

SCIENCES OF EDUCATION, DIGITAL TECHNOLOGIES, AND PEDAGOGICAL INNOVATION: CHALLENGES AND POSSIBILITIES FOR CONTEMPORARY EDUCATION

**CIÊNCIAS DA EDUCAÇÃO, TECNOLOGIAS DIGITAIS E INOVAÇÃO
PEDAGÓGICA: DESAFIOS E POSSIBILIDADES PARA A EDUCAÇÃO
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ABSTRACT

The social and technological transformations of recent decades have expanded the possibilities for integrating digital technologies into education while also making longstanding challenges more evident, particularly those related to teacher training, school infrastructure, and digital inclusion, which remains an unresolved issue. In this context, the general objective of this research is to analyze the challenges and possibilities associated with the integration of digital technologies and pedagogical innovation in the field of Educational Sciences. Methodologically, a qualitative approach was adopted, based on a literature review of scientific articles, book chapters, and books, combined with documentary research. The integration of these procedures made it possible to relate theoretical contributions to documentary guidelines relevant to the subject under investigation. The findings indicate that the integration of digital technologies and pedagogical innovation depends on the articulation of pedagogical intentionality, teacher training, infrastructure, and digital inclusion. The analysis also revealed that technological resources can support diverse teaching and learning approaches when combined with pedagogical mediation and adequate institutional conditions. It is concluded that integrated educational policies focused on professional development, connectivity, and equity can contribute to the development of innovative educational practices. Future research could examine the effects of these initiatives across different school contexts.

Keywords: Educational Sciences; Digital technologies; Pedagogical innovation; Digital inclusion.

RESUMO

Com as transformações sociais e tecnológicas das últimas décadas, abriram-se novas possibilidades de uso das tecnologias digitais na

educação, embora ao mesmo tempo tenham ficado mais visíveis alguns problemas antigos: a formação dos professores, a infraestrutura das escolas e a inclusão digital, que continua longe de estar resolvida. Nesse contexto, o objetivo geral desta pesquisa consiste em analisar os desafios e as possibilidades da integração das tecnologias digitais e da inovação pedagógica no campo das Ciências da Educação. Metodologicamente, adotou-se uma abordagem qualitativa, desenvolvida por meio de revisão bibliográfica de artigos científicos, capítulos de livros e livros, associada à pesquisa documental. A articulação desses procedimentos permitiu relacionar contribuições teóricas e orientações documentais pertinentes à temática investigada. Os resultados da análise evidenciaram que a integração das tecnologias digitais e da inovação pedagógica depende da articulação entre intencionalidade didática, formação docente, infraestrutura e inclusão digital. Verificou-se que os recursos tecnológicos favorecem diferentes possibilidades de ensino e aprendizagem quando associados à mediação pedagógica e a condições institucionais adequadas. Conclui-se que políticas educacionais integradas, voltadas à formação profissional, à conectividade e à equidade, podem contribuir para práticas educativas inovadoras. Pesquisas futuras poderão examinar os efeitos dessas iniciativas em diferentes contextos escolares.

Palavras-chave: Ciências da Educação; Tecnologias digitais; Inovação pedagógica; Inclusão digital.

1. INTRODUCTION

The social, cultural, and technological transformations of recent decades have substantially changed how knowledge is produced and how teaching and learning processes are organized, and the

field of Educational Sciences has not remained unaffected by these developments. Digital technologies are now present in various dimensions of educational activity, including access to information, communication between teachers and students, and the organization of pedagogical work itself. In this context, systematic reflection on the purposes of education today and the conditions under which these resources can be incorporated in ways consistent with educational objectives has become necessary, rather than adopting them merely because they are available. Without such reflection, the incorporation of technological resources tends to be limited to the replacement of traditional tools and materials.

The integration of digital technologies does not, in itself, ensure pedagogical innovation, and this distinction is frequently overlooked in current debates. Their actual contribution to learning depends on teacher mediation, activity planning, teachers' professional training, the availability of equipment and connectivity, and the actual access conditions of each student. This discussion becomes particularly relevant in contexts marked by structural inequalities, where some schools have access to equipment, stable connectivity, and teachers qualified to use these resources, whereas others still lack such conditions. These disparities highlight infrastructure deficiencies and gaps in teacher training as factors that constrain the integration of digital technologies into educational contexts. Educational transformation, when achieved, requires coordinated action among teachers, school administrators, teacher education institutions, and public policymakers, rather than the mere provision of technological tools. Understanding the challenges associated with this integration, while considering the actual conditions under which it occurs, provides a basis for developing educational practices that are

contextually appropriate, inclusive, and responsive to contemporary demands.

