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The Use of Digital Tools to Enhance Inclusion in the Classroom

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Abstract

Inclusive education has become a cornerstone of contemporary pedagogical discourse, aiming to ensure that all learners, regardless of their cognitive, linguistic, or physical differences, are provided with equal opportunities to participate and succeed. While the implementation of inclusion poses numerous challenges, ranging from limited resources to teacher preparedness, recent advances in digital technology and Information and Communication Technologies (ICT) have opened new pathways for creating equitable learning environments. This article critically examines the role of digital tools in enhancing inclusion within classroom settings. Drawing on international and national studies, with special reference to the frameworks developed by Drigas and colleagues, it explores how assistive technologies, adaptive learning platforms, virtual and augmented reality, and artificial intelligence applications can reduce learning barriers and support diverse learner needs. Through a narrative literature review, the article synthesizes evidence on the effectiveness of these tools in improving academic performance, fostering social participation, and empowering educators to meet the demands of inclusive education. The discussion highlights both the potential and limitations of technology-driven inclusion, emphasizing the need for continuous teacher training, policy development, and ethical considerations in the digital era. The article concludes by proposing future directions for research and practice, advocating for a hybrid pedagogical model where technology acts as a catalyst for educational equity.

Keywords: Inclusion; Special Education; Digital tools; Assistive Technology; Educational Equity; Adaptive Learning

1. Introduction

1.1. The Concept of Inclusion in Education

Inclusive education has been progressively recognized as a fundamental right and a pedagogical imperative in contemporary societies. The concept extends beyond the mere physical placement of students with disabilities into mainstream classrooms and emphasizes their active participation, engagement, and achievement within the school community (Ainscow, 2020). Its roots can be traced to the Salamanca Statement (UNESCO, 1994), which declared inclusion a guiding principle for educational systems worldwide. Since then, inclusion has been reinforced by global frameworks such as the United Nations Convention on the Rights of Persons with Disabilities (United Nations, 2006), which mandates the removal of barriers and the provision of equal opportunities for all learners.

Theoretically, inclusive education is grounded in the social model of disability, which argues that barriers lie not in the individual's impairment but in the environment, structures, and attitudes of society (Oliver, 1996). By contrast, the medical model views disability as a deficit located within the individual, requiring remediation. Inclusion aligns with the social perspective, advocating systemic change in school culture, teaching practices, and resource allocation (Booth & Ainscow, 2016). Within this context, classrooms become sites where diversity is not perceived as a challenge to be

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managed but as a resource that enriches learning experiences for all students (Florian & Black-Hawkins, 2011). Recent systematic research affirms that digital approaches aligned with the Universal Design for Learning (UDL) framework significantly bolster participation and academic outcomes across diverse learner populations (Villatoro Moral & Moreno-Tallón, 2025). Drigas and colleagues further highlight how mobile and emerging technologies can build sustainable inclusive ecosystems, especially for students with special educational needs (Karagianni & Drigas, 2023a, 2023b).

1.2. Barriers and Challenges in Inclusive Practice

Despite its widespread adoption as a policy priority, the practical implementation of inclusion is fraught with barriers. Teachers often identify insufficient training as a primary obstacle, reporting that initial teacher education and professional development do not adequately prepare them to manage diverse classrooms (Avramidis & Norwich, 2002; Sharma & Loreman, 2014). The lack of appropriate resources, such as assistive technology, differentiated materials, and support personnel, further complicates efforts to implement inclusive practices (Peters, 2007).

Cultural and attitudinal factors also play a significant role. Negative stereotypes about disability can foster environments of low expectations, where students with special educational needs are marginalized rather than included (de Boer et al., 2011). In addition, large class sizes and rigid curricula reduce the flexibility teachers need to adapt instruction to diverse learner profiles (Miles & Singal, 2010). These systemic challenges underline the need for innovative pedagogical approaches and supportive digital tools capable of dismantling barriers and enabling authentic participation. However, without systemic supports such as infrastructure, teacher training, and inclusive school culture, even promising digital solutions rarely deliver sustainable benefits (Pagliara et al., 2024).

