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The Application of Virtual Reality in Teaching Students with Dyslexia: New Approaches

Christos Simos [1,*], Constantine Skordoulis [1] and Athanasios Drigas [2]

[1] *Department of Pedagogy and Primary Education, National and Kapodistrian University of Athens, Greece.*
[2] *Net Media Lab, IIT, NCSR "Demokritos", Athens, Greece*

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Abstract

Dyslexia is one of the most common specific learning difficulties, affecting reading fluency, decoding, and comprehension. Traditional interventions, while effective to some extent, often struggle to maintain student engagement and motivation. In recent years, Virtual Reality (VR) has emerged as a promising tool for reimagining dyslexia instruction by providing immersive, multisensory, and adaptive learning environments. This article critically examines the role of VR in teaching students with dyslexia, highlighting its pedagogical potential, empirical evidence, and challenges. Through a narrative literature review covering studies from 2015 to 2025, it explores how VR can enhance phonological awareness, reading comprehension, and self-confidence, while also fostering inclusive and collaborative learning contexts. Drawing on frameworks such as Universal Design for Learning (UDL) and recent cognitive neuroscience findings, the paper positions VR not as a replacement for evidence-based interventions but as an innovative complement to them. It concludes by proposing directions for future research and practice, emphasizing ethical considerations, accessibility, and the need for sustained teacher professional development.

Keywords: Virtual Reality (VR); Dyslexia; Inclusive Education; Assistive Technology; Universal Design For Learning (UDL); Digital Pedagogy

1. Introduction

1.1. Dyslexia and the Need for Innovative Pedagogies

Dyslexia is a neurodevelopmental condition characterized by persistent difficulties in accurate and/or fluent word recognition, poor spelling, and decoding abilities. These challenges occur despite adequate intelligence, conventional instruction, and sufficient educational opportunities (Peterson & Pennington, 2015; Snowling, 2019). Current estimates suggest that dyslexia affects between 5% and 10% of the global population, with prevalence varying slightly depending on diagnostic criteria and linguistic context (Lyon et al., 2003; Shaywitz & Shaywitz, 2020). Recent epidemiological research underscores that dyslexia is not confined to alphabetic languages but manifests across diverse orthographies, including transparent ones such as Italian and Greek, though with different profiles of difficulty (Ziegler & Goswami, 2005; Landerl et al., 2013).

The academic consequences of dyslexia are well-documented. Students often experience delays in reading fluency and comprehension, which in turn affect broader learning outcomes in content areas such as science and social studies (Snowling, 2019). Beyond literacy, dyslexia is linked to heightened risk of school dropout, lower academic self-concept, and increased prevalence of anxiety and depression during adolescence (Nelson & Harwood, 2011; Alexander-Passe, 2015). Longitudinal studies further indicate that, without effective intervention, the gap in literacy performance

* Corresponding author: Christos Simos

between students with and without dyslexia tends to widen over time, creating cumulative educational disadvantage (Francis et al., 1996).

While structured literacy programs grounded in phonological awareness and multisensory teaching have shown consistent effectiveness in improving decoding and spelling skills (Torgesen et al., 2006; Galuschka et al., 2014), they frequently fail to maintain learner engagement over extended periods. Many students with dyslexia report feelings of frustration, stigma, or lack of motivation when interventions emphasize repetitive drills or highlight their deficits (Humphrey & Mullins, 2010). These psychosocial barriers illustrate the need for approaches that not only remediate cognitive difficulties but also enhance motivation and self-efficacy.

Furthermore, the increasing diversity of classrooms—encompassing linguistic minorities, students with co-occurring attention or working memory difficulties, and varying socioeconomic backgrounds—intensifies the demand for pedagogical flexibility (Miles & Singal, 2010; Ainscow, 2020). Recent frameworks in inclusive education argue for the integration of digital technologies to create adaptive, multimodal, and engaging learning environments (Drigas & Mitsea, 2021; Karagianni & Drigas, 2023a). Tools such as immersive platforms, gamified learning, and personalized feedback systems are increasingly viewed as essential complements to traditional interventions, offering the potential to reduce both cognitive and emotional barriers to literacy acquisition.

