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Technological Advances and Educational Transformation: Towards Inclusive Education

Avances tecnológicos y transformación educativa: Hacia una enseñanza inclusiva

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ABSTRACT

The incorporation of technology in educational settings, emphasizing its progression from basic tools to advanced resources like virtual classrooms and augmented reality, has significantly redefined teaching and learning modalities. This examination evaluates technology's influence on educational ethics and values, highlighting its function in fostering inclusivity and enhancing accessibility. The manuscript probes the nuanced distinction between technological integration and adaptation within pedagogical frameworks, emphasizing a profound alteration in educational methodologies beyond mere supplementation. Furthermore, the impact of the COVID-19 pandemic in accelerating the transition towards digital educational models and e-learning is scrutinized. Challenges and prospects associated with technological adoption are discussed, encompassing the imperative for teacher training in nascent technologies. Additionally, the manuscript contemplates the future trajectory of education with the prospective implementation of artificial intelligence, weighing its potential benefits against ethical and practical challenges.

RESUMEN

Este estudio examina el propósito y los efectos de la incorporación de la tecnología en la educación, desde el uso inicial de herramientas básicas hasta la adopción de innovaciones avanzadas como aulas virtuales y realidad aumentada, que han transformado radicalmente los métodos de enseñanza y aprendizaje. A partir de la revisión de literatura y el análisis de experiencias educativas recientes, se plantea como problema la brecha entre la disponibilidad tecnológica y su integración efectiva en el aula, así como la falta de preparación para abordar las necesidades de inclusión y accesibilidad. La metodología empleada se basa en un análisis teórico de los enfoques educativos actuales que integran la tecnología de manera significativa. Entre los principales hallazgos se destacan la influencia de la tecnología en la promoción de valores de inclusión y la importancia de un enfoque adaptativo más allá de la simple adición de dispositivos. Las conclusiones subrayan la necesidad de capacitación continua para el personal docente en tecnologías emergentes y la adopción responsable de herramientas de inteligencia artificial, abordando sus oportunidades y desafíos éticos y prácticos en el contexto educativo. Por último, se reflexiona sobre el futuro de la educación, y se sugiere que el avance tecnológico puede, si se maneja adecuadamente, democratizar el acceso al aprendizaje y crear ambientes educativos inclusivos y adaptados a las diversas necesidades del alumnado.

Introduction

The incorporation of technology into educational settings has fundamentally transformed teaching and learning techniques and approaches. The adoption of digital tools has renewed these practices by fostering interaction and adaptation among students. This transition has surpassed geographical barriers and democratized access to knowledge. In this context, this study seeks to understand how technological evolution can be used to overcome existing educational barriers and transform pedagogical practices, particularly in terms of inclusion and equity. Critical reflection enables the identification of strategies that align 21st-century education with the needs of an increasingly technological society (Şentürk & Baş, 2020).

However, this evolution has not been uniform across all educational contexts. Significant challenges persist in its implementation, such as unequal access to these tools, insufficient teacher training, and the absence of pedagogical models that guide the effective integration of technologies. These issues particularly affect students in vulnerable environments, limiting their equitable access to the educational opportunities that technology promises to deliver.

Educational technology fosters innovation, personalization, and enriched learning (Moreno et al., 2021). It also prepares students to tackle current and future challenges with innovative solutions, making it an integral part of modern education and contributing to skill development at all educational levels. In this sense, technology has become decisive in shaping behavioral practices and resolving learning issues.

Nevertheless, its incorporation into classrooms entails intrinsic challenges, including the need for specialized training, concerns about excessive screen time, and equity issues surrounding access. Despite notable improvements in productivity and enriched opportunities for students, debates persist about its impact and real efficacy in different educational contexts (Jiang, 2023).

The technological resources used in classrooms have evolved from simple tools to advanced digital devices. Initially, instruments like magic lanterns and chalk marked the beginning of this trajectory (Şentürk & Baş, 2020). Today, virtual classrooms and augmented reality, among others, enrich and energize the educational process (Cabero & Palacios, 2021). These advances enhance student engagement, enable more personalized teaching, and develop key future skills (Coll et al., 2023). They have also played a pivotal role in fostering critical thinking and problem-solving skills. Through interactive platforms and online educational resources, students are challenged not only to access information but also to analyze, synthesize, and critically evaluate it (Faustino & Kaur, 2023). This leads to a deeper and more applied understanding of knowledge, preparing them for real and complex challenges.