In light of this context, the following research question was formulated: What are the main challenges and possibilities associated with the integration of digital technologies and pedagogical innovation in the field of Educational Sciences, considering contemporary transformations, teacher training, school infrastructure, and digital inclusion? Based on this question, the general objective was defined as analyzing the challenges and possibilities associated with the integration of digital technologies and pedagogical innovation in the field of Educational Sciences.

To achieve this objective, three specific objectives were established: to analyze contemporary transformations in the field of Educational Sciences, considering their implications for teaching and learning processes; to examine the pedagogical possibilities afforded by digital technologies and their contributions to these processes; and to discuss the challenges and conditions required for pedagogical innovation, with an emphasis on teacher training, school infrastructure, and digital inclusion. This delimitation guided the organization of the investigation and the articulation of the conceptual, pedagogical, and institutional dimensions related to the research subject.

Regarding the methodological procedures, the study adopted a qualitative approach based on a literature review and documentary research. The literature review included scientific articles published in specialized journals, book chapters, and books relevant to the subject. The documentary research involved an examination of the reference framework on teachers' digital competence developed by

UNESCO IITE and SOU (2022), as well as the international handbook on information technologies in primary and secondary education, edited by Voogt and Knezek (2018). The combination of these procedures made it possible to relate different theoretical contributions to the guidelines presented in the documents examined, thereby supporting an integrated analysis of the research problem.

The article is organized into four sections. The first presents the introduction, including the contextualization of the subject, the research question, and the objectives. The second comprises the theoretical framework, structured into three subsections addressing contemporary transformations in Educational Sciences, the pedagogical possibilities of digital technologies, and the conditions required for pedagogical innovation. The third section presents the methodology, describing the approach and procedures employed. Finally, the fourth section presents the concluding remarks, synthesizing the main arguments developed, the contributions of the study, and prospects for future research.

2. THEORETICAL FRAMEWORK

2.1. Educational Sciences And Contemporary Transformations

Understanding the transformations in educational processes resulting from changes in the ways knowledge is produced, accessed, and shared remains a subject of ongoing debate in the field of Educational Sciences, whose relevance is renewed by the continuous social, cultural, and technological changes of contemporary society. The ways in which knowledge is produced, accessed, and shared have changed considerably, requiring a

reassessment of pedagogical practices and of the relationships among teachers, students, and content. Teaching is no longer synonymous with the transmission of information. Rather, it involves educating individuals who can critically interpret reality and participate in its transformation. The expansion of the Internet has changed access to information and broadened opportunities for interaction in educational environments. According to Ferrari (2018, p. 379):

The internet has significantly changed culture, people's lifestyles, and the way business is conducted. It has also had a significant impact on education. An initial example of how the internet has affected education is the new way of accessing information, which may contribute to knowledge construction in formal or informal contexts. Through the internet, we have access to numerous books (e-books), scientific article databases, and various types of information, both scientific and non-scientific, on a wide range of subjects. In different ways and through multiple devices, the internet has also been used as a means of interaction between students and teachers [...].

This greater availability of information changes the conditions for learning but does not, in itself, ensure knowledge construction. Strategies must be developed to support the selection, interpretation, and critical analysis of available content. In this regard, Alves (2021) and Cardozo et al. (2023) contribute to discussions on methodologies and the integration of technologies in contemporary educational contexts, helping situate technological transformations in relation to pedagogical demands and students' educational needs. The incorporation of technological resources into

educational systems, however, is not a linear process. Peixoto (2023, p. 13) explains that:

Over recent decades, the integration of technologies has become an important objective of educational systems. It is important to note that the incorporation of technologies into education has occurred through unfinished cycles involving successive technical tools, without rigorous evaluation of the pedagogical practices mediated by these tools. This is evident in educational policies, initiatives, and programs promoting the pedagogical use of resources such as interactive whiteboards, laptops, mobile phones, and tablets, as well as the implementation of educational applications, electronic games, virtual learning environments, and various networked communication tools.

Peixoto (2023) argues that evaluating technological integration involves more than acquiring equipment or adopting platforms. The central issue, according to the author, is the incorporation of digital resources without rigorous evaluation of the pedagogical practices underpinning their use. Testa and Stentzler (2022) add another dimension to this discussion that Peixoto (2023) does not address in the same way: educational technologies do not reach individuals under neutral conditions, as their use depends on users' social access and cultural capital. While one perspective focuses on classroom practices and how resources are used once they become available, the other examines who has the opportunity to access them. Peixoto (2023) highlights the limitations of integration processes that fail to evaluate their own pedagogical outcomes, whereas Testa and Stentzler (2022) demonstrate that opportunities to use these resources are not equally distributed. Taken together,

these perspectives suggest that evaluating pedagogical innovation requires examining both the quality of educational practices and the access conditions of students and institutions. Since opportunities to use digital resources vary across educational contexts, understanding ongoing transformations requires acknowledging these inequalities. Castro and Brazão (2022, p. 1) state that:

Education, in its fullest sense, must help people establish a more effective and affective relationship with knowledge and the world around them. It should not be responsible for reproducing society, but rather for producing it, since human beings are understood as being in a process of continuous development, constructing and transforming themselves while also constructing and transforming the environment in which they live. Within this complex relationship, people are transformed by the world they themselves transform. Accordingly, education should fulfill a humanizing role, seeking to improve society through the individuals it educates.