1.2. The Promise of Virtual Reality in Education

Digital technologies have transformed education over the last two decades, with Virtual Reality (VR) emerging as a particularly innovative tool for inclusive learning. VR creates immersive, interactive environments that allow learners to engage through visual, auditory, and kinesthetic modalities, aligning with Universal Design for Learning (UDL) principles of multiple means of representation, engagement, and expression (Rose & Meyer, 2002; CAST, 2018). Unlike traditional screen-based tools, VR enables students to interact with three-dimensional representations of language and text, creating experiences that feel both authentic and motivating (Howard & Gutworth, 2020).

For students with dyslexia, VR offers unique affordances. It can reinforce phoneme–grapheme correspondence by visually highlighting letter–sound pairings while learners hear and manipulate sounds, strengthening decoding pathways (Chen et al., 2020). VR can also scaffold reading fluency by presenting texts in adaptive formats—slowed down, segmented, or accompanied by multisensory cues—thus reducing cognitive overload. Importantly, VR applications can gamify literacy practice, embedding learning tasks into interactive storylines and challenges that sustain motivation, especially for younger learners (Cai et al., 2021; Appelbaum et al., 2022).

Beyond cognitive improvements, VR supports socio-emotional inclusion. In group-based VR tasks, learners with dyslexia can collaborate with peers in problem-solving scenarios, practice communication skills, and engage in cooperative gameplay. Such environments normalize the use of digital supports and reduce the stigma often associated with learning differences (Drigas & Angelidakis, 2017; Karagianni & Drigas, 2023a). Emerging studies further suggest that VR-based interventions can lower reading-related anxiety and foster resilience by enabling repeated practice in low-stress, immersive contexts (Chalkiadakis et al., 2024).

Overall, VR represents a convergence of cognitive support, motivational enhancement, and social participation, offering a holistic tool for inclusive literacy instruction. However, its promise can only be fully realized through thoughtful pedagogical design, accessibility considerations, and sustained teacher training.

1.3. Cognitive Neuroscience Insights and VR for Dyslexia

Recent advances in neuroscience highlight the critical role of neural plasticity in reading acquisition. Functional MRI and electrophysiological studies reveal that dyslexia involves atypical activation in the left temporo-parietal and occipito-temporal regions—areas linked to phonological decoding and visual–orthographic integration (Shaywitz & Shaywitz, 2020; Gabrieli, 2023). These findings underscore that reading difficulties in dyslexia are not rooted in low intelligence but in specific neural processing differences.

Virtual Reality (VR), by engaging multiple sensory pathways simultaneously, holds potential to stimulate cross-modal integration and strengthen compensatory neural mechanisms. Multisensory VR activities—such as pairing auditory phonemes with dynamic visual letters or embedding reading practice into interactive environments—may enhance functional connectivity between auditory and visual cortices, thereby supporting phonological decoding and orthographic mapping (Howard & Gutworth, 2020; Krafnick et al., 2014).

Neurocognitive research also indicates that immersive VR can reduce cognitive load by breaking tasks into smaller, engaging units, thus freeing working memory resources for literacy processing (Bailenson, 2018). This is particularly important for learners with dyslexia, who often experience reduced working memory and slower processing speed (Swanson et al., 2009). Controlled, low-stress VR practice environments further allow repeated exposure without performance-related anxiety, which has been shown to hinder reading development (Alexander-Passe, 2015).

When VR-based tasks are paired with evidence-based literacy interventions—such as phonics instruction or multisensory structured language programs—they may accelerate skill transfer to real-world reading tasks. Pilot studies suggest that such integration can improve not only decoding accuracy but also metacognitive awareness of reading strategies (Karagianni & Drigas, 2023a).

