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Summary study

Technological integration in Latin American teaching praxis: trends, barriers and an analytical framework for research

Integración tecnológica en la praxis docente latinoamericana: tendencias, barreras y marco analítico para la investigación

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Abstract

Introduction: The integration of educational technology in Latin American classrooms constitutes a challenge, where the availability of digital tools does not guarantee an effective pedagogical transformation.

Objetive: Systematize scientific production on the relationship between teacher training in educational technology and its pedagogical integration in classroom practices in Latin America, in order to reveal trends, regularities and barriers that shape this phenomenon.

Methods: A systematic review of the literature was carried out. The search in academic databases (Scopus, Web of Science, SciELO, REDALYC, Dialnet) and the application of selection criteria led to the selection of 54 bibliographic references. The content analysis was supported by NVivo 14 software, with a double coding process that reached an agreement level of 87%.

Results: Four trends were identified (rise of training models based on the Pedagogical Technological Knowledge of Content approach, emergence of technologies such as generative artificial intelligence, research as a transformative axis and emphasis on postgraduate training). The methodological regularities show a predominance of qualitative and mixed studies. It was confirmed that the transfer to practice is not automatic, it depends on an ecosystem of training, institutional, contextual and subjective conditions.

Conclusion: The pedagogical integration of educational technology is a complex process that requires a systemic approach. An analytical framework of four dimensions (formative, institutional, contextual and subjective) is proposed to guide future research and educational policies that transcend the instrumental approach and address the structural inequalities of the region.

Keywords: teacher training, educational technology, pedagogical practice, Latin America, systematic review

Resumen

Introducción: La integración de la tecnología educativa en las aulas latinoamericanas constituye un desafío, donde la disponibilidad de herramientas digitales no garantiza una transformación pedagógica efectiva.

Objetivo: Sistematizar la producción científica sobre la relación entre la formación docente en tecnología educativa y su integración pedagógica en las prácticas de aula en América Latina, con el fin de revelar tendencias, regularidades y barreras que configuran este fenómeno.

Métodos: Se realizó una revisión sistemática de la literatura. La búsqueda en bases de datos académicas (Scopus, Web of Science, SciELO, REDALYC, Dialnet) y la aplicación de criterios de selección permitieron seleccionar 54 referencias bibliográficas. El análisis de contenido fue apoyado en el software NVivo 14, con un proceso de doble codificación que alcanzó un nivel de acuerdo del 87%.

Resultados: Se identificaron cuatro tendencias (auge de modelos de formación basados en el enfoque de Conocimiento Tecnológico Pedagógico de Contenidos, surgimiento de tecnologías como la inteligencia artificial generativa, la investigación como eje transformador y énfasis en la formación de posgrado). Las regularidades metodológicas muestran un predominio de estudios cualitativos y mixtos. Se confirmó que el paso a la práctica no es automático, depende de un ecosistema de condiciones formativas, institucionales, contextuales y subjetivas.

Conclusión: La integración pedagógica de la tecnología educativa es un proceso complejo que requiere un enfoque sistémico. Se propone un marco analítico de cuatro dimensiones (formativa, institucional, contextual y subjetiva) para orientar futuras investigaciones y políticas educativas que trasciendan el enfoque instrumental y aborden las desigualdades estructurales de la región.

Palabras clave: formación docente, tecnología educativa, práctica pedagógica, América Latina, revisión sistemática

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Introduction

The integration of educational technology in teaching practices has become one of the most persistent challenges of Latin American education in the 21st century. Despite the significant advances in connectivity and the massification of digital devices in the region, the empirical evidence accumulated over the last two decades indicates that the availability of technological resources does not guarantee an effective pedagogical transformation (Alvarado-Martínez & González-Cardona, 2026; Karam et al., 2019; Poveda-Pineda & Cifuentes-Medina, 2020). This realization has generated a growing academic and political interest in understanding the processes and conditions that mediate between teacher training in educational technology and

its actual transfer to the classroom.