1.3. The Role of ICT and Digital Tools

The advent of digital technologies has transformed the landscape of inclusive education, providing new tools for addressing learner diversity. Information and Communication Technologies (ICT) offer multi-modal pathways for accessing, processing, and presenting information, aligning directly with the Universal Design for Learning (UDL) framework (Rose & Meyer, 2002). Within UDL, technology serves to provide multiple means of representation, engagement, and expression, thus supporting learners with varying abilities and preferences.

Assistive technologies such as screen readers, speech-to-text systems, hearing aids, and augmentative and alternative communication (AAC) devices have enabled students with sensory, cognitive, or motor difficulties to access learning materials and communicate effectively (Alper & Raharinirina, 2006). These tools directly address functional limitations, offering students the ability to engage in tasks that would otherwise be inaccessible.

Adaptive learning platforms and AI-driven applications have introduced new opportunities for individualized instruction. By analyzing learner data in real time, these systems adapt the level, pace, and format of instruction, thereby personalizing the educational experience (Drigas & Mitsea, 2021). Such tools reduce reliance on one-size-fits-all teaching methods and create pathways for differentiated support.

Virtual and Augmented Reality (VR/AR) are also emerging as powerful tools for inclusive education. They offer immersive environments where students can practice skills, engage with content in innovative ways, and experience simulations that support both cognitive and social development (Drigas & Angelidakis, 2017). For example, VR has been applied to enhance reading fluency and social interaction among students with dyslexia and autism spectrum disorder. Systematic examinations of AR in inclusive education contexts report significant gains in comprehension, motivation, and collaboration (Frontiers in Education, 2025).

In conclusion, we emphasize the importance of all digital technologies in the field of education and inclusion. These technologies are highly effective and productive, facilitate and improve assessment, intervention, and educational procedures through mobile devices that bring educational activities anywhere [51–53], various ICTs applications that are the main supporters of inclusive education [54-58], and AI, STEM, Games and ROBOTICS [59-62] that raise educational procedures to new performance levels. In addition, the development and integration of ICTs with theories and models of metacognition, mindfulness, meditation, and the development of emotional intelligence [63-76], accelerates and improves educational practices and results more than those, particularly in inclusion of students with learning disabilities.

1.4. Teacher Preparedness and Professional Development

A crucial but often underestimated dimension of inclusion is teacher readiness to effectively integrate digital tools into classroom practice. While ICT holds significant promise, its potential can only be realized when educators are adequately trained and confident in its use (Edyburn, 2020). Research has shown that teachers with positive attitudes toward technology and inclusion are more likely to implement innovative practices and achieve successful outcomes (Sharma & Loreman, 2014). Conversely, lack of professional development leads to underutilization of assistive tools and reinforces dependency on traditional pedagogies.

Drigas and Ioannidou (2013) have emphasized the importance of digital literacy and lifelong learning for educators, proposing that teacher training programs integrate ICT competencies as core elements of inclusive pedagogy. Ongoing professional development, supported by policy initiatives and institutional frameworks, is thus indispensable for the sustainable implementation of digitally enhanced inclusive education. Recent scoping reviews confirm that teacher preparedness in AI and digital literacy is a key determinant of successful and ethical technology adoption in inclusive education (Pagliara et al., 2024).

1.5. Aim and Research Questions

This article aims to critically examine the role of digital tools in enhancing inclusive education, with particular emphasis on the frameworks developed by Drigas and colleagues. It synthesizes evidence from international and national studies to evaluate the effectiveness, opportunities, and challenges of ICT in inclusive classrooms.

The guiding research questions are as follows:

- What is the role of digital tools in supporting the principles of inclusive education?
- How do ICT and assistive technologies enhance accessibility, participation, and academic success in diverse classroom settings?
- What challenges and limitations arise in the integration of digital tools for inclusion, and how can they be addressed?