1.4. Teacher Readiness and Ethical Considerations

The integration of VR into dyslexia instruction depends heavily on teacher preparedness. Teachers require not only technological competence but also pedagogical strategies to embed VR meaningfully into literacy curricula (Edyburn, 2020; Sharma & Loreman, 2014). Research consistently shows that when educators receive structured professional development, they are more confident and creative in implementing VR-based interventions (Al-Azawei et al., 2017). Conversely, without systematic training, VR risks being underutilized or misapplied, potentially reinforcing rather than reducing learning inequalities. Sustained professional learning communities and peer mentoring have been suggested as effective ways to build teachers' digital fluency and pedagogical adaptability (Drigas & Ioannidou, 2013).

Equally critical are the ethical and equity-related considerations surrounding VR use in classrooms. Issues of equitable access remain central: students in under-resourced schools may lack the infrastructure (e.g., reliable internet, updated devices) to benefit from immersive learning tools, potentially exacerbating the digital divide (Miles & Singal, 2010). In addition, VR platforms often collect sensitive learner data, raising concerns about privacy, informed consent, and responsible data governance (Holmes et al., 2021; Kooli, 2025).

Another challenge is sensory safety. Learners with dyslexia often experience co-occurring visual stress or attention difficulties, and poorly designed VR environments may cause sensory overload, cybersickness, or fatigue (Howard & Gutworth, 2020). Educators must therefore be trained not only to integrate VR into lessons but also to monitor student responses and adapt use to individual needs.

Finally, researchers emphasize that VR interventions should be designed with inclusivity by design, ensuring accessibility features (e.g., adjustable fonts, text-to-speech, multimodal cues), cultural responsiveness, and opportunities for learner agency (Pagliara et al., 2024; Chalkiadakis et al., 2024). Embedding ethical considerations at the design stage ensures that VR supports rather than undermines the values of inclusive education.

1.5. Aim and Research Questions

The increasing prevalence of dyslexia, combined with the rapid development of immersive technologies, underscores the urgency of exploring new pathways for inclusive literacy instruction. While traditional phonics-based and multisensory interventions have established evidence of effectiveness, they often fail to sustain engagement or address the emotional and motivational barriers faced by learners with dyslexia (Snowling, 2019; Shaywitz & Shaywitz, 2020). In this context, Virtual Reality (VR) has emerged as a transformative tool, providing immersive, interactive, and adaptive learning environments that align with Universal Design for Learning (UDL) principles (Rose & Meyer, 2002; CAST, 2018).

The primary aim of this article is to critically examine how VR can be applied to teaching students with dyslexia, synthesizing evidence from empirical research, cognitive neuroscience, and inclusive pedagogy between 2015 and 2025. Particular attention is paid to both cognitive outcomes (e.g., decoding, comprehension, fluency) and psychosocial dimensions (e.g., motivation, self-confidence, social participation). Furthermore, this study considers systemic implications such as teacher readiness, ethical adoption, and the sustainability of VR integration within educational ecosystems (Drigas & Angelidakis, 2017; Holmes et al., 2021).

By framing VR not merely as a technological intervention but as part of a hybrid inclusion model—where pedagogy, digital innovation, and professional development converge—this article seeks to contribute to international discussions on how emerging technologies can foster authentic participation for students with learning differences.

The guiding research questions are:

- What are the pedagogical affordances of VR for supporting students with dyslexia in literacy acquisition?
- How does VR influence reading skills, learner motivation, and classroom inclusion compared to traditional interventions?
- What challenges, limitations, and ethical considerations accompany the application of VR in dyslexia instruction, particularly regarding accessibility, privacy, and teacher preparedness?

2. Methodology

This study adopts a narrative literature review approach to critically examine the potential and challenges of Virtual Reality (VR) as an instructional tool for students with dyslexia. The methodology is guided by the principles of inclusivity, evidence-based practice, and technological innovation, and it synthesizes findings from international and interdisciplinary research published between 2015 and 2025.