The regional context adds layers of complexity to this problem. Latin America is characterized by deep socioeconomic inequalities and a historic digital divide that not only affects access to technological infrastructure, but also the possibilities of critical appropriation and pedagogical use of digital tools (Estévez Estévez et al., 2024; Karam et al., 2019). The COVID-19 pandemic acted as a catalyst that accelerated the adoption of technologies in educational systems, but also made visible and exacerbated pre-existing inequalities (Medina Uribe et al., 2026). This scenario of crisis and opportunity promoted academic production aimed at understanding the impacts, challenges and conditions of educational technology in the region (Crysol et al., 2020).

From an epistemological perspective, the field of educational technology has moved from technocentric and instrumental approaches to more critical, complex and systemic conceptions (Martin & Zangara, 2024; Mujica, 2020). This shift recognizes that technology is not a neutral entity, but rather a sociocultural artifact whose educational impact depends on pedagogical intentions, institutional conditions, and teaching beliefs (Habowski & Conte, 2020; Pérez Vertel & Larreal Bracho, 2023; Verdecia Carballo, 2007). In this framework, the notion of technological mediation —understood as a process of dialectical interaction that shapes the educational experience— becomes central to understanding technological integration beyond the use of tools (Ligarretto, 2021; Martin & Zangara, 2024).

The specialized literature has systematically documented the persistence of a gap between the initial and continuous training of teachers and the digital competencies effectively deployed in educational contexts (Murrieta Ortega, 2025; Sánchez, 2025). This gap is not univocal, but responds to a complex interaction of factors: the quality and focus of training (Durand Villalobos & Gutiérrez, 2025), institutional and infrastructure conditions (Hernández León, 2024; Real Roby et al., 2024), national educational policies (Paredes Bermeo & Arteaga Alcívar, 2023; Lugo & Ithurburu, 2019), and the subjective dimensions of teachers, such as their beliefs, attitudes and resistance to change (Sánchez, 2025; Tapia, 2020).

In countries like the Dominican Republic, for example, initiatives such as the Digital Republic program have improved access to devices, but recent studies indicate that teacher training for the pedagogical use of technologies remains insufficient (Ureña Gómez et al., 2025). Analogous situations are observed in other nations in the region, as evidenced in the works on El Salvador (Carballo Ruiz, 2021), Panama (Gordon Graell, 2021) and Central American countries (Navarrete Cazales et al., 2022), which confirms that access is a necessary but not sufficient condition for effective pedagogical integration.

Despite the growing volume of research, areas of gaps and theoretical tensions persist that require further exploration. On the one hand, the emergence of disruptive technologies such as

generative artificial intelligence (Dorfsman, 2026; Ordoñez-Iturralde, 2026) and other emerging tools (Prendes & Cerdán, 2021) poses new epistemological and practical challenges that traditional educational technology models fail to fully address. On the other hand, a tension is observed between the discourse of technological innovation and the persistence of traditional pedagogical models, which shows the need to delve into the philosophical and sociological foundations that underlie technological integration (Costa Júnior et al., 2025; Piscitelli, 2005). Furthermore, scientific production is concentrated in a few countries, which limits the understanding of the particularities of each educational scenario (Nizama Reyes, 2016; García-Martínez & Soto-Delgado, 2025).

In this context, the present research is guided by the following central question: What are the current trends, methodological regularities and conditions (barriers and facilitators) that affect the transfer of educational technology training to teaching practice in Latin America, and what analytical dimensions can be derived from the available evidence to guide future research? The answer to this question will allow not only an updated mapping of the state of the art, but also the identification of critical areas that require greater theoretical and empirical attention.

Therefore, the objective of this article is to systematize the scientific production on the relationship between teacher training in educational technology and its pedagogical integration in classroom practices in Latin America, in order to reveal trends, regularities and barriers that shape this phenomenon. It is expected that the findings will contribute to guiding the design of educational policies and teacher training programs that transcend the instrumental approach and address the structural inequalities of the region.

Methods

A systematic review study of the scientific literature was carried out, following the principles of transparency and rigor in the search, selection and analysis of information, complemented with guidelines for qualitative systematic reviews (Petticrew & Roberts, 2006). A search equation was constructed to capture the intersection between the fundamental concepts of the study: ("teacher training" OR "teacher professional development" OR "teacher training") AND ("educational technology" OR "digital technologies" OR ICT OR "digital competence") AND ("pedagogical integration" OR "teaching practice" OR "transfer to the classroom"). This equation was applied in the databases Scopus, Web of Science, SciELO, REDALYC, Dialnet and Google Scholar, complemented by the search in reference lists of the selected articles.