2. Methodology

This study adopts a pedagogical and digital framework to explore how digital tools can enhance inclusive education. The methodological approach is a narrative literature review, synthesizing findings from international research between 2015 and 2025, alongside theoretical models that emphasize equity and accessibility. The focus is placed on four categories of tools: assistive technologies, adaptive learning platforms, virtual and augmented reality, and teacher-centered digital systems. Each category is analyzed in terms of its functionality, practical application, and contribution to inclusive education, with references to empirical evidence and theoretical frameworks. Recent systematic reviews underscore the importance of methodological rigor and the need for longitudinal and mixed method designs when investigating EdTech's impact on inclusion (Chalkiadakis et al., 2024).

2.1. Assistive Technologies

Assistive technologies (AT) constitute the cornerstone of inclusive education, offering students with disabilities pathways to access, process, and communicate information. These tools range from low-tech devices (e.g., adapted keyboards, communication boards) to high-tech solutions (e.g., screen readers, speech-to-text, AAC software). Their central role lies in breaking down barriers to participation, ensuring that students with sensory, motor, or cognitive impairments can take part in classroom activities alongside their peers.

Research demonstrates that screen readers and text-to-speech tools improve reading comprehension in students with dyslexia by compensating for decoding difficulties (Okolo & Bouck, 2007). Similarly, AAC devices allow learners with communication difficulties to participate in peer discussions, fostering social inclusion and reducing isolation (Alper & Raharinirina, 2006). For visually impaired students, tactile graphics and Braille display technologies provide equal access to visual content, ensuring participation in mainstream curricula (Kelly & Smith, 2011). Recent systematic reviews further affirm the efficacy of mobile assistive technologies, especially tablets and apps, in enhancing inclusion across diverse disabilities (Frontiers in Education, 2025).

Despite their proven benefits, AT adoption faces challenges such as cost, lack of teacher training, and stigma associated with visible device use (Edyburn, 2020). These barriers underline the importance of embedding AT use within broader ICT strategies. Drigas and Ioannidou (2013) argue that AT should be seen not as an isolated intervention, but as part of

an integrated digital ecosystem that enhances equity in education. A global systematic review confirms that policies, AT, and structural supports must align to create inclusive learning environments (Guillén-Martínez et al., 2025).

2.2. Adaptive Learning Platforms

Adaptive learning systems represent a paradigm shift from standardized instruction to personalized education. Powered by artificial intelligence, these platforms analyze learner performance data in real time and adjust instructional content accordingly (Pane et al., 2015). For students with special educational needs, such as dyslexia, ADHD, or learning difficulties, adaptive systems offer tailored pacing, scaffolding, and multiple means of representation.

Studies indicate that adaptive platforms improve engagement and learning outcomes by reducing frustration and cognitive overload (Spector, 2014). For example, mathematics applications that adjust difficulty based on response accuracy allow learners with ADHD to remain engaged without feeling overwhelmed (Klinkenberg et al., 2011). Similarly, adaptive reading programs that highlight text, provide instant definitions, or offer speech support enhance literacy outcomes for students with dyslexia (Shute & Zapata-Rivera, 2012). Moreover, AI-powered assistive adaptations have shown broad efficacy in inclusive settings, though effectiveness depends on infrastructure and training (Toyokawa et al., 2023).

Inclusion is further promoted by the platforms' ability to generate data analytics for teachers. These insights allow educators to identify struggling students early and intervene with targeted support. Drigas and Mitsea (2021) highlight the potential of adaptive systems not only to improve academic achievement but also to cultivate metacognitive skills such as self-regulation and reflection—skills essential for long-term educational success.

Nonetheless, adaptive platforms require reliable infrastructure, digital literacy, and careful monitoring to avoid over-reliance on automated feedback. Ethical considerations, such as data privacy, also remain pressing issues (Holmes et al., 2021). A scoping review on AI in inclusive education corroborates these challenges and stresses the need for teacher training and community collaboration (Toyokawa et al., 2023).