Unlike systematic reviews that follow rigid protocols, a narrative review allows for the integration of diverse types of evidence—empirical studies, cognitive neuroscience findings, pedagogical frameworks, and policy analyses—to provide a holistic perspective (Baumeister & Leary, 1997; Greenhalgh et al., 2018). This approach is particularly suitable for an emerging field like VR-based dyslexia interventions, where experimental data are still limited and scattered across disciplines.

2.1. Data Sources and Selection Criteria

The sources included in this review were identified through academic databases such as Scopus, Web of Science, PsycINFO, and ERIC, as well as reputable open-access publishers (e.g., MDPI, Frontiers, Springer, Elsevier, Taylor & Francis). Keywords used in the search included: dyslexia, virtual reality, immersive learning, literacy interventions, inclusive education, cognitive neuroscience, Universal Design for Learning (UDL), and assistive technologies.

Inclusion criteria were as follows:

- Studies published between 2015–2025, ensuring contemporary relevance.
- Peer-reviewed journal articles, academic books, or high-quality institutional reports.
- Research directly addressing VR applications in literacy, dyslexia, or broader inclusive education contexts.
- Empirical studies (quantitative, qualitative, or mixed methods), meta-analyses, and conceptual/theoretical frameworks.
- Exclusion criteria involved studies without educational relevance, papers lacking methodological rigor, and grey literature not subjected to peer review.

2.2. Analytical Framework

The analysis was structured around four interrelated dimensions that reflect both pedagogical and systemic factors:

- Cognitive and Literacy Outcomes – Examining the impact of VR on reading fluency, decoding, phonological awareness, and comprehension.
- Motivational and Psychosocial Outcomes – Assessing VR's role in reducing reading anxiety, enhancing learner confidence, and fostering social participation.
- Teacher Preparedness and Pedagogical Integration – Evaluating the readiness of teachers to embed VR into literacy curricula, including professional development needs.
- Ethical and Systemic Considerations – Exploring issues such as accessibility, equity of access, data privacy, and alignment with inclusive education policies.

This framework aligns with Universal Design for Learning (UDL) (CAST, 2018), the social model of disability (Oliver, 1996), and contemporary models of digital inclusion (Holmes et al., 2021; OECD, 2023).

2.3. Data Synthesis

A thematic synthesis method was applied, combining inductive coding of empirical findings with deductive alignment to the four analytical dimensions. Key themes such as phoneme–grapheme reinforcement, gamification of reading practice, teacher training, learner motivation, and ethical governance were identified across studies. Cross-validation was achieved by comparing results from neuroscience, educational psychology, and technology-enhanced learning.

The integration of findings also draws on conceptual frameworks by Drigas and colleagues, who emphasize the role of immersive technologies (VR/AR) in inclusive education and the need for sustained teacher professional development to maximize their benefits (Drigas & Angelidakis, 2017; Karagianni & Drigas, 2023a).

2.4. Methodological Limitations

This study acknowledges several limitations. First, the novelty of VR in dyslexia interventions means that the number of large-scale, longitudinal studies remains limited. Most available research involves small samples, pilot projects, or case studies, which may constrain generalizability (Appelbaum et al., 2022). Second, publication bias may favor positive findings, underreporting potential negative or null outcomes. Finally, this review is restricted to English-language sources, which may exclude relevant research conducted in other linguistic contexts.

Despite these limitations, the narrative review approach provides valuable insights into how VR can be strategically integrated into dyslexia instruction and what systemic conditions are required for sustainable implementation.

3. Results

The synthesis of reviewed studies demonstrates that Virtual Reality (VR) has significant potential to support students with dyslexia. Evidence shows consistent gains in literacy acquisition, learner engagement, and psychosocial well-being when VR is embedded within inclusive pedagogical frameworks. However, effectiveness varies according to contextual factors such as teacher readiness, infrastructure, and ethical safeguards.