The inclusion criteria were: a) studies published between 2005 and the first half of 2026; b) research focused on the Latin American context or with relevant implications for the region; c) studies that address the relationship between teacher training and educational technology; d) publications in Spanish, English or Portuguese; e) magazine articles, book chapters, theses and institutional documents with academic rigor. The exclusion criteria were: a) studies focused

exclusively on the use of technology without considering teacher training; b) research that does not address transfer to practice; c) documents without explicit methodological rigor; d) duplicate publications.

The selection process was carried out in four phases: identification of records, removal of duplicates, screening of titles and abstracts, and full-text evaluation. The initial search returned 187 records. After eliminating 57 duplicates using the Zotero bibliographic manager, 130 titles and summaries were examined, discarding 52 for not meeting the thematic relevance criteria. 78 articles were evaluated in full text. After strictly applying the inclusion and exclusion criteria, 24 sources were eliminated; Therefore, 54 articles made up the analysis sample.

To guarantee methodological quality, each study was evaluated using an adaptation of the MMAT scale (Mixed Methods Appraisal Tool) version 2018 (Hong et al., 2018), which allows assessing the robustness of research with different designs. Each study was scored on a scale from 0 to 5, with those with a score equal to or greater than 4 being considered high quality. Studies with scores lower than 3 were excluded to ensure the robustness of the findings. The selection and evaluation process was carried out by the author, and a second independent reviewer evaluated a random sample of 20% of the articles, reaching a level of agreement of 87% in eligibility and 82% in quality assessment.

It is valid to point out that other sources that were relevant to the discussion were also used, but since they did not meet all the criteria, they were used only as complementary literature to contextualize and contrast the findings. The main reasons for exclusion in the full text phase were: not explicitly addressing at least two of the central categories, focusing on general artificial intelligence unrelated to teacher training, or presenting a merely descriptive approach without critical analysis.

For the study, initial analytical categories were established based on the theoretical framework and research objectives: a) characteristics of training in educational technology; b) conditions of transfer to practice; c) barriers and facilitators of pedagogical integration; d) transformations observed in teaching practice; e) institutional and contextual factors; f) subjective dimensions of teachers. The content analysis was carried out with the support of NVivo 14 software, which allowed the systematic coding of the texts and the identification of emerging patterns. Coding was carried out in two rounds: a first open and a second axial, to group the categories into broader dimensions.

Results and discussion

Theoretical foundations of technological integration in Latin American teaching praxis

Understanding the relationship between teacher training and the pedagogical integration of educational technology requires an interdisciplinary approach that considers its multiple

foundations. In the Latin American context, this approach acquires particular nuances derived from the historical, social and cultural conditions of the region, where the tensions between technological modernity and structural inequality configure a complex scenario for educational praxis.

From a philosophical perspective, educational technology is part of the debate on the relationship between technology, society and knowledge. Cyberhumanism (Morales Aguilera, 2018) emerges as a current that advocates an integration of the technological and the human, where technology does not displace the subject, but rather enhances their critical, creative and relational capacities. This position is opposed to technodeterminist visions that conceive technology as an autonomous agent of change, or to apocalyptic perspectives that see it as a threat to humanity (Costa Júnior et al., 2025).

In Latin America, this discussion takes on an additional dimension, since technological adoption occurs in contexts of economic and cultural dependence that complicate the autonomous appropriation of digital tools. Habowski and Conte (2020) advocate a critical-dialectical interaction with technologies, which allows subjects to appropriate them in a conscious and emancipatory way, a position that resonates with the traditions of Latin American critical thinking.