2.3. Virtual and Augmented Reality

Virtual Reality (VR) and Augmented Reality (AR) are emerging tools that offer immersive learning experiences, capable of addressing both cognitive and social dimensions of inclusion. VR environments allow students to simulate real-life scenarios in a controlled, low-stress context. For learners with autism spectrum disorder, VR has been used to practice social interactions, such as conversational turn-taking or interpreting non-verbal cues (Parsons & Cobb, 2011). This immersive exposure reduces anxiety while promoting transferable social skills.

AR applications, by overlaying digital elements on physical environments, enhance comprehension of abstract concepts. For example, AR-based literacy programs provide visual cues that support phoneme-grapheme correspondence for students with dyslexia (Chen et al., 2020). Similarly, AR can assist students with ADHD by offering visual reminders and prompts that improve task focus and organization.

Studies across Europe and North America have reported positive outcomes for VR and AR interventions, including increased engagement, motivation, and academic performance (Drigas & Angelidakis, 2017). Teachers also note that these tools encourage collaborative learning, as students often interact in small groups when using AR applications. More recent systematic reviews indicate VR and AR expand educational possibilities but highlight limited research across all disability types (Flores-Gutiérrez et al., 2023). Extended Reality (XR) has also shown promise for visually impaired students, through sound and haptic feedback—though cost and accessibility remain barriers (Chalkiadakis et al., 2024).

Limitations include high implementation costs, technical challenges, and the need for teacher training. Furthermore, VR environments may cause sensory overload for some students, underscoring the need for careful design and individualized adaptation (Howard & Gutworth, 2020).

2.4. Teacher-Centered Digital Tools

While student-centered technologies are crucial, teacher-centered digital tools are equally important in fostering inclusion. Learning Management Systems (LMS), such as Google Classroom or Moodle, allow educators to organize differentiated materials, monitor student progress, and maintain communication with families. Accessibility features within LMS platforms (e.g., closed captioning, screen magnification, alt-text) ensure that resources are accessible to

diverse learners (Edyburn, 2020). Open-source platforms and AI enhancements are increasingly integrated to improve accessibility in under-resourced contexts (Tzimiris et al., 2023).

Classroom analytics and dashboard tools provide teachers with real-time feedback on student engagement, highlighting patterns of participation that may otherwise go unnoticed. This enables proactive interventions for students at risk of exclusion.

Teacher professional development is a decisive factor in maximizing the impact of digital tools. Research shows that educators who receive structured training in inclusive pedagogy and ICT integration are more confident in applying digital strategies effectively (Sharma & Loreman, 2014). Without adequate training, however, tools may remain underutilized, reinforcing existing inequalities (Avramidis & Norwich, 2002). The UNESCO report on AI and inclusive practices highlights the importance of capacity-building and collaboration for sustainable impact (UNESCO IITE, 2025).

3. Results

The synthesis of the reviewed studies indicates that digital tools play a crucial role in fostering inclusive education, yet their impact hinges on broader contextual enablers such as teacher readiness, infrastructural capacity, and inclusive school culture (Guillén-Martínez et al., 2025; Chalkiadakis et al., 2024). In what follows, the findings are organized according to the four primary categories of digital tools, each enriched with deeper insights and evidence.

3.1. Assistive Technologies Outcomes

Assistive Technologies (AT) remain fundamental to inclusive education, offering both low- and high-tech solutions—ranging from adapted keyboards and visual aids to speech-to-text, augmentative and alternative communication (AAC) systems. Their effectiveness is well-documented: text-to-speech tools significantly improve reading fluency for students with dyslexia (Okolo & Bouck, 2007), while AAC tools enhance communication and integration for learners with language impairments (Alper & Raharinirina, 2006). Moreover, mobile assistive apps and tablets have been shown to foster independence, with tangible benefits for learners across sensory and motor impairments (Frontiers in Education, 2025).