3.1. Cognitive and Literacy Outcomes

Empirical research highlights VR's ability to reinforce foundational literacy skills in students with dyslexia. VR applications that gamify phoneme–grapheme correspondence have been shown to improve decoding accuracy and fluency by providing interactive multisensory feedback (Chen et al., 2020; Cai et al., 2021). Neurocognitive studies further suggest that VR's immersive environments stimulate cross-modal neural pathways, enhancing phonological awareness and orthographic mapping (Gabrieli, 2023; Howard & Gutworth, 2020).

Controlled trials report that VR-based literacy programs significantly outperform traditional reading interventions, particularly in improving reading comprehension and working memory capacity (Smith et al., 2019; Appelbaum et al., 2022). Recent longitudinal evidence from European pilot programs demonstrates that VR-supported phonics training yields durable gains in spelling accuracy and transfer of skills to real-world reading contexts (Martín-Gutiérrez et al., 2021; Chalkiadakis et al., 2024).

Furthermore, adaptive VR systems that integrate artificial intelligence (AI) provide personalized scaffolding, adjusting task difficulty in real time. This functionality is particularly beneficial for dyslexic learners, who often struggle with one-size-fits-all approaches (Pagliara et al., 2024; Yang & Taele, 2025).

3.2. Motivational and Psychosocial Outcomes

One of the most consistent findings is that VR interventions enhance student motivation and engagement. Traditional literacy programs often struggle to sustain attention among dyslexic learners; VR, by contrast, creates dynamic, game-like environments that reduce frustration and increase persistence (Bailenson, 2018; Parong & Mayer, 2021).

Students report decreased reading anxiety and increased self-confidence when practicing literacy skills in VR compared to paper-based exercises (Shaywitz & Shaywitz, 2020; Karagianni & Drigas, 2023a). Collaborative VR tasks, such as virtual storytelling or group-based reading games, further promote social participation, enabling dyslexic learners to work alongside peers without stigma (Drigas & Angelidakis, 2017; Huang et al., 2022).

In addition, psychosocial outcomes extend to improved emotional regulation. Immersive VR environments allow learners to practice literacy tasks in low-stress contexts, reducing the fear of failure and fostering resilience (Marino et al., 2019). These benefits align with broader research on the positive relationship between immersive technologies and socio-emotional learning (Hamilton et al., 2021).

3.3. Teacher Preparedness and Pedagogical Integration

The successful application of VR in dyslexia instruction is mediated by teacher readiness. Studies show that when educators receive structured professional development in immersive technologies, they are more likely to integrate VR

into literacy curricula effectively (Edyburn, 2020; Sharma & Loreman, 2014). Teachers trained in Universal Design for Learning (UDL) frameworks report greater confidence in using VR to differentiate instruction and support diverse learners (CAST, 2018; Rose & Meyer, 2002).

However, gaps persist. Many educators cite limited time, insufficient technical support, and lack of evidence-based training materials as barriers to VR adoption (Green et al., 2020; OECD, 2023). Without proper guidance, VR risks being implemented superficially, reducing its potential to foster meaningful literacy gains (Drigas & Ioannidou, 2013; Westover, 2025).

Teacher attitudes also play a role. Positive perceptions of VR's benefits correlate with higher adoption rates, while skepticism about its efficacy or fears of classroom disruption hinder integration (Howard & Gutworth, 2020; Appelbaum et al., 2022). These findings suggest that professional development must include not only technical training but also pedagogical modeling and reflective practice.

3.4. Ethical and Systemic Considerations

While promising, VR integration raises significant ethical and systemic issues. First, equitable access remains a challenge: high implementation costs and unequal distribution of digital infrastructure create risks of a "VR divide," particularly in under-resourced schools (Saini et al., 2024; Guillén-Martínez et al., 2025).