Understanding education from this perspective means recognizing it as a social practice aimed at human development and critical participation in society. Therefore, pedagogical innovation should not be equated with simply introducing digital tools into the classroom. What matters is how these choices relate to educational purposes, student autonomy, and the development of meaningful learning experiences. This discussion directly relates to the issues raised by Devechi and Trevisan (2022) concerning the challenges currently facing Educational Sciences in Brazil.

Ongoing transformations also affect teacher education and professional practice. Curricular changes and the increasing

presence of digital resources require teachers to develop knowledge that extends beyond subject-matter expertise. They demand pedagogical competence and, more importantly, a critical understanding of the technologies that increasingly shape classroom practices. In this regard, Sousa and Purificação (2026) provide insights into the relationship between educational reforms and teacher education, examining the directions, tensions, and possibilities associated with these changes. The effectiveness of educational initiatives therefore depends on how professional training, institutional conditions, and pedagogical objectives are coordinated, rather than on any one of these elements in isolation. Understanding this context requires examining interdependent dimensions, including social and cultural changes, the expansion of technological resources, the reassessment of teaching practices, teacher education, and institutional conditions. Table 1 summarizes these aspects, outlining their implications for teaching and learning processes and providing an integrated overview of the transformations affecting Educational Sciences.

Table 1. Main aspects of contemporary transformations in the field of Educational Sciences

Dimension	Key aspects	Implications for education
Social and cultural	Changes in social relationships, communication, and access to information.	Diversification of ways of learning and sharing knowledge.
Technological	Expansion of the Internet, digital devices, and virtual environments.	Broader teaching resources and increased opportunities for interaction.

Pedagogical	Reassessment of methodologies and relationships among teachers, students, and knowledge.	Greater student participation and diversification of learning experiences.
Teacher education	Development of pedagogical and digital competencies.	More informed and planned integration of technologies into teaching.
Institutional	Infrastructure conditions, educational policies, and inequalities in access.	Need for planning, institutional support, and digital inclusion initiatives.

Source: Prepared based on Ferrari (2018), Alves (2021), Castro and Brazão (2022), Testa and Stentzler (2022), Devecchi and Trevisan (2022), Peixoto (2023), Cardozo et al. (2023), and Sousa and Purificação (2026).

The transformations discussed here do not occur in isolation. Social change, technological resources, teacher education, and pedagogical practice influence one another, forming an ongoing process. Figure 1, presented below, seeks to represent this sequence of transformations and the challenges it poses for the development of a more inclusive contemporary education system.

Figure 1. Timeline of contemporary transformations in education in Brazil



Source: Prepared based on Ferrari (2018), Peixoto (2023), Castro and Brazão (2022), Alves (2021), Devechi and Trevisan (2022), and other references included in the study.

Note: Prepared by the authors with the assistance of ChatGPT (OpenAI, 2026).

The representation illustrates that educational transformations do not result solely from the introduction of technologies into schools. Rather, they emerge from the interaction between social changes, the actual conditions of each institution, and the pedagogical decisions made within these settings. This interplay constitutes a complex process that requires systematic analysis. Understanding it involves critically examining the possibilities that digital resources can offer, the professional development teachers require and the existing gaps in their training, as well as persistent inequalities in access. Pedagogical innovation is meaningful only when it contributes to democratic, humanizing, and socially responsible education.

2.2. Digital Technologies And Pedagogical Possibilities

Digital technologies have become part of educational processes, changing how information is accessed, how interactions occur, and how knowledge is constructed. Connected resources, virtual environments, and interactive tools expand methodological possibilities. However, this expansion does not, in itself, guarantee educational outcomes, since, without pedagogical planning, their use tends to assume a merely instrumental character, without effective alignment with learning objectives. The relevant question, therefore, is not whether schools have access to technology, but rather which educational experiences these resources actually support when incorporated into teaching and learning processes.

Oliveira (2017, p. 16) emphasizes that:

[...] Web 4.0 integrates solutions and artifacts available on the internet, in cities, through the Internet of Things, Artificial Intelligence, and processes involving the production of goods, services, and knowledge. This configuration makes it possible to envisage ubiquitous and disruptive curricula developed through personal and collective learning environments. From this perspective, the boundaries between formal and informal educational settings become more permeable, expanding opportunities for collaboration and student participation in organizing their learning pathways.