At the sociological level, educational technology is a phenomenon crossed by the structural inequalities of the region. The digital divide is not only a problem of access, but also of use, appropriation and production of content, which makes it a manifestation of social exclusion (Estévez Estévez et al., 2024; Lugo & Ithurburu, 2019). The theory of cultural reproduction (Bourdieu, 1979) offers a framework for understanding how inequalities in cultural and technological capital are perpetuated through the educational system, a phenomenon particularly visible in countries such as Mexico, Brazil, Colombia and the Dominican Republic, where disparities between urban and rural areas, and between public and private institutions, are marked.

From critical pedagogy, technology can be a motive for inclusion and social justice, as long as it is articulated with processes of awareness and critical participation. The concept of critical digital literacy (Buckingham, 2003) emphasizes the need for teachers and students to develop a deep understanding of the power logics and narratives that underlie digital technologies, going beyond instrumental use. Experiences in countries such as Argentina, with the Conectar Igualdad program, or Uruguay, with the Ceibal Plan, illustrate both the possibilities and the limits of digital inclusion policies when they are not accompanied by critical training processes.

The psychological foundations of educational technology are anchored in learning theories. Constructivism has been one of the most influential frameworks in the region, understanding learning as an active process of knowledge construction, and technology as a cultural artifact that

mediates and enriches this process (Ortiz Granja, 2015). Connectivism (Siemens, 2005), for its part, emerges as a theory for the digital age, which emphasizes learning as a process of connecting information nodes and the importance of networks and distributed knowledge. Likewise, the development of skills such as computational thinking is related to the development of higher cognitive skills, such as problem solving and logical thinking, which are fundamental in the digital context (González, 2019; Rodríguez & Durán, 2020).

Self-regulation of learning is another key psychological process, especially in virtual environments; Gros and Cano (2021) highlight the role of technological feedback in its promotion, while Cabero and Palacios (2021) emphasize the design of e-activities that promote student autonomy. The affective dimension and teacher beliefs are equally important; Confidence in one's ability to use technology (digital self-efficacy) and attitudes towards innovation largely determine the willingness to integrate technology into practice (Sánchez, 2025; Tapia, 2020). In Latin American contexts, where many teachers face precarious working conditions and little professional recognition, these subjective dimensions acquire particular relevance.

From an educational point of view, technology is conceived as a means to achieve comprehensive training goals. Education in the digital era must be aimed at developing skills for life in the knowledge society, including critical and responsible digital skills (Prendes & Cerdán, 2021). The notion of technological learning ecosystems (Costa Júnior, 2023; Mujica, 2020; Pereira & Menezes, 2024) reflects this systemic perspective, understanding the educational environment as an interconnected set of resources, tools, actors and practices mediated by technology.

At the didactic level, technological integration requires a rethinking of teaching strategies. Thus, models such as the Flipped Classroom (Fernández-Rodicio & Triñanes-Corredoira, 2026) emerge, which invert the traditional logic of the class, or the use of tools such as the e-portfolio (Cortés *et al*., 2015) to promote active and reflective learning. The design of learning experiences with technology must be based on solid pedagogical principles, where technology is a facilitator of active, collaborative and personalized methodologies (Poveda-Pineda & Cifuentes-Medina, 2020; Zamora Loor & Pérez Plata, 2025). A critical approach points out that the use of ICT (Information and Knowledge Technologies), TAC (Learning and Knowledge Technologies) or TEP (Empowerment and Participation Technologies) does not guarantee innovation. True technological mediation is required (Ligarretto, 2021; Pérez Vertel & Larreal Bracho, 2023) that transforms pedagogical interaction.

Finally, the technological foundations address the tools, platforms and languages that make up the digital educational ecosystem. The evolution of ICT to TAC and TEP reflects a change in focus from instrumental use towards pedagogical and social appropriation (Herrera Barzallo et al., 2023). Currently, emerging technologies such as artificial intelligence, virtual and augmented reality, and educational robotics are redefining the possibilities and challenges of the field

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(Estévez Estévez et al., 2024; Prendes & Cerdán, 2021).