Second, data privacy and algorithmic bias are pressing concerns as VR platforms increasingly incorporate AI-based analytics. Ethical frameworks must safeguard student data and prevent discriminatory outcomes (Holmes et al., 2021; Kooli, 2025). Transparent policies, informed consent, and parental involvement are critical to ensuring responsible adoption (Toyokawa et al., 2023; Zahurin et al., 2024).

Third, sensory and cognitive overload poses risks for some learners. Although VR reduces anxiety for many students, poorly designed environments may trigger discomfort or overstimulation, especially in individuals with co-occurring attentional difficulties (Parsons & Cobb, 2011; Bailenson, 2018). Thus, inclusive design principles—such as customizable settings, gradual exposure, and accessibility features—must guide development (Karagianni & Drigas, 2023b).

Finally, systemic adoption requires supportive policy and institutional frameworks. OECD (2023) and UNESCO guidelines stress that VR should complement, not replace, evidence-based literacy instruction, and that teachers, students, and families must be engaged in co-design processes. Without systemic alignment, VR risks being a temporary novelty rather than a sustainable inclusion strategy (Booth & Ainscow, 2016; Miles & Singal, 2010).

4. Discussion

The findings of this review confirm that Virtual Reality (VR) offers significant opportunities for transforming the teaching of students with dyslexia, targeting not only reading accuracy and fluency but also learner motivation, social inclusion, and long-term engagement with literacy practices. However, the literature also underscores that the impact of VR is not automatic; its effectiveness depends on careful pedagogical integration, sustained teacher readiness, and systemic equity in access. Interpreting these findings through the frameworks of Universal Design for Learning (UDL) and the social model of disability allows for a deeper understanding of both the opportunities and limitations of VR-supported instruction.

4.1. VR and the Universal Design for Learning Framework

VR aligns powerfully with UDL principles by providing multiple, flexible means of representation, engagement, and expression (Rose & Meyer, 2002; CAST, 2018). In practical terms, VR environments integrate visual cues, auditory narration, and kinesthetic interaction, making literacy learning more accessible for students with dyslexia who often struggle with single-channel instruction. Studies demonstrate that VR applications which synchronize phoneme–grapheme correspondence with visual animations and auditory reinforcement accelerate decoding and enhance word recognition accuracy (Chen et al., 2020; Cai et al., 2021). More recent systematic reviews highlight that immersive VR not only improves technical literacy outcomes but also enhances emotional engagement, a key determinant of persistence in learning (Appelbaum et al., 2022; Chalkiadakis et al., 2024).

An equally critical UDL dimension is the reduction of affective barriers. By simulating literacy practice in low-stress, game-like environments, VR reduces performance anxiety, a factor strongly correlated with reading avoidance behaviors in students with dyslexia (Snowling, 2019). Drigas and Angelidakis (2017) emphasize that when VR tools are

designed with accessibility features such as adjustable text size, captioning, and adaptive scaffolding, they provide equitable entry points for diverse learners, aligning inclusively with UDL's core vision.

4.2. Cognitive and Metacognitive Benefits

From a cognitive neuroscience perspective, VR appears to leverage neural plasticity by engaging multiple sensory pathways simultaneously. Functional neuroimaging studies reveal that dyslexia involves under-activation in left temporo-parietal regions associated with phonological decoding and orthographic processing (Shaywitz & Shaywitz, 2020; Gabrieli, 2023). Immersive environments that combine visual highlighting with auditory input can stimulate compensatory activation patterns, thereby strengthening cross-modal integration. Pilot VR interventions using interactive spelling games and decoding simulations have reported measurable improvements in working memory and transfer of reading skills to classroom tasks (Howard & Gutworth, 2020).

Beyond decoding, VR fosters metacognition, a domain essential for independent learning. Through real-time feedback, progress monitoring dashboards, and adaptive difficulty adjustments, learners are encouraged to self-reflect, set goals, and regulate their strategies (Drigas & Mitsea, 2021). These metacognitive benefits align with research on adaptive learning platforms but are amplified by VR's immersive qualities, which promote deeper engagement and sustained practice (Klinkenberg et al., 2011; Pagliara et al., 2024).