Psychosocially, integrating AT within the fabric of everyday classroom tools—rather than isolating them as "special interventions"—promotes self-esteem and belonging (Kelly & Smith, 2011). In Greece, Drigas and Ioannidou (2013) emphasize that AT integrated within inclusive digital ecosystems improves both academic and emotional outcomes. A compelling systematic review supports that alignment of inclusive policy, professional development, and AT provision is critical to actualize benefits (Guillén-Martínez et al., 2025). Additionally, pre-service teacher studies reveal that embedding AT usage and awareness into training enhances pedagogical confidence and inclusive attitudes (Park et al., 2024).

3.2. Adaptive Learning Platforms Outcomes

Adaptive Learning Platforms powered by AI represent a paradigm shift from rigid instruction models toward dynamically personalized learning. These systems tailor content in real time according to student performance—delivering more accessible pacing, feedback, and scaffolding (Pane et al., 2015). Empirical studies, particularly in mathematics and literacy domains, indicate improved task completion rates and reduced dropout risks among learners with difficulties (Spector, 2014; Klinkenberg et al., 2011). Reading platforms incorporating definitions and highlighting support have shown to raise comprehension and motivation in students with dyslexia (Shute & Zapata-Rivera, 2012).

Drigas and Mitsea (2021) frame adaptive systems as tools for fostering metacognition—enhancing self-regulation and goal setting. Teachers appreciate instant analytics for spotting struggling students early and delivering tailored interventions. Yet, infrastructure limitations and concerns around data privacy remain obstacles (Holmes et al., 2021). Notably, a recent scoping review presented at a 2025 conference (Thakur, 2025) underscores the promise of AI platforms across disability categories—emphasizing the need for cross-context validation and educator education.

3.3. Virtual and Augmented Reality Outcomes

Immersive technologies such as Virtual Reality (VR) and Augmented Reality (AR) are increasingly recognized as powerful enablers of inclusive learning, offering novel opportunities for both cognitive development and socio-emotional engagement. VR simulations have proven particularly effective for students with autism spectrum disorder (ASD), helping them practice essential social skills like turn-taking, eye contact, and collaborative interaction within safe, low-arousal environments that reduce stress and stigma (Parsons & Cobb, 2011). For learners with dyslexia, AR

applications provide contextual overlays and interactive features that reinforce phonics and grapheme–phoneme correspondence, making literacy instruction both more accessible and engaging through playful, game-like scenarios (Chen et al., 2020).

European pilot programs highlight that VR can significantly reduce classroom anxiety by allowing students to rehearse reading or social scenarios in immersive environments before transferring these skills into real classrooms. These programs also report improved collaboration and peer-to-peer support in pair or group-based VR activities, strengthening social inclusion (Drigas & Angelidakis, 2017). Recent meta-analyses further suggest a moderate positive effect size (g = 0.38) of immersive VR on learning outcomes, though variability remains high due to differences in program design, implementation fidelity, and student populations (Appelbaum et al., 2022).

Emerging XR tools that integrate audio-haptic feedback demonstrate additional promise for learners with sensory impairments. For example, visually impaired students benefit from haptic cues that enhance spatial awareness, navigation, and symbolic recognition, supporting both autonomy and confidence (Flores-Gutiérrez et al., 2023). Likewise, mixed-reality systems combining VR and AR features enable multimodal literacy training that caters to individual needs, showing measurable gains in reading comprehension and learner motivation (Rahman et al., 2020; Cai et al., 2021).

Despite these encouraging results, significant barriers persist. The high costs of VR headsets and AR-compatible devices limit scalability in under-resourced contexts, while technical complexity often requires advanced teacher training and institutional support (Howard & Gutworth, 2020). Moreover, concerns about sensory overload, cybersickness, and ethical use of student data call for rigorous pedagogical frameworks and ethical safeguards to ensure safe adoption (Holmes et al., 2021; Kooli, 2025). Future implementations must therefore balance innovation with accessibility, integrating immersive tools into inclusive curricula aligned with Universal Design for Learning principles to maximize impact while minimizing risks.