The incorporation of these resources also requires changes in the organization of pedagogical work. According to Vidal and Miguel (2020, p. 377), technologies have “significantly changed conceptions of teaching, learning, the classroom, and assessment, requiring schools, teachers, and administrators to reconfigure their pedagogical practices.” This reconfiguration involves reviewing

teaching strategies, approaches to monitoring learning, and assessment criteria so that digital resources contribute to content comprehension and active student participation. The use of digital technologies, however, involves decisions that extend beyond selecting available resources. Souza (2022, p. 8) points out that:

The use of technologies in education presents major challenges and raises questions such as why, how, and which digital technologies should be used in education. Given the numerous changes and possibilities, it is difficult to establish a single direction for education. Nevertheless, the interactions between the desire to learn and teaching practice help identify pathways that support learning. Knowledge constitutes the foundation of this process, while technologies can facilitate access to knowledge and engagement with it. These interactions contribute to defining the quality of education.

Teacher mediation, therefore, guides the selection and use of digital resources in accordance with students' needs and curricular objectives. In examining the contributions and limitations of digital technologies in education, Simão et al. (2023) contribute to this discussion by emphasizing the need for critical analysis, planning, and attention to the actual conditions under which technological applications are implemented. Teacher training is another factor influencing the pedagogical integration of these technologies. Sá et al. (2025, p. 12) state that:

Digital technologies in the country's educational system offer significant opportunities for educational transformation, positively supporting teachers' work. However, for these benefits to materialize, teacher education must equip educators to use these technologies, helping them develop the skills and competencies required for their application and, particularly, their integration into the curriculum and classroom practice.

Providing access to digital technologies does not, in itself, resolve the challenges associated with their pedagogical use. Almeida (2020) had already highlighted this issue by discussing the relationship between teacher training, technical proficiency, and the ability to design activities that closely monitor student learning and assess its outcomes. Knowing how to operate a tool represents only one dimension of the problem. The teaching competence required in this context involves integrating technological resources into planning, classroom instruction, and the assessment of what students have actually learned. Boscarioli (2022) shifts the focus to another issue: the discrepancy between the expectations surrounding digital technologies and the training available to Basic Education teachers, which does not always provide sufficient conditions to realize these possibilities.

The gap between what Almeida (2020) identifies as necessary and what Boscarioli (2022) describes as available is itself relevant to this research. Considered together, these perspectives suggest that teaching educators to operate a technological tool does not necessarily prepare them to use it pedagogically. Similarly, identifying deficiencies in working conditions is insufficient on its own. Teacher education must address technical proficiency, pedagogical knowledge, and learning assessment while

acknowledging the actual conditions under which teachers work. This is where the research problem becomes particularly evident: transforming available resources into learning experiences aligned with educational objectives is primarily a matter of teacher preparation and working conditions, rather than technology alone.

Teacher competence, however, cannot resolve every challenge. No educational initiative can be sustained without adequate infrastructure, connectivity, and institutional support. In this regard, Coppi et al. (2022) discuss pathways for the future of digital education, while Voogt and Knezek (2018) provide a reference for examining the integration of information technologies into basic education. Considered together, these approaches make it possible to relate the prospects for digital education to the conditions required for its implementation in school settings. The issue is not simply whether teachers know how to use a tool, but whether they have the material and organizational conditions necessary to sustain its use over time. A well-designed initiative may fail to produce lasting results if institutional support is discontinued. This relationship demonstrates that infrastructure and institutional support are not secondary considerations, but conditions that influence the continuity of technology-mediated pedagogical practices.

An even more fundamental issue concerns the unequal distribution of access. The availability of devices and internet connectivity varies among students and educational institutions, and these disparities may restrict participation in proposed activities and exacerbate existing differences in learning opportunities. Adopting technology without considering the socioeconomic, territorial, and educational conditions of the populations served risks reproducing the very

barriers that pedagogical innovation is intended to reduce. To synthesize the main pedagogical possibilities of digital technologies, their benefits, and the limitations requiring attention during implementation, Table 2 is presented below.

Table 2. Pedagogical possibilities of digital technologies

Pedagogical possibility	Benefits	Examples of application	Challenges and limitations
Diversification of methodologies	Expanded opportunities for participation and learning.	Multimedia resources, educational games, and virtual environments.	Superficial use and lack of pedagogical planning.
Access to information	Broader range of research and reference sources.	Digital libraries, e-books, and databases.	Misinformation and difficulties in evaluating sources.
Collaboration and interaction	Promotion of communication and collective knowledge construction.	Discussion forums, collaborative projects, and videoconferencing.	Connectivity problems and distractions.
Autonomy and creativity	Encouragement of inquiry and problem-solving.	Simulations, digital production, and inquiry-based activities.	Need for teacher mediation and curricular alignment.
Personalized learning	Opportunities to adapt activities to different needs.	Adaptive platforms and accessibility resources.	Unequal access and data protection concerns.