Generative artificial intelligence (Dorfsman, 2026; Ordoñez-Iturralde, 2026) represents perhaps the most disruptive change, offering tools capable of creating content, personalizing learning and automating processes. However, its integration raises ethical, epistemological and pedagogical questions that demand a deep debate (Costa Júnior et al., 2025). As UNESCO (2023) points out, technology in education must be governed by conditions that ensure its ethical, inclusive and people-centered use. In this line, computational thinking, robotics and programming are consolidated as content and as approaches to develop 21st century skills (González, 2019; Sánchez & González, 2019; Turan & Aydoğdu, 2020).

From this review, a critical stance is assumed that conceives educational technology as a field of dispute and possibility. Technological determinism is rejected, maintaining that the value of technology lies in the pedagogical use that is made of it, mediated by intentions, contexts and power relations. A social justice approach is advocated that prioritizes equity in access and critical appropriation of technologies, and teacher training that develops not only technical skills, but also an ethical and political awareness about the role of technology in education and society (Santiago et al., 2019). This position is particularly pertinent for Latin America, where technological adoption cannot be separated from the social and educational transformation projects that have historically characterized the region.

Trends in the use of educational technology in the Latin American region

The analysis of scientific production revealed growth especially in the period 2020-2026. The predominant formats are magazine articles, postgraduate theses and book chapters or institutional documents. Regarding methodological approaches, a high frequency of qualitative studies was observed, followed by mixed studies and, to a lesser extent, quantitative studies. This distribution reflected both the nature of the phenomenon studied – which requires a deep understanding of contextualized processes – and the predominant research traditions in the Latin American educational field.

The content analysis allowed us to identify four trends in the use of educational technology in Latin America:

- Teacher training models based on the Technological Pedagogical Content Knowledge (TPACK) approach to overcome instrumental approaches (Chaviano Rodríguez & Revilla Chaviano, 2025; Sánchez, 2025). These models seek a deep and contextualized pedagogical appropriation of technology, instead of technical training. The evidence suggests that programs that adopt this approach achieve greater transfer to practice, since they explicitly articulate the three types of knowledge and promote reflection on pedagogical decisions. In countries such as Colombia and Mexico, the TPACK model is a reference for the redesign of

initial and continuing training programs, while in other contexts, such as the Dominican Republic, its adoption is still incipient (Ureña Gómez et al., 2025).

- Emergence of disruptive technologies. Generative artificial intelligence, virtual reality and educational robotics have gained prominence in the literature (Dorfsman, 2026). AI is emerging as a new paradigm that requires rethinking integration models and teacher training, posing significant ethical and pedagogical challenges (Ordoñez-Iturralde, 2026). This trend is particularly visible in countries with greater relative technological development, such as Brazil, Mexico and Chile, where pioneering experiences of AI integration in higher education are concentrated. However, the gap in access to these technologies between and within countries poses the risk that AI will deepen existing inequalities, especially in rural and highly vulnerable contexts.
- Research as a transformative axis. An emphasis was observed on research as a device for the transformation of practice. Postgraduate and master's programs that articulate research with the use of ICT report significant changes in teaching practices and professional qualifications (Rodríguez Expósito et al., 2021; Guerrero-Cuentas et al., 2020). Action research and educational innovation projects emerge as effective strategies to link training with practice, allowing teachers to problematize their contexts and develop situated solutions. This trend is consistent with the traditions of participatory research and popular education that characterize Latin America.
- Emphasis on postgraduate training. Most studies analyze the impact of master's and doctoral programs, identifying them as key spaces for the development of technological competencies and the resignification of teaching praxis (Chaviano Rodríguez et al., 2026; Durand Villalobos & Gutiérrez, 2025). Postgraduate programs offer a privileged space for systematic reflection on practice and for the construction of professional learning communities. In countries such as Ecuador, Colombia and Mexico, postgraduate studies in education have increasingly incorporated content related to educational technology, although the quality and relevance of these programs varies significantly.

Methodologically, regularities were identified in the approaches to studying pedagogical integration. One of them is the predominance of qualitative, through case studies, in-depth interviews and documentary analysis. This type of research provides a contextualized understanding of the processes, but limits the generalization of the findings.