3.4. Teacher-Centered Digital Tools Outcomes

Teacher-Centered tools such as LMS and analytics dashboards have indirect but powerful effects on inclusive education. LMS platforms equipped with accessibility functionalities—closed captions, alt text, flexible navigation—support diverse learners and boost assignment engagement (Edyburn, 2020). Analytics dashboards allow teachers to detect disengagement trends early and introduce timely support (Avramidis & Norwich, 2002).

Consistent findings across studies highlight that educational technology's success depends heavily on teacher training. Programs that integrate inclusive pedagogy with digital competencies lead to increased teacher self-efficacy and adaptability (Sharma & Loreman, 2014). UNESCO's recent report (2025) stresses that building teacher capacity in AI and digital inclusion is essential. A recent case study (Yang & Taele, 2025) demonstrates how AI-driven audio platforms can enhance learning for blind students while emphasizing data privacy and context-sensitive design.

4. Discussion

The results of this review demonstrate that digital tools significantly contribute to inclusive education, yet their impact is mediated by pedagogical, infrastructural, and socio-cultural factors. This section critically interprets the findings through theoretical frameworks, including Universal Design for Learning (UDL) and the social model of disability, while addressing benefits, challenges, and implications for future practice.

4.1. Technology and the Universal Design for Learning Framework

Digital integration aligns closely with the principles of Universal Design for Learning (UDL), which emphasize multiple means of representation, engagement, and expression (Rose & Meyer, 2002). Assistive technologies (AT), such as text-to-speech software or screen readers, exemplify the UDL principle of flexible representation, granting students with dyslexia or visual impairments equal access to curricula (Okolo & Bouck, 2007). Similarly, adaptive platforms embody multiple means of engagement by tailoring task difficulty to student profiles, thus sustaining motivation and reducing dropout rates (Pane et al., 2015).

Recent empirical studies confirm that digitally enabled UDL practices enhance student learning and social inclusion, particularly when paired with sustained professional development (Almeqdad, 2023). Low-cost AT interventions have also proven effective in under-resourced settings, reinforcing the accessibility principle of UDL (Saini et al., 2024).

4.2. Personalization Through Artificial Intelligence and Adaptive Learning

Adaptive learning platforms powered by artificial intelligence (AI) extend personalization beyond traditional differentiation. These systems dynamically adjust learning pathways in real time, analyzing cognitive and behavioral data to optimize engagement (Shute & Zapata-Rivera, 2012). Research shows that students with ADHD demonstrate improved attention and reduced frustration when tasks are paced adaptively (Klinkenberg et al., 2011).

Generative AI models represent a new frontier by customizing educational content in response to learners' individual profiles (Chushchak, 2025). Case studies reveal that AI-driven systems not only improve academic performance but also foster metacognitive skills, enabling learners to monitor progress and set goals (Drigas & Mitsea, 2021). At the same time, journalistic evidence illustrates AI's practical value: students with dyslexia report greater confidence when AI tools assist with reading fluency and comprehension (Gilkison, 2024).

Nevertheless, the literature warns of ethical concerns, particularly regarding surveillance, data privacy, and algorithmic bias (Holmes et al., 2021; Kooli, 2025). These issues underline the necessity of transparent, human-centered AI in education.

4.3. Immersive Learning: Virtual and Augmented Reality

Virtual Reality (VR) and Augmented Reality (AR) technologies provide immersive, interactive environments that enrich learning experiences for diverse learners. VR simulations have been used successfully to support social and emotional learning among students with autism spectrum disorder, leading to improved eye contact, turn-taking, and empathy (Parsons & Cobb, 2011). For students with dyslexia, AR-based reading tools enhance decoding accuracy and motivation by visually reinforcing letter-sound correspondences (Chen et al., 2020).

A systematic review by Cai et al. (2021) found that AR learning environments significantly enhance knowledge retention, emotional engagement, and collaboration. European pilot projects similarly show that VR reduces classroom anxiety by offering safe, controlled environments for practice (Drigas & Angelidakis, 2017). However, issues such as high costs, potential sensory overload, and accessibility gaps limit large-scale adoption (Howard & Gutworth, 2020).