Source: Prepared based on Oliveira (2017), Vidal and Miguel (2020), Almeida (2020), Souza (2022), Boscarioli (2022), Coppi et al. (2022), Simão et al. (2023), and Sá et al. (2025).

Table 2 brings together several pedagogical possibilities and highlights an important finding: the contribution of technologies to teaching depends on how educational objectives, methodological choices, and the conditions under which resources are actually used are coordinated. Figure 2 seeks to illustrate this relationship by presenting the benefits commonly associated with digital resources and showing how teacher mediation and pedagogical planning influence their application.

Figure 2. Benefits and pedagogical conditions for the use of digital technologies in education



Source: Prepared based on Oliveira (2017), Vidal and Miguel (2020), Almeida (2020), Souza (2022), and Sá et al. (2025). Note: Prepared by the authors with the assistance of ChatGPT (OpenAI, 2026).

The analysis of digital technologies in education also requires an understanding of how innovation, institutional culture, and pedagogical responsibility interact within schools. Ertmer and Ottenbreit-Leftwich (2020) examine this relationship from the teacher's perspective, demonstrating how knowledge, beliefs, and institutional culture intersect when teachers modify their technology-mediated practices. Their work shows that technological

integration cannot be explained solely by individual competencies, since teachers' conceptions and the contexts in which pedagogical practices develop are equally relevant. Heinen (2026), in turn, shifts the discussion toward the regulation of digital life and the tensions it generates between protecting existing structures and promoting change. Although these studies adopt different perspectives, considered together, they challenge the assumption that technology adoption is merely a technical or individual decision. Rather, they indicate that technological solutions must be evaluated in relation to their effects on teaching, learning, teachers' professional practices, and the responsibilities associated with the use of digital resources. Within the scope of this research, this relationship requires simultaneous consideration of the pedagogical and institutional conditions under which technological integration occurs and the responsibilities associated with digital resource use. Consequently, opportunities for innovation must be examined alongside the challenges accompanying their implementation, rather than as separate issues.

Digital technologies expand the possibilities for teaching and learning, but their contributions depend on intentional curricular integration, teacher mediation, continuing professional development, and infrastructure capable of meeting schools' everyday needs. Their educational value therefore depends less on the resources themselves than on their ability to respond to students' actual needs and foster critical, collaborative, and inclusive learning experiences. Pedagogical innovation, accordingly, is not an automatic consequence of adopting technological tools, but rather the outcome of a planned educational process.

2.3. Pedagogical Innovation, Teacher Training, Infrastructure, And Digital Inclusion

Discussing pedagogical innovation in contemporary education involves examining concrete changes in classroom practices, teaching strategies, learning approaches, and the role of students in the educational process. Such changes do not occur spontaneously. They depend on teachers receiving appropriate training, schools having functional technological infrastructure, institutions providing sustained support, and students having adequate levels of digital inclusion to use these resources in their daily learning activities. Therefore, incorporating digital technologies without linking them to clearly defined educational objectives may fail to improve learning outcomes or reduce educational inequalities, despite the potential benefits often associated with these resources.

Within this set of conditions, teacher training has a particularly direct influence on the possibility of achieving critical and planned technological integration rather than relying on incidental or unstructured use. UNESCO IITE and Shanghai Open University (2022) emphasize the importance of developing teachers' digital competencies and strengthening technological infrastructure to transform educational processes, indicating that technology integration requires appropriate institutional conditions and continuing professional development. This perspective makes it possible to relate the development of digital competencies to the material and organizational conditions that must be ensured for these competencies to be effectively applied in everyday school practice. Teacher training, therefore, should not be regarded as the sole responsibility of individual educators, but as part of an institutional policy integrating professional development,

infrastructure, and technical support. This distinction is important because it shifts the focus of responsibility. Rather than expecting teachers to independently resolve the challenges of a structural transformation, education systems must provide the conditions necessary for these professionals to develop and apply their digital competencies. This issue directly relates to the research question, as the challenges of technological integration cannot be addressed from a single perspective. They involve both teacher preparation and the capacity of educational institutions to provide the practical conditions required for pedagogical innovation (UNESCO lite; Sou, 2022).

