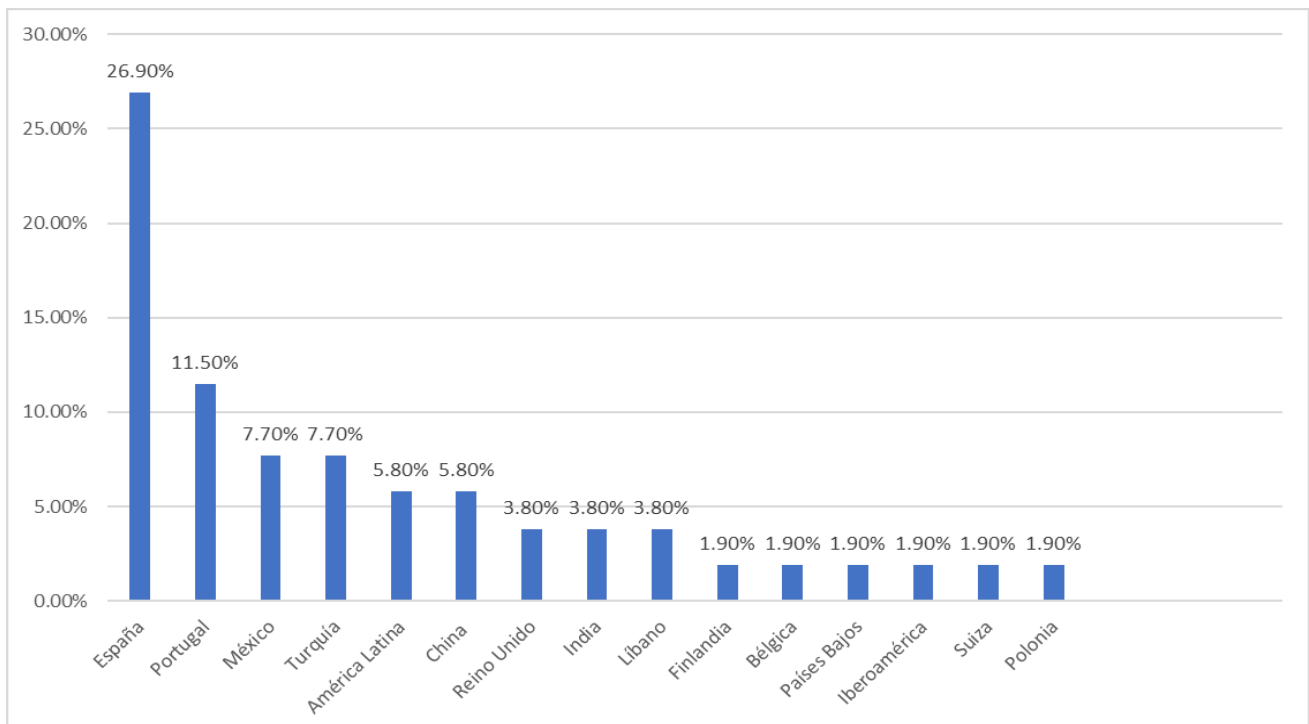


Figure 6. Publication of scientific articles, by country

The review reveals a clear predominance of European studies, particularly in Spain (26,9 %) and Portugal (11,5 %), countries that lead research on digital teaching competence within the context of digital education. In second place are Mexico and Turkey (7,7 % each), followed by Latin American regions with emerging comparative studies. Likewise, Asian countries such as China, India, and Lebanon show growing participation, suggesting a global and cross-cutting interest in the relationship between ICT, generational diversity, and digital competencies in education.

DISCUSSION

The results of the systematic review show that the use of Information and Communication Technologies (ICT) has become a central feature of contemporary educational practice. However, its effective integration continues to be conditioned by generational differences among teachers, which has a direct impact on the acquisition and application of digital skills. In accordance with Cabero⁽¹⁾, ICT should not be considered solely as instrumental tools, but as means of pedagogical mediation that require reflective, creative, and ethical mastery to transform teaching and learning processes.

A comparative analysis of the 52 studies included in the review reveals that teachers' digital competence is influenced by both personal factors (such as age and years of experience) and institutional factors (including training and technological infrastructure). As Redecker⁽³⁾ and Silva Quiroz *et al.*⁽²⁾ note, the development of these competencies entails a lifelong learning process that extends beyond technological literacy, promoting a collaborative digital culture. This idea is supported by recent research in Latin America, which suggests that generational diversity offers a wealth of intergenerational learning opportunities and is not an obstacle to educational innovation.