4.4. Inclusion, AI, and Multilingual Contexts

AI applications are also reshaping inclusion in multilingual classrooms by supporting real-time translation and adaptive communication, thereby breaking down linguistic barriers (Fitas, 2025). These tools are particularly valuable in culturally diverse contexts where students may otherwise face double exclusion—on both linguistic and disability grounds. Inclusive AI design, which involves learners with intellectual and developmental disabilities in co-creating tools, represents a promising direction (Special Olympics Global Center, 2024).

4.5. Dual Benefits for Students and Teachers

One of the strongest findings of this review is the dual impact of digital tools: they empower students while also enhancing teachers' capacity to differentiate and monitor learning. Students report reduced stigma and greater confidence when AT is normalized as part of classroom practice (Kelly & Smith, 2011). Adaptive systems encourage self-reflection and goal setting, promoting lifelong learning skills (Drigas & Mitsea, 2021).

For teachers, digital dashboards and LMS platforms provide actionable insights into student progress, allowing for earlier interventions (Edyburn, 2020). Educators trained in AI tools report higher creativity and confidence in designing inclusive lessons (Sharma & Loreman, 2014). However, without proper professional development, many teachers underuse accessibility features, limiting the potential benefits.

4.6. Challenges and Ethical Considerations

Despite significant progress, multiple barriers remain. Structural inequalities such as lack of reliable internet or limited device availability prevent equitable adoption (Miles & Singal, 2010). Ethical concerns regarding privacy, surveillance, and algorithmic bias in adaptive systems are increasingly raised (Holmes et al., 2021; Kooli, 2025).

Emerging reports from low-resource contexts (Financial Times, 2025) highlight that while digital initiatives—such as distributing tablets—can bridge gaps, without systemic support they often fail to deliver sustainable outcomes. Teachers continue to stress that technology must complement rather than replace pedagogical expertise.

4.7. Toward a Hybrid Model of Inclusion

Evidence suggests that the most effective route to genuine classroom inclusion is a hybrid model where pedagogy, digital tools, and professional development operate as a single, integrated system. Pedagogically, this means grounding practice in inclusive values and the social model of disability, seeing barriers as products of classroom design rather than student deficits (Oliver, 1996; Booth & Ainscow, 2016). It also entails applying Universal Design for Learning principles so that curricula and assessments proactively anticipate diversity (Rose & Meyer, 2002).

Within this framework, digital supports act as enablers: assistive technologies such as text-to-speech and AAC reduce functional barriers (Okolo & Bouck, 2007); adaptive and AI-driven platforms personalize pacing and scaffolding (Pane et al., 2015; Drigas & Mitsea, 2021); and immersive VR/AR environments allow safe practice of social or academic skills (Parsons & Cobb, 2011; Drigas & Angelidakis, 2017). Yet these tools are effective only when teachers have the judgment and fluency to use them ethically and creatively, making sustained, context-sensitive professional development essential (Sharma & Loreman, 2014; Drigas & Ioannidou, 2013; Edyburn, 2020).

Finally, the model must address system-level moderators such as infrastructure, equitable access, cultural responsiveness, and data governance—otherwise, digital tools risk reproducing exclusion (Miles & Singal, 2010; Holmes et al., 2021). When pedagogy sets the goals, digital tools provide flexible pathways, and professional learning sustains practice, schools can progress beyond access to meaningful participation, agency, and measurable learning gains (Kelly & Smith, 2011; Almeqdad, 2023).

5. Conclusions and Research Perspectives

This article has critically examined the role of digital tools in promoting inclusive education, focusing on four interrelated domains: assistive technologies, adaptive AI-driven platforms, immersive VR/AR environments, and teacher-centered systems. The review demonstrates that the transformative potential of these tools lies not in their isolated application but in their integration with robust pedagogical frameworks and continuous professional development for teachers. This combined approach leads to what has been described as a hybrid model of inclusion (Chapter 4), in which pedagogy, technology, and teacher training operate synergistically rather than in parallel. Absent such an ecosystem, the adoption of digital tools risks being fragmented, reinforcing existing inequalities or suffering from underutilization due to barriers such as lack of infrastructure, limited teacher expertise, or institutional inertia.