Continuing professional development limited to the technical operation of tools overlooks a fundamental dimension of teaching: teachers may learn to operate digital applications without understanding how to integrate them effectively into classroom practice. Ramos et al. (2025) address this issue by linking teacher training to pedagogical innovation and the transformation of practices in digital contexts. This perspective calls for training programs that treat technology and didactics as interconnected dimensions rather than separate areas of knowledge. An effective training program should integrate technological knowledge, didactic foundations, curriculum planning, and learning assessment strategies, enabling teachers to select digital resources according to established pedagogical objectives and students' characteristics, while prioritizing educational relevance over popularity or temporary technological trends.

Pedagogical innovation also requires changes in conceptions of teaching and in the organization of school activities. Santos, Ferreira, and Maneschky (2023, p. 33) argue that it is necessary to “break with

the mere transfer of the lecture-based lesson to technological media, since reproducing traditional practices in digital environments changes the medium but maintains the same teaching logic.” This observation demonstrates that the presence of devices or platforms does not, in itself, represent pedagogical transformation. Innovation takes shape when resources support alternative forms of participation, inquiry, collaboration, and knowledge construction.

Oliveira and Garcia (2023, p. 3) observe that the presence of digital information and communication technologies (DICT) in education “calls upon teachers to (re)configure their teaching practices, situating technology within pedagogical decision-making and the very constitution of teaching work.” This perspective highlights the need for initial and continuing teacher education policies that integrate technological knowledge with practical teaching experiences. Professional development should encompass the selection of educational materials, the design of contextualized activities, and the critical assessment of the results obtained.

Furthermore, teachers' digital competence includes understanding both the potential and the limitations of the resources they use. According to Cybis and Júnior (2022), the challenges and prospects associated with developing this competence in Basic Education warrant further discussion. From this perspective, digital competence must be examined in relation to the specific demands and conditions of Basic Education rather than treated as a generic requirement. Teixeira (2026) contributes to this discussion by examining teacher training and the pedagogical use of digital technologies, thereby connecting professional development to actual teaching and learning practices. Considered together, these

perspectives point to the same conclusion: digital competence extends beyond operational knowledge and must be connected to pedagogical decisions and the needs of the school context. These contributions reinforce the need for continuing professional development programs aligned with educators' professional responsibilities and working conditions. Teacher training thus presents both a challenge and an opportunity for integrating technologies into classroom practice, as it can improve their pedagogical use when linked to teachers' actual working conditions.

Pedagogical mediation is another important component of this process. According to Oliveira and Silva (2022, p. 3), “the mere incorporation of DICT is insufficient to ensure teaching effectiveness, since mediation involves planning, guidance, and monitoring of the activities undertaken.” Accordingly, teachers are responsible for creating learning opportunities, guiding student participation, and identifying difficulties encountered during learning. Student autonomy develops through appropriate pedagogical interventions that support progressively independent engagement with knowledge.

School infrastructure, in turn, determines the conditions under which digital technologies can be used. The availability of devices, internet connectivity, equipment maintenance, and technical support must be sufficiently reliable to sustain the proposed innovations. Cruz et al. (2025) examine digital technologies as resources for pedagogical innovation, situating their use within broader educational transformations and the integration of technology into teaching practices. Even well-trained teachers may encounter obstacles to implementing digital activities consistently

when the necessary material and organizational conditions are lacking.

Digital inclusion broadens this discussion by demonstrating that access to technologies and the ability to use them remain unevenly distributed among schools and students. According to Onofri, Ripa, and Martins (2024, p. 21), “it is necessary to understand which resources teachers have mastered in order to incorporate them into pedagogical practices.” This observation suggests that training and innovation initiatives cannot be designed without considering existing professional competencies, the resources actually available, and the specific needs of school contexts. Figure 3 presents recommendations for the bodies responsible for educational policymaking, emphasizing the relationship between teacher training, pedagogical innovation, and digital inclusion.

Figure 3. Guidelines for teacher training integrated with pedagogical innovation and digital inclusion



Source: Prepared based on UNESCO IITE and SOU (2022), Cybis and Júnior (2022), Oliveira and Silva (2022), Oliveira and Garcia (2023), Onofri, Ripa, and Martins (2024), Cruz et al. (2025), Ramos et al. (2025), and Teixeira (2026). Note: Prepared by the authors with the assistance of ChatGPT (OpenAI, 2026).

Figure 3 brings together guidelines that point toward a common conclusion: transforming educational practices cannot be achieved through isolated efforts. It requires coordinated action by public policymakers, teacher education institutions, and schools. Continuing professional development, infrastructure, digital inclusion, and evaluation of educational initiatives emerge as complementary areas that are effective only when integrated into coherent policies that account for the specific characteristics of each school context. The ultimate aim is to ensure that pedagogical practices are continuously reassessed, supported by adequate institutional conditions, and directed toward improving learning outcomes.