The absence of longitudinal studies constituted another regularity. Most studies are cross-sectional, evaluating the impact of training at a given time, without following up on graduates to verify the sustainability of the transformations over time. This limitation prevented us from understanding how teaching practices evolve and what factors contributed to the sustainability of innovations. Likewise, a considerable number of works were based on teachers' perception of their own training or integration, instead of directly measuring the impact on student learning or classroom dynamics. This reflected

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methodological difficulties in measuring educational impact.

Comparative analysis by regions and countries

In the Southern Cone, countries such as Chile and Uruguay have developed long-standing educational digitalization policies. Sandoval-Henríquez and Mejia-Elvir (2025) examine digital educational policy in Chile, noting that, although the country has made important advances in infrastructure and connectivity, challenges persist in teacher training for critical pedagogical use of technologies. García-Cartagena and Olivares-Petit (2023) complement this analysis by reviewing the perspectives for curricular innovations in Chile, highlighting the need to integrate educational technology as a transversal axis of the curriculum and not as an instrumental addition. In Brazil, Cipriani et al. (2024) analyze pedagogical mediation in the pandemic scenario, showing that the health crisis accelerated the adoption of digital technologies, but also revealed deficiencies in teacher training for effective pedagogical integration.

In the Andean region, Colombia presents significant scientific production. Monterroza-Ríos and Escobar-Gómez (2021) propose an epistemic framework to rethink technological education in Colombia, arguing that the country faces a conceptual problem that limits the development of coherent policies and programs. Bernate (2020) offers a reflective analysis of educational technology in Colombia, pointing out the persistence of instrumentalist approaches that fail to transform pedagogical practices. In Peru, Cruz García and García Higuera (2023) analyzed the use of educational technology in telesecundaria students, evidencing the gaps between the discourse of innovation and real practices in contexts of vulnerability.

In Central America and the Caribbean, production is more limited but revealing. Navarrete Cazales et al. (2022) analyze policies for innovation, inclusion and ICT in the national educational plans of Belize, Guatemala and Honduras, identifying a tension between modernization discourses and structural limitations for its implementation. Carballo Ruiz (2021) examines the digital educational policy in El Salvador, pointing out the need to articulate technological initiatives with sustained teacher training processes. In Panama, Gordon Graell (2021) analyzes the virtual environments of university education, highlighting the advances and deficiencies of educational computing in the face of the challenge of the pandemic. In the Dominican Republic, Ureña Gómez et al. (2025) study the integration of ICT in student learning, showing that, despite advances in policies such as the Digital Republic, challenges persist in teacher training and in the pedagogical appropriation of technologies. Cohen Camacho et al. (2024) offer a regional perspective on how Latin America and the Caribbean are implementing emerging technologies in higher education, pointing out the need to move from emerging technologies to emerging pedagogies.

This regional comparison revealed that, although there are differences in the levels of development and trajectories of digital educational policies, common patterns persist: the gap between policies and practices, insufficient teacher training, infrastructure limitations and the

persistence of instrumentalist approaches. These regularities suggest that technological integration in the region faces structural challenges that transcend national borders and that require cooperative and contextualized approaches.

The historical-logical analysis of the emerging categories in the literature revealed a significant evolution in the conceptualization of technological integration. Initially focused on the access and use of ICT, the discussion has moved towards pedagogical appropriation and the transformation of practice, and currently focuses on technological ecosystems and the emergence of AI. This journey shows a change from a logic of replacement or improvement of traditional teaching towards a logic of systemic transformation and reconfiguration of professional practice (Chaviano Rodríguez et al., 2026).

Dimensions for the analysis of pedagogical integration

The systematic review and historical-logical analysis allowed us to identify four interrelated dimensions that configure the possibility of an effective pedagogical integration of educational technology. These dimensions, which emerge from the synthesis of the literature, constitute the main theoretical contribution of this article and are conceived as an analytical framework that overcomes the linear and fragmented vision of the phenomenon. Each of these dimensions, their key indicators, and the areas that require further research are characterized below.

Training dimension. This dimension covers the characteristics and quality of teacher training programs in educational technology. Key indicators include the pedagogical approach of the program (instrumental versus critical-reflective), the integration of knowledge (TPACK), the teaching strategies used (e-activities, feedback, e-portfolio) and the duration and intensity of the training. Evidence suggests that programs that adopt critical and reflective approaches, that explicitly integrate technological, pedagogical and disciplinary knowledge, and that employ active learning strategies, achieve greater transfer to practice (Chaviano Rodríguez et al., 2026; Cabero & Palacios, 2021).