In the same vein, technological resources facilitate interdisciplinarity in education. Students can integrate concepts from different subjects to gain a broader understanding of content and prepare for the labour market. Similarly, advanced methods for continuous assessment and instant feedback are offered. This allows users to improve and adjust their learning processes more effectively, while teachers can adapt their teaching methods based on concrete performance data (Karpenko et al., 2019). Additionally, integrating social media into education opens new pathways for interaction and collaborative learning, extending the educational experience beyond the traditional classroom limits (Marzulina et al., 2023).

Technological innovations in education have played an essential role in overcoming obstacles related to learning and have been particularly beneficial for individuals with disabilities (Joshi, 2023). Examples include accessible software programs, assistive devices, and interactive platforms that have paved the way for inclusive educational methods. These tools offer adaptive solutions, enable access to educational content, and foster active participation in learning processes (Karagianni & Drigas, 2023). Despite these advances, not all educational institutions have successfully implemented these technologies efficiently or inclusively. This highlights the need for clear strategies to ensure equitable and effective adoption of technology, especially in under-resourced educational contexts.

Along the same lines, adaptive applications such as screen readers and special keyboards have significantly improved accessibility for individuals with sensory, visual, or motor disabilities (Prabhu et al., 2023). Programs that convert text to speech and vice versa benefit those facing reading or writing challenges, such as students with dyslexia (Patnoorkar et al., 2023). Moreover, they offer diverse channels for interaction between teachers and students, ensuring that the latter can express their educational needs and receive adequate support (Sabrifha & Darmawati, 2023). These advances provide a pathway to overcome barriers that previously limited their participation and success in the educational sphere.

Technology in education goes beyond a merely operational function in the learning process: it has transformed what teachers teach and how they teach, emphasizing accessibility, critical thinking, and innovation (Kohila, 2023). Educational frameworks have been redefined to include greater flexibility, collaboration, and lifelong learning (Alkhatib, 2023; Mphahlele & Korkmaz, 2023). Professionals instill the responsible and ethical use of these tools and adapt to a constantly changing environment.

This study addresses the impact of technology in the educational context, extending its influence beyond mere integration into existing methodologies, towards a complete reconfiguration of teaching and learning paradigms. It posits that technological adoption in education exceeds the simple incorporation of new tools into conventional frameworks, leading the transition towards an inclusive and holistic approach. This transition not only promotes interactive and personalized learning modalities but also poses challenges and reformulates established pedagogical practices. Technology, emerging as a key element of inclusion, contributes to democratizing access to education and increasing equity, particularly in complex educational contexts.

The objective of this study is to analyze how technology in education, besides transforming pedagogical practices, promotes inclusion and educational democratization. Additionally, it seeks to identify the main challenges that arise when integrating technologies into diverse educational contexts, with a focus on pedagogical models that respond to 21st-century demands.

Development

Technological Advances in the Classroom

The origins of educational technology lie in the United States military training during the 1940s, specifically in instructional strategies aimed at efficiently preparing large groups of people (Area, 2009). However, since the 1960s, it has experienced significant evolution. Initially, it was based on a technical-rational approach supported by behaviorist psychology (Cabero, 2003). Despite initial obstacles such as high costs and limitations of computing resources, the landscape changed significantly in the 1980s with the mass adoption of personal computers (Luján & Salas, 2009). This led to the emergence of technology in education. UNESCO (1986) subsequently defined educational technology as a systematic process that integrates technical and human resources to optimize teaching methods.

This integration into education dates back to the early decades of the 20th century, marking a significant shift in teaching methodologies. With the invention of cinema, ra-

dio, and eventually television, teachers found new ways to enrich their lessons and expand the reach of education beyond traditional classrooms (Cabero, 2007; Aguaded & Ortiz, 2022). These media allowed for the presentation of content in visual and auditory forms, facilitating more dynamic and accessible learning. The arrival of personal computers and the internet in the final decades of the 20th century revolutionized classrooms (Guaña et al., 2022). These innovations provided interactive tools and nearly unlimited online resources, enabling unprecedented access to information. The process continued with the introduction of mobile devices and educational software, allowing for personalized and collaborative interactions between students and teachers (Valdemir, 2023). These mediums facilitated the presentation of educational content visually and auditorily to make learning more dynamic and accessible (Vital et al., 2021).