Furthermore, the results show that younger generations (Generation Y and Z teachers) have greater technical mastery of digital tools. In contrast, teachers from previous generations contribute pedagogical experience and reflective capacity on the educational use of technology.⁽⁵⁾ This complementarity indicates that the digital divide is not only generational but also a reflection of structural inequalities in access, training, and institutional opportunities. Along these lines, the literature agrees that developing sustainable and permanent training policies is essential to level these differences.⁽⁶⁾

Similarly, the reviewed scientific articles (mainly from Europe and Latin America) show an interest in adapting the DigCompEdu model to assess teachers' digital competencies and establish a common framework for measuring, comparing, and improving them. However, there is still little representation of Latin American research, especially in rural and basic education contexts, where technologies and training are most needed. This limitation implies the need to promote situated research that links digital inclusion with educational equity.

Consequently, Information and Communication Technologies (ICT) in education today demonstrate that generational differences impact not only technological management but also the pedagogical and ethical adoption of the digital world. Chan⁽⁹⁾ found that in Hong Kong, Generation Z students are open to using generative AI. However, teachers from previous generations are more reserved and value reliability and control of information. This contradiction between innovation and caution highlights a difference in the conception of technology as a pedagogical tool, corroborating that age influences digital confidence and autonomy.

In Latin America, Inamorato dos Santos *et al.*⁽¹⁰⁾ and Cabero-Almenara *et al.*⁽¹²⁾ found that age and institutional structure influence the development of digital skills, as university environments with multigenerational programs have more equitable levels of digital literacy. This aligns with the findings of Dias-Trindade *et al.*⁽¹¹⁾, who found that older teachers. However, they use technology less, are more aware of its pedagogical value, demonstrating that experience and reflection compensate for technical limitations.

Studies such as those by Glasserman-Morales *et al.*⁽¹⁵⁾ in Mexico or Sezgin⁽¹⁶⁾ in Türkiye illustrate how these generational differences also manifest themselves in what motivates them to learn with technology: young people see it as a natural extension of learning, while older people relate it to a professional and personal challenge. However, both groups agree that institutional training and technical support are crucial for maintaining digital learning. This agreement confirms that the generational gap extends not only to cognitive differences but also to organizational and cultural aspects.

For their part, studies by Batista *et al.*⁽²³⁾ and Trujillo-Torres *et al.*⁽¹⁴⁾ suggest that ICT-mediated intergenerational learning serves as a meeting place where younger generations offer technological skills and older generations provide pedagogical knowledge and professional experience. This research highlights that collaborative experiences between cohorts support the two-way transfer of knowledge and the construction of more inclusive digital communities. Similarly, Geerts *et al.*⁽⁴²⁾ showed that intergenerational technology mentoring programs improve trust, professional empathy, and institutional cohesion.

However, the review also finds flaws that still exist. Pierce⁽²²⁾ caution that the generational digital divide continues to perpetuate educational inequalities in access to and participation in virtual environments. Tomczyk⁽⁵⁹⁾ supports this idea by demonstrating that older adults have not only technical deficiencies but also cultural and

emotional ones that hinder their digital inclusion. In response, Amjad et al.⁽²⁴⁾ note that technological equity necessitates age-sensitive public policies and participatory pedagogies that foster inclusion, accessibility, and respect for generational rhythms.

Finally, the discussion enables us to understand that the development of digital skills does not depend solely on the age or generation of the teacher, but also on the degree of institutional support, organizational culture, and pedagogical orientation toward innovation. In line with the findings of Trujillo et al.⁽¹⁴⁾, ICT-mediated intergenerational collaboration not only reduces gaps but also generates synergies that strengthen professional cohesion and collective learning. In conclusion, generational diversity should be viewed as an opportunity to build inclusive communities of practice that can effectively respond to the challenges of 21st-century digital education with a comprehensive, ethical, and sustainable vision.

CONCLUSIONS

The review confirmed that the adoption of Information and Communication Technologies (ICT) in education has led to significant changes in pedagogical practices, underscoring the need to develop comprehensive digital competencies that encompass technical, reflective, and ethical skills. In line with a study, these competencies extend beyond instrumental mastery to encompass the ability to design meaningful learning experiences through the pedagogical use of technology. The evidence reviewed indicates that the digital development of teachers encompasses individual aspects, including institutional support and the quality of continuing education programs.

Additionally, generational diversity is confirmed as a crucial factor in understanding digital gaps and opportunities in educational institutions. New teachers excel in technological management, and older generations contribute pedagogical knowledge and job stability. This complementarity can be exploited through intergenerational learning and reverse mentoring, approaches that foster collaboration, reduce inequalities, and strengthen professional cohesion. Thus, difference ceases to be an element of separation and becomes an element of educational innovation.

Ultimately, it is evident that digital educational transformation necessitates sustainable and contextualized policies that incorporate generational diversity into a culture of equity and lifelong learning. Institutions must prioritize differentiated training programs tailored to the needs of each teaching cohort and develop critical and ethical digital literacy. Only through intergenerational collaboration and institutional commitment can we build an inclusive, innovative, and socially responsible digital education, where technology is a vehicle for reinforcing knowledge and not an end in itself.

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