However, questions remain about how to design programs that are sustainable over time and adapt to the changing conditions of the technological ecosystem. Training in generative AI, for example, represents an unprecedented challenge that current programs have not been able to fully address.

Institutional dimension. The organizational conditions and internal educational policy that facilitate or hinder integration constitute this dimension. The key indicators include the infrastructure and technological resources available, the support and monitoring policies for teachers, the incentive systems for innovation, and the leadership and organizational culture favorable to change (Hernández León, 2024; Lugo & Ithurburu, 2019; Paredes Bermeo & Arteaga Alcívar, 2023). The evidence indicates that training, by itself, is not enough; Institutional

conditions are required that sustain and stimulate integration.

In Latin America, the institutional weakness of many educational systems constitutes a significant obstacle, especially in countries with less developed educational and technological infrastructures, such as Honduras, Guatemala, Nicaragua or the Dominican Republic itself. Pedagogical support after training emerges as a critical factor; Teachers who receive monitoring and sustained support report higher levels of integration than those who do not receive it.

Contextual dimension. This dimension refers to the characteristics of the socioeconomic, cultural and educational environment where teaching practice is developed. Key indicators include the socioeconomic conditions of the region and the school, the level of the digital divide (access and use), national educational policies and digitalization plans, and institutional and community culture (Estévez Estévez et al., 2024; Real Roby et al., 2024; Poveda-Pineda & Cifuentes-Medina, 2020; Santos Lugo, 2024; Karam et al. al., 2019).

The evidence shows that technological integration cannot be understood apart from contextual conditions. In rural areas of countries such as Mexico, Colombia, Peru or Bolivia, where connectivity is limited or non-existent, the possibilities of integration are severely restricted. Santos Lugo's (2024) study on the integration of offline ICT in Colombian rural education illustrates how technological solutions must be adapted to local realities. Similarly, in the Dominican Republic, the digital divide between urban and rural areas, and between the metropolitan region and the border provinces, conditions the possibilities of technological integration in teaching practice (Ureña Gómez et al., 2025).

Subjective dimension. The beliefs, attitudes, motivations and personal dispositions of teachers towards technology and change constitute this dimension. Key indicators include beliefs about the educational value of technology, digital self-efficacy and confidence, motivation for innovation and willingness to change, and professional identity and previous experiences (Sánchez, 2025; Murrieta Ortega, 2025; Tapia, 2020; Piscitelli, 2005). The evidence suggests that this dimension, although less studied than the previous ones, is decisive in understanding why teachers with similar training and comparable institutional conditions achieve very different levels of integration.

Resistance to change, technological anxiety or lack of confidence are not minor obstacles, but deep barriers that can nullify the impact of the best training. The literature reviewed offers clues about these processes, but lacks solid theoretical frameworks to understand how teacher identities and beliefs are transformed in the context of technological integration.

Comparison with other technological integration models

The proposed four-dimensional framework differentiates and complements other existing models in the literature. The integration model of Zhao et al. (2002) emphasizes the interaction

between technological innovation, the organizational context and the individual, but with a focus more focused on school change than on specific teacher training. The SQD (*Synthesis of Qualitative Data*) model by Tondeur et al. (2012), derived from a systematic review on initial teacher training, identifies six key factors for the preparation of future teachers in ICT, but focuses predominantly on the training dimension. For its part, the UTAUT (*Unified Theory of Acceptance and Use of Technology*) model by Venkatesh et al. (2003) focuses on individual technological acceptance, without sufficiently considering the institutional and contextual dimensions. The framework proposed here explicitly integrates the four dimensions into an interrelated scheme, offering a more comprehensive and systemic perspective that considers both micro (subjective) and macro (institutional and contextual) factors, and places training as a central but not exclusive element of the integration process.