Educational applications began to emerge in the 1990s, covering a wide array of uses (Jiménez et al., 2020). The multi-screen society and the adoption of new digital platforms have redefined the use of audiovisual resources (Ortega & Pinto, 2021). Mobile devices such as tablets and smartphones have become essential for accessing and producing content (Hidalgo & Aliaga, 2020). The role of audiovisual media in teaching and learning processes has been a continuous area of study and interest. Specifically, it encompasses a broad field focused on the use of diverse instructional and audiovisual resources (Sosa et al., 2023).

In the midst of this evolution, the COVID-19 pandemic marked a turning point, accelerating the adoption of digital educational models such as e-learning and the use of podcasts and videos in various formats (García Martín & García Martín, 2021). This shift highlighted the importance and flexibility of audiovisual media in education, demonstrating that technology can be a powerful tool. Today, it has been established as a key discipline in the study and application of technological media, materials, and platforms serving education.

Weaving the Educational Future: Integration of Models and Technology in Teaching

When technology was introduced, its role was complementary to learning (Joshi, 2023). Tools such as overhead projectors, televisions, and radios were used in classrooms to support lessons (Vishnupriya & Bharathi, 2022). Although they introduced a novel way of presenting information, their impact was limited to serving as visual and auditory aids (Velayudham et al., 2022). The teacher was the primary transmitter of knowledge, the students passive receivers, and technology neither challenged nor transformed the classroom (Noguera & Valdivia, 2023). Computers and internet access in the late 20th century accelerated this integration within educational models (Jaakkola et al., 2023). This evolution fostered a gradual but significant shift towards student-centered perspectives (Nabulsi & Khaldi, 2023). Thus, education began to move away from the traditional model, making way for pedagogical approaches that valued autonomy and participation.

The consolidation towards the acquisition of competencies and practical skills has encouraged integration. This paradigm is characterized by the implementation of online learning platforms, virtual and augmented reality tools, and advanced learning management systems, which facilitate the creation of more enriching and adaptive educational environments (Íñiguez & León, 2017). The diversity of digital resources allows for the personalization of learning, tailored to individual needs. These perspectives are an emerging trend in modern pedagogy, a field where the centrality of learning shifts towards the development of specific and applicable skills, thus enhancing the comprehensive and functional formation of individuals within technologically advanced educational contexts (Guaña, 2023).

In the evolution of educational approaches towards greater use of digital resources, the TPACK model stands out as a comprehensive approach that effectively combines three key elements for integrating technology into the classroom: specific content knowledge, pedagogical skills, and technological competence (Mishra & Koehler, 2006). The theoretical framework emphasizes the importance of harmonious integration of these areas to optimize teaching. The technological dimension goes beyond the mere use of devices or programs; it extends to a detailed understanding of how technology can enhance the educational experience. In parallel, the pedagogical aspect of the model considers innovative teaching methods, enriched and redefined by the possibilities offered by modern technology. The interaction among these components, along with a solid mastery of the content to be taught, fosters a dynamic and adaptive learning environment, crucial in today's era where distance and digital learning have become increasingly important (Ortiz et al., 2023).

The effective application of TPACK presents both a challenge and an opportunity to adapt and enrich pedagogical methods with advanced technology to ensure high-quality education. Current innovations have led to alternative teaching and learning methods. For example, blended learning combines face-to-face teaching with online components (Savvidou & Häggström, 2019), while the flipped classroom reverses the traditional approach, with students reviewing material outside the classroom. Additionally, gamification integrates game elements into education, and virtual reality offers immersive experiences that enhance learning (De la Cruz et al., 2022; Liao, 2023).

The pandemic accelerated the evolution of educational methods towards online and remote formats, sparking interest in hybrid strategies that combine face-to-face and digital teaching. This adaptation improved flexibility and effectiveness in education by integrating technology with conventional methods. In the context of inclusion, approaches such as flipped classroom, blended learning, gamification, and virtual reality offer significant benefits for students with disabilities, increasing accessibility and providing adaptive learning options (Faiqotuzzulfa & Putra, 2023; Liao, 2023). These methodologies allow the personalization of learning pace and facilitate access to diverse content. Therefore, it is correct to say that technology has played a crucial role in promoting inclusion, especially through the development of specialized tools such as screen readers and voice recognition systems, which have enabled all students to participate in conventional classrooms (Muntaner, 2013).