Taken together, the studies reviewed provide an answer to the research question guiding this investigation: the integration of digital technologies into pedagogical innovation does not depend on a single factor, but on the coordination of teacher training, infrastructure, institutional support, and digital inclusion. Access to technological resources alone is insufficient. The central challenge lies in their critical appropriation and meaningful integration into the broader educational purposes that guide teaching and learning.

3. METHODOLOGY

Research in the field of Educational Sciences on digital technologies and pedagogical innovation begins with a concrete scenario: educational processes undergoing transformation, teacher training that remains insufficient to meet digital demands, unequal school infrastructure, and digital inclusion that remains an unresolved issue. Understanding how these elements interact requires bringing together the existing literature on the subject and examining the

documents that currently guide the integration of technologies into education. The study adopted a qualitative approach, combining a literature review with documentary research to interpret theoretical and documentary contributions concerning the challenges and opportunities that the integration of digital technologies and pedagogical innovation presents for Educational Sciences.

A qualitative approach was selected because it is better suited to interpreting concepts, theoretical perspectives, and educational issues that cannot be adequately explained by numerical indicators alone. This approach makes it possible to understand the meanings attributed to pedagogical practices, educational policies, and the relationships between technology and learning without reducing these phenomena to frequencies and percentages. In international scientific research, this type of analysis interprets phenomena within their specific contexts and develops evidence-based interpretations of problems that cannot be resolved through a single variable, an approach that Risemberg, Wakin, and Shitsuka (2026) also associate with methodological rigor. The analysis focused on interpreting the arguments presented in the selected publications and documents, considering their relationship to the research question and the thematic dimensions established for the study.

The research design combined two complementary procedures: a literature review and documentary research. A narrative literature review was chosen to reflect the way the study was actually conducted, through the reading, interpretation, and critical integration of academic contributions gathered throughout the research process, without the intention of conducting a systematic review based on an exhaustive protocol for identifying and selecting studies. The literature review focused on examining academic

research on the subject. The materials collected were consistent with the scope of this type of investigation and included articles published in specialized journals, book chapters, and books addressing Educational Sciences, digital technologies, and pedagogical innovation, identified through journal platforms, repositories, and other scientific collections. The inclusion criterion was the relevance of each source to the research question and the study's objectives. As Sousa, Oliveira, and Alves (2021) point out, reviewing the literature makes it possible to synthesize existing research, identify theoretical contributions, and establish connections among different scientific perspectives.

In scientific research, a literature review organizes existing knowledge, facilitates the comparison of arguments, and provides a conceptual foundation for interpreting the object of study. This study followed the same principle. Through the review, educational transformations were examined in conjunction with the pedagogical contributions of digital technologies and the challenges faced by education professionals and institutions in their daily activities. Reading these publications also helped structure the discussion around teacher training, pedagogical mediation, technological infrastructure, and digital inclusion, while maintaining alignment with the theoretical framework and the research objectives.

Documentary research, in turn, involved a different type of source: institutional and technical-scientific materials related to digital education, which were particularly useful for examining frameworks, concepts, and guidelines relevant to the integration of technologies into education. The documents were selected because they were directly related to the object of investigation and addressed digital teaching competencies and the use of information technologies in

basic education. Their institutional or academic origins were also identifiable. The materials considered for this stage included the report *Analytical Report on the Use of Advanced ICT/AI for Digital Transformation of Education*, published in 2022 by the UNESCO Institute for Information Technologies in Education and the Shanghai Open University, and the *Second Handbook of Information Technology in Primary and Secondary Education*, edited by Voogt, Knezek, Christensen, and Lai and published in 2018.

The documentary analysis was organized around five interconnected dimensions rather than treating them as isolated categories: teachers' digital competencies, institutional conditions for technological integration, infrastructure and educational resources, opportunities for transforming pedagogical practices, and the challenges that technology use poses for education. The analysis sought to identify arguments and guidelines associated with these dimensions and interpret them in light of the research question. This process involved comparing the contributions of the selected texts and examining their convergences, differences, and relevant insights for a better understanding of the object of study.

Working with this type of document makes it possible to interpret recorded information in relation to the research problem, thereby helping situate concepts and guidelines relevant to scientific inquiry (Alves et al., 2021).

Together, the two procedures addressed aspects that neither could have adequately covered on its own. The literature review provided conceptual foundations and different interpretations of the subject, while documentary research added an analysis of content drawn from selected institutional publications and technical-scientific

works. These procedures were integrated by comparing the arguments and guidelines identified in the sources against the thematic dimensions that structure the study. Ultimately, this combination supported an integrated interpretation of the challenges and opportunities associated with pedagogical innovation, consistent with the qualitative approach adopted and the objectives established for the research.