4.3. Motivation, Engagement, and Social Inclusion

One of the strongest contributions of VR lies in its motivational power. Traditional dyslexia interventions, although evidence-based, often struggle to keep learners engaged due to their repetitive nature. VR transforms these routines into interactive experiences that gamify reading, incorporate storytelling, and reward progress. Learners report higher confidence and reduced stigma when VR is used, as it reframes literacy practice as a playful, creative challenge rather than a remedial burden (Karagianni & Drigas, 2023a; Kelly & Smith, 2011).

Equally important is the social dimension. Group-based VR activities create opportunities for collaboration, where students with dyslexia can take active roles in problem-solving and shared exploration. This reduces feelings of isolation, one of the most reported emotional consequences of dyslexia in mainstream classrooms (Ainscow, 2020). Collaborative VR environments support inclusive participation, positioning dyslexic learners as co-constructors of knowledge rather than passive recipients of special accommodations (Miles & Singal, 2010; Almeqdad, 2023).

4.4. Practical Challenges and Ethical Considerations

Despite its promise, scaling VR for inclusive literacy instruction remains challenging. Financial barriers such as the high costs of VR headsets and specialized software disproportionately affect under-resourced schools (Edyburn, 2020). Even when infrastructure is available, teachers frequently report a lack of confidence in embedding VR into existing literacy curricula, emphasizing the urgent need for targeted professional development (Sharma & Loreman, 2014; Drigas & Ioannidou, 2013).

Ethical concerns must also be addressed to ensure responsible adoption. Data privacy is a pressing issue, as VR systems often collect sensitive learner data, from behavioral patterns to biometric feedback (Holmes et al., 2021). Additionally, potential side effects such as motion sickness or sensory overload highlight the necessity of individualized adaptation and cautious design, especially for younger learners (Howard & Gutworth, 2020). Pagliara et al. (2024) stress that inclusive VR requires attention to cultural responsiveness, accessibility features, and learner agency to prevent unintentional exclusion.

4.5. Toward a Hybrid Model of VR-Supported Inclusion

The synthesis of findings points to a hybrid model of inclusion as the most promising pathway for VR in dyslexia education. In such a model, robust pedagogy provides the foundation, VR serves as a flexible enabler of multimodal access, and teacher professional development ensures sustainable implementation. UDL principles guide curriculum design so that diversity is anticipated rather than accommodated retroactively (Booth & Ainscow, 2016). VR then scaffolds access by reducing functional barriers, enhancing motivation, and facilitating collaborative learning experiences. Sustained training empowers teachers to deploy VR ethically and creatively, preventing both underuse and misuse (Sharma & Loreman, 2014; OECD, 2023).

When these three layers—pedagogy, technology, and training—are intentionally aligned, VR has the potential not only to improve reading fluency and comprehension but also to foster social inclusion, learner agency, and equitable participation. This hybrid model moves inclusion beyond mere physical presence in mainstream classrooms toward

genuine educational equity rooted in justice, accessibility, and learner empowerment (Kelly & Smith, 2011; Drigas & Mitsea, 2021; Almeqdad, 2023).

5. Digital technologies and future Perspectives

The future of VR in dyslexia education depends on robust and sustained research efforts. Longitudinal studies are particularly necessary to determine the long-term impact of VR-based interventions on reading fluency, comprehension, and emotional well-being, as well as their capacity to support learner agency across different educational stages. Evidence from initiatives such as the DO-IT AccessSTEM project underscores the value of longitudinal tracking for understanding inclusive outcomes (DO-IT Center, 2025).

Equally important are cross-cultural and contextual studies, as much of the existing evidence is concentrated in high-income countries. Comparative research should investigate how VR literacy interventions function in under-resourced or multilingual contexts, where infrastructure constraints and cultural differences may alter outcomes (Miles & Singal, 2010; Saini et al., 2024). Such inquiries are vital for preventing global inequities in access to immersive technologies.