Technological innovations have also transformed the educational curriculum towards student-centered approaches and fostered equal learning environments (Chiroleu, 2018). Accessibility and Universal Design for Learning (UDL) are key to inclusive education, overcoming obstacles, and ensuring the participation of all students (Booth & Ainscow, 2015; Maringe & Chiramba, 2022). This approach addresses diverse skills and needs, making it essential for competency development (Ayala et al., 2023). Educational barriers vary depending on the context and range from resources to teacher beliefs. Identifying and addressing these barriers is vital to achieving inclusion. Information and Communication Technologies (ICTs), when properly integrated, foster this inclusive and collaborative educational environment (Booth & Ainscow, 2015; Cruz et al., 2020).

ICTs play a triple role: universal accessibility through online learning, individualized attention, and promotion of intercultural communication (González, 2022). Educators must use them reflectively to promote inclusion and the success of all students. The effective integration of ICTs, along with UDL, forms a transformative strategy for achieving equitable education, offering multiple means of engagement, representation, and expression (CAST, 2018; Espada et al., 2019). The principles of UDL are as follows:

- Provide Multiple Means of Engagement: This focuses on motivation by offering diverse ways for students to participate in learning processes.
- Provide Multiple Means of Representation: This involves delivering information in varied formats to accommodate cognitive and sensory variability.
- Provide Multiple Means of Action and Expression: This allows students to demonstrate their knowledge and skills through various methods.

UDL emphasizes accessibility and usability in education, advocating for curricula and environments designed to serve all students, thereby avoiding the need for later adaptations. This perspective fosters motivation in learning and evaluation processes (Sánchez & López, 2020). Activities or teaching proposals are conceived with ICTs as intrinsic elements rather than as external add-ons to educational planning and design. In this way, they become an inherent part of universal teaching proposals.

All of this has led to a transformation in the teacher's role and the methods used to transmit knowledge to students. Teachers now assume flexible roles, focusing on guidance, motivation, and learning adaptation using diverse formats and pedagogical strategies that promote academic success. Adjusting to these technologies requires professionals to be competent in digital tools and innovative teaching strategies. Thus, digital innovation demands abandoning traditional methods in favor of proactive and engaging approaches (Neira & Pulgarín, 2020).

The union of teacher innovation and creativity with the use of ICTs promotes continuous professional development, enabling educators to refine skills and pedagogical practices throughout their careers (López, 2021). This process involves active and constructive decision-making to contribute to the development of teaching teams (Pyhältö et al., 2015).

Technological Innovation for Inclusive Education through Universality and Accessibility

This reflection leads us to consider a critical duality among current educational challenges: technological integration versus technological adaptation in inclusive education. Although often used interchangeably, these two concepts hold fundamental differences with significant impacts on methodologies. Technological integration refers to the use of digital tools as an extension of the existing curriculum, a means to reinforce traditional teaching methods. In contrast, technological adaptation goes further: it implies a profound restructuring and redesign of the educational process, where technology not only complements but also transforms how knowledge is delivered and perceived. This debate is not merely academic; it has practical consequences for how educational institutions must approach inclusion, ensuring that technological advancement is not only accessible but also meets the diverse learning needs of all students.

The integration of technology into education has brought both considerable challenges and opportunities for the future of the sector. Transitioning to alternative models has provided more interactive and personalized experiences, though not without its difficulties.

One of the main challenges has been the need for specialized teacher training. Effectively adopting these technologies requires professionals to be not only competent in their content areas but also skilled in handling digital tools and innovative pedagogical strategies (García Tartera, 2023). At the same time, concerns persist about excessive screen use and issues related to equal access to technology (Soares et al., 2022). This situation highlights the digital divide, which can limit access to quality education for students from diverse socioeconomic backgrounds (Afzal et al., 2023).

Nevertheless, the opportunities arising from this integration are numerous. Educational technology has helped overcome learning-related obstacles and has been particularly beneficial for people with disabilities by providing tools and adaptive solutions for inclusive education. Technological advancements have also enabled the collection of detailed data on student performance, facilitating more effective pedagogical interventions. Additionally, they have enriched learning opportunities, preparing students to face current and future challenges with innovative solutions. These innovations promise to further transform education in the future.

Looking ahead, the integration of artificial intelligence (AI) into educational models presents both significant opportunities and challenges. On one hand, it has the potential to revolutionize education further by providing personalized and adaptive solutions. For example, AI systems can analyze student learning progress in real-time and adjust teaching materials to their specific needs, which is particularly beneficial for students with unique learning styles or disabilities (Piedra et al., 2023).