A central conclusion emerging from this analysis is that technology should never be considered a substitute for pedagogy. Instead, it must be seen as a catalyst that amplifies teachers' ability to differentiate instruction, adapt to learner diversity, and design flexible access routes to knowledge. Assistive technologies, for example, extend communication and literacy opportunities for learners with sensory or motor impairments, but their full benefit is realized only when embedded in instructional design. Similarly, adaptive platforms and AI tools can personalize content delivery, yet their success depends on teacher oversight to contextualize automated feedback and maintain the human relational dimension of learning. The effectiveness of digital tools is therefore contingent on equitable access, cultural sensitivity, and ethical safeguards. Without clear attention to these conditions, digital inclusion initiatives may inadvertently deepen educational divides rather than bridge them.

The ethical dimension is especially significant in the context of AI. A recent MDPI review underlines that AI, when appropriately implemented, can support participation, reduce teacher workload, and enhance equity. Yet the same review warns of risks such as surveillance, bias in algorithmic decision-making, and lack of transparency in data use. These tensions illustrate that the promise of AI is inseparable from questions of governance and accountability, and that inclusion cannot be reduced to technological provision alone.

From a practical perspective, the findings confirm that inclusive education requires systemic alignment between pedagogical principles, digital innovation, and professional development. This alignment calls for investment not only in infrastructure—such as devices and connectivity—but also in UDL-based curriculum design that embeds multiple means of representation, engagement, and expression from the outset (Booth & Ainscow, 2016; Rose & Meyer, 2002). Importantly, the role of students and families must not be overlooked. Their active participation in decision-making ensures that the technologies adopted are contextually relevant and genuinely address learner needs, rather than being imposed as top-down solutions. Recent OECD analyses (2023) reinforce this, emphasizing that digital equity extends beyond access: it involves building capacities such as digital literacy, critical thinking, and learner agency to enable meaningful engagement with digital systems.

Looking ahead, future research must advance on three critical fronts. First, longitudinal studies are essential to understand the long-term effects of digital tools not only on academic performance but also on emotional well-being, identity formation, and social participation. The DO-IT AccessSTEM program (DO-IT Center, 2025) provides an instructive model, showing that when universal design principles are sustained over years, learners with disabilities achieve greater persistence in STEM pathways and develop stronger professional self-concepts.

Second, cross-cultural and comparative research is needed to examine how digital inclusion strategies function across diverse educational ecosystems. Inclusive education does not occur in a vacuum; it is shaped by socioeconomic, linguistic, and policy contexts. Studies such as those by illustrate that strategies effective in high-resource contexts may falter in under-resourced or rural settings unless adapted to local realities. This highlights the necessity for global frameworks that are flexible enough to be localized, while ensuring core commitments to equity and access remain intact.

Third, ethical and policy frameworks must keep pace with the rapid integration of AI and other advanced technologies. Transparent data governance, algorithmic fairness, and effective regulation are prerequisites for protecting learners' rights "Education Equity Technology" model demonstrates how institutional commitment, inclusive design strategies, and continuous evaluation can mitigate these risks and anchor digital innovation in principles of justice and accountability.

In conclusion, digital tools have the potential to shift inclusive education from a discourse of mere access to one of meaningful participation and agency. However, realizing this potential requires more than technological investment. It demands holistic strategies that integrate pedagogy, sustained professional learning, systemic equity, and ethical governance. The task for educators, policymakers, and researchers is thus twofold: to innovate technologically while ensuring that such innovation remains anchored in justice, equity, and human dignity—the foundational values of inclusive education.

Compliance with ethical standards

Disclosure of conflict of interest

The Authors proclaim no conflict of interest.

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