4. FINAL CONSIDERATIONS

The integration of digital technologies and pedagogical innovation into the field of Educational Sciences is no longer a niche concern. Social, cultural, and technological changes currently affecting teaching and learning processes have brought this topic to the forefront of educational debate. Within this context, the present study sought to understand the challenges and opportunities associated with incorporating digital resources into educational practice, with particular attention to teacher training, infrastructure conditions, and digital inclusion. The analysis points to an issue that goes beyond the now widely acknowledged importance of technology in education: the effective integration of digital technologies into teaching and learning depends on how pedagogical, institutional, and social conditions interact, facilitating this process in some circumstances while constraining it in others. Educational transformation, therefore, cannot be achieved simply by making technological tools available, as it also involves pedagogical decisions, institutional conditions, and policies that guide their use.

Returning to the research question concerning the main challenges and opportunities associated with this integration in light of contemporary transformations, teacher training, school

infrastructure, and digital inclusion, the study concludes that the question was addressed within the scope of the bibliographic and documentary analysis conducted. Accordingly, the general objective is considered to have been achieved, since the analysis brought together the pedagogical, technological, and institutional factors involved in this process. The specific objectives were addressed through the discussion of changes in the educational field, the pedagogical possibilities offered by digital technologies, and the conditions required to innovate teaching practices. This achievement, however, concerns the interpretation and systematization of the aspects identified in the sources examined, rather than the empirical verification of their effects in actual educational settings.

The main contribution of this study is analytical in nature: it organizes the dimensions identified in the sources examined as interdependent components of the process of integrating technology into education. It should be emphasized that this contribution concerns the interpretation and systematization of aspects documented in these sources, rather than the empirical demonstration of their effects in specific school contexts.

Teacher training depends on the infrastructure and connectivity conditions under which pedagogical work actually takes place. Without these conditions, even the most carefully designed training initiatives encounter material constraints that cannot be overcome through training alone. The reverse is also true. The availability of digital resources does not, in itself, guarantee pedagogical innovation, since their use is meaningful only when aligned with learning objectives, teacher mediation in the classroom, and students' actual opportunities to participate. From this perspective,

the discussion moves beyond the question of which technological tool to adopt and considers instead how professional development, material conditions, pedagogical planning, and digital inclusion relate to one another.

Educational Sciences must now address two simultaneous developments: changes in the ways people access information, interact, and produce knowledge, and the diversity of contexts in which these processes occur. Digital technologies expand opportunities for collaboration, interaction, methodological diversification, and student participation. However, expanded opportunities do not guarantee educational outcomes. Their effectiveness depends on how these resources are incorporated into educational practice and on the conditions available to teachers and students for using them meaningfully. Integrating technology into schools is not simply a matter of transferring conventional practices to digital environments. It involves pedagogical decisions aligned with students' needs and the educational purposes pursued by schools.

Another point highlighted by the analysis is that pedagogical innovation is a shared responsibility. Initial and continuing teacher education, adequate infrastructure, connectivity, technical support, and digital inclusion initiatives must be considered together because shortcomings in any one of these areas can limit progress in the others. Inequalities in access and differences in working conditions across schools also demonstrate that responsibility for this process cannot rest solely with teachers. Institutional conditions and public education policies are integral to the problem under investigation. In this regard, the study brings together conceptual contributions that can inform discussions of teacher education

policies and pedagogical practices responsive to the specific characteristics of each school context, without assuming that the same strategy will be equally appropriate for all educational institutions.

The study's limitations stem from its research design. As a bibliographic and documentary investigation, its conclusions are restricted to the interpretation of the publications and documents examined. No observations were conducted in schools, no interviews were carried out with teachers or school administrators, and no data were collected on student learning. Consequently, the study cannot directly determine how the conditions discussed manifest themselves in specific institutions, measure their effects, or establish causal relationships between technological integration and educational outcomes. The scope of the analysis also depends on the breadth and relevance of the selected sources. These limitations do not negate the study's theoretical contribution but delimit the extent of its inferences and indicate the need for complementary investigations that empirically examine the relationships discussed.

These considerations open several avenues for future research, including examining how continuing teacher education programs relate to instructional planning and students' learning experiences; comparing technology integration strategies in schools with different infrastructure and connectivity conditions; and empirically investigating the participation of students with unequal access, ongoing digital inclusion initiatives, and the criteria institutions use to evaluate their pedagogical innovation efforts. Such investigations would make it possible to determine the extent to which the relationships identified in this analysis hold in actual school contexts and to identify contextual factors that facilitate or constrain them.

This would contribute to a more comprehensive understanding of the conditions under which digital technologies support pedagogical innovation and generate evidence to inform the development of more coordinated and equitable educational policies.

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