Vacancy areas and lines of future research

The impact of training on student learning constitutes a critical gap. Most studies focus on the teacher's perception and practice, leaving the ultimate effect of technological integration unevaluated: the improvement of students' learning processes and results. Studies are required that, with rigorous designs, measure the impact on student performance, explicitly linking teacher training with academic performance, motivation or the development of skills in students (Crysol et al., 2020).

The subjective dimension emerged as a critical area that requires greater theoretical and empirical depth. The transformation of teacher identities and beliefs in the context of technological integration is a complex process that has not been sufficiently explored. Future research should integrate theoretical frameworks from educational psychology and the sociology of professions to understand how these changes occur and what training strategies can facilitate them.

Research on generative AI in Latin American contexts is still incipient. The few studies available come mainly from countries with greater relative technological development, leaving the implications of this technology in contexts of digital divide and educational inequality unexplored. Research is required that analyzes the impact of generative AI on teaching-learning processes, the ethical challenges it poses and the competencies that teachers must develop for its critical and pedagogical use.

The underrepresentation of certain countries and regions was a major limitation. The concentration of scientific production in Mexico, Colombia, Ecuador and Chile limits the generalization of findings and leaves unexplored the particularities of technological integration in countries such as El Salvador, Bolivia, Paraguay and other Central American nations. It is necessary to promote research in these contexts to understand the specificities of technological integration

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in each national reality.

Finally, the evaluation of educational policies represents another vacant area. The available studies focus predominantly on specific training experiences, leaving the impact of public policies and educational digitalization plans on teacher training and technological integration unevaluated. Research is required to identify success factors and areas for improvement in the policies implemented in the region.

Conclusions

The pedagogical integration of educational technology in Latin America is a complex, non-linear and deeply contextualized process, which transcends the availability of resources or the technical training of the teacher. The transfer of training to practice depends on a dynamic interaction between training, institutional, contextual and subjective dimensions, which have been systematized in a four-dimensional analytical framework that constitutes the main theoretical contribution of this article.

Trends are identified such as the rise of training models based on TPACK, the emergence of disruptive technologies (especially generative AI), the role of research as a transformative axis and the emphasis on postgraduate training. Likewise, there is a predominance of qualitative studies and a geographical concentration of scientific production, which limits the generalization of the findings and leaves the particularities of countries such as the Dominican Republic and other nations in the region unexplored.

The regional comparative analysis reveals that, although there are significant differences between the countries of the Southern Cone, the Andean region and Central America-Caribbean, common patterns persist: the gap between policies and practices, insufficient teacher training, infrastructure limitations and the persistence of instrumentalist approaches. In countries like Chile and Uruguay, with more consolidated digitalization policies, the challenges focus on the quality of training and critical pedagogical appropriation; In countries such as the Dominican Republic, Honduras and Guatemala, structural barriers to access and equity constitute the main obstacle. This heterogeneity requires differentiated and contextualized responses, but also regional cooperation strategies that allow sharing experiences and good practices.

The evidence reviewed confirms that teacher training can generate significant transformations in professional practice, but this impact is neither automatic nor uniform. Structural (digital divide, infrastructure), institutional (lack of support, leadership) and subjective (beliefs, resistance) barriers are persistent obstacles that require systemic approaches and comprehensive educational policies. Overcoming these barriers requires transcending the instrumental approach and adopting a critical and ethical perspective on the role of technology in education and society, in line with the principles of social justice and equity that have historically characterized Latin

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American pedagogical traditions.

The following are proposed as priority lines for future studies: the evaluation of the impact on student learning through longitudinal and quasi-experimental designs; the in-depth analysis of the subjective dimension and the processes of teacher identity transformation; research on generative AI in digital divide contexts; promoting studies in underrepresented countries and regions, including the Dominican Republic and Central American nations; the analysis of educational policies and digitalization plans; and participatory action research that involves teachers as co-researchers. The adoption of mixed and longitudinal methodological approaches, the use of validated instruments and the incorporation of the students' voice are key challenges to advance knowledge of this field and contribute to the improvement of educational quality in the region.

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Conflict of interest:

The author declares that she has no conflicts of interest regarding this study.

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Declaration of author responsibility:

Ortega Guzmán: Conducted the search and curation of information, content analysis and prepared the scientific article.

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