However, adopting AI in education also poses ethical and practical challenges. Data privacy and security are primary concerns, especially when algorithms are used to analyze performance and behavior. The inherent risk is that it may exacerbate existing educational inequalities if its implementation and use are not carefully managed

(Chávez, 2022). Another significant challenge is ensuring that AI does not replace essential human interaction in education but rather complements it. In any case, training educators in the ethical and effective use of AI will be crucial to ensuring that this and other technologies are used in ways that equitably benefit all students.

Conclusions

As discussed throughout this article, education has evolved from traditional methods to inclusive and holistic strategies, promoting accessibility and equity (Şentürk & Baş, 2020). This evolution has democratized knowledge, benefiting students from diverse socioeconomic backgrounds with enriched learning experiences (Moreno et al., 2021). Nonetheless, some challenges persist, such as teacher training in new technologies and the digital divide (Rimpy et al., 2022).

Despite these challenges, technology has played a key role in fostering inclusion, particularly for individuals with disabilities, by providing adaptive solutions (Anastasopoulou et al., 2023). Additionally, it has influenced educators' roles and pedagogical values (Kohila, 2023). Technological integration will continue to transform education, offering opportunities and posing challenges for the development of future generations. Digitalization in education has highlighted the need for a dynamic and participatory teaching approach. Indeed, by integrating ICT, an interactive and collaborative educational model is promoted (López, 2021). However, the digital divide underscores the importance of equitable access to technological resources (Afzal et al., 2023). Looking ahead, the integration of advanced technologies such as AI expands educational boundaries while demanding ethical and equitable considerations (Piedra et al., 2023).

Teacher training in technological aspects from the initial stages is necessary to facilitate classroom practices and contribute to professional development, understood as a lifelong process rather than a one-time event (UNESCO, 2019). Often, training programs offer a superficial and temporary understanding of technological tools, neglecting the development of deep and sustained comprehension of how to integrate them effectively. A lack of continuous and adaptive training limits educators' ability to keep pace with advancements, resulting in a gap between acquired skills and the real needs of classrooms where technology constantly evolves. Therefore, it is evident that rethinking competency acquisition is essential. One solution is the focus on long-term training programs that address not only the technical use of ICT but also their pedagogical integration and impact on teaching practices.

When designing didactic proposals for the 21st century, technology should be an ingredient that permeates and acts transversally throughout the pedagogical sequence; it is already present, embedded in contemporary culture (Seas, 2021), and it also removes barriers to student participation and learning (Sanahuja et al., 2020). Digital transformation in education has become a powerful tool for democratizing knowledge and promoting more inclusive educational practices. While we face significant challenges, such as the need for continuous teacher training and overcoming the digital divide, advances in educational technology offer unprecedented opportunities. The key lies in the conscious and strategic integration of these tools, ensuring they complement the educational process effectively rather than being superficial additions.

To consolidate these advancements and address emerging challenges, it is crucial for educational institutions to adopt a long-term strategic vision. Technology must be seen not only as a complementary tool but as an integral component of modern pedagogy. This entails continuous investment in technological infrastructure, as well as in teacher training and professional development, with a focus on digital skills and innovative methodologies. Additionally, fostering a culture of collaboration among educators, technologists, and policymakers is vital to creating an educational ecosystem that prioritizes both innovation and equity. The co-creation of inclusive and equitable educational policies will ensure that all students, without exception, benefit from the opportunities that technology offers. The goal must be to build a resilient and adaptable educational system, providing high-quality, accessible education for all, capable of preparing students for a constantly changing future.

Therefore, institutions must continuously evaluate their effectiveness and adaptability in various contexts. Creating collaborative learning networks can be an effective strategy for sharing best practices and resources among educators and students globally. Furthermore, fostering a mindset of continuous learning among educators will ensure they are prepared to integrate new technologies and innovative pedagogies into their daily practice. Education must go beyond the mere transmission of knowledge and instead focus on developing critical, creative, and collaborative skills that enable students to navigate and thrive in an increasingly digital world. By prioritizing these areas, we can ensure that technology acts as a catalyst for more inclusive, equitable, and effective education.

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Conflict of interest statement

The authors declare that they have no conflicts of interest.

Authorship statement

Sofía Villatoro Moral participated in conceptualization, data curation, research, project administration, resource management, supervision, validation, visualization, writing, review and editing. Francisca Moreno-Tallón participated in conceptualization, research, resource management, validation, visualization, writing, review and editing.

Ethics statement

The work complies with international ethical guidelines applicable to the discipline. It does not include the treatment of human or animal participants, so informed consent or approval by ethics committees does not apply.