Finally, greater attention must be given to the ethical, policy, and design dimensions of VR applications. Transparent governance frameworks are needed to regulate data use, safeguard learner rights, and ensure accessibility for all. Collaborative approaches involving policymakers, educators, and learners themselves can foster VR environments that are inclusive, culturally responsive, and ethically grounded (Holmes et al., 2021; Westover, 2025). The development of conceptual frameworks such as Education Equity Technology provides a promising foundation but requires empirical validation across diverse educational contexts.

The importance of all digital technologies in the field of education is highlighted in our final point. ICTs support universal access to education, provide innovative approaches for effective teacher training, enhance learning retention, promote cooperation, increase openness, develop learner-centered approaches, and hasten the process of learning. Additionally, by using virtualization, mobilization, artificial intelligence, and new learning environments like virtual worlds, support educational activities and methodologies. More specifically, ICTs are very effective and productive in Dyslexia training, facilitating and improving the assessment, intervention, and educational procedures via mobile devices that bring educational activities everywhere [54-55] and through a variety of ICT applications that serve as the backbone of education [56-59]. The use of AI, STEM, and robotics raises educational practices to new levels of flexibility, innovation, and performance [60-61], while games turn education into a multimodal, incredibly amiable, and pleasurable engagement [62-63]. Moreover, the adoption, improvement, and fusion of ICTs with theories and models of metacognition, mindfulness, meditation, and emotional intelligence cultivation [64-69] places the development of mental abilities at the center of educational procedures and policies, which accelerates and improves educational practices and outcomes, particularly in Dyslexia domain and its procedures like assessment and intervention.

6. Conclusions

This review has examined the role of Virtual Reality (VR) as an innovative pedagogical tool for supporting students with dyslexia, emphasizing both its transformative potential and the systemic conditions required for its effective adoption. Across the evidence reviewed, VR emerges as a technology that not only addresses cognitive and linguistic challenges in reading but also enhances motivation, social participation, and learner confidence. When embedded within strong pedagogical frameworks such as Universal Design for Learning (UDL) and reinforced through sustained professional development, VR can serve as a catalyst for inclusive education rather than a supplementary add-on.

A key conclusion is that VR should not be seen as a substitute for traditional literacy interventions but as a complementary force that amplifies their impact. Structured literacy practices remain crucial for building phonological awareness and decoding skills. VR strengthens these approaches by offering multimodal reinforcement, gamified activities, and safe environments for repeated practice, thus reducing anxiety and sustaining motivation. Importantly, VR contributes to the affective and social domains of learning, fostering peer collaboration and reducing stigma—elements often overlooked in traditional instructional approaches

Despite its promise, literature highlights persistent systemic barriers. Unequal access to VR infrastructure, insufficient teacher training, and unresolved ethical concerns such as data governance, privacy, and sensory overload remain pressing challenges. Without targeted investments and inclusive design, there is a risk that VR could reinforce rather than dismantle exclusion, privileging better-resourced contexts while leaving disadvantaged learners behind. For this

reason, VR adoption must be understood within a broader hybrid inclusion model, where pedagogy, technology, and professional learning operate in unison.

In conclusion, VR holds significant potential to transform dyslexia education from a deficit-centered perspective into one that emphasizes learner strengths, engagement, and equity. By uniting insights from cognitive neuroscience, immersive design, and inclusive pedagogy, VR can reimagine literacy as a multisensory, motivating, and collaborative process. Yet this transformation will only materialize if digital innovation is embedded within holistic strategies that integrate pedagogy, professional learning, infrastructure, and ethical safeguards. The collective responsibility of educators, researchers, and policymakers is therefore to ensure that VR's promise is realized not merely as technological novelty but as a vehicle for justice, equity, and human dignity in inclusive education.

Compliance with ethical standards

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The Authors proclaim no conflict of interest.

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