

The Impact of Teaching Using Technology and Multisensory Approaches in Special Education for Students with Dyslexia: A Systematic Literature Review

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Abstract

Students with Special Educational Needs particularly those with dyslexia often experience difficulties in mastering the fundamental skills of reading, writing and numeracy (3M). These difficulties negatively affect their academic achievement and self-confidence. In line with the rapid development of technology in education, various technological innovations and multisensory approaches have been introduced to support the learning of students with dyslexia. These include assistive technologies, mobile applications and digital game-based learning. Therefore, this study aims to synthesize findings from previous research related to the use of technology in teaching students with dyslexia through a systematic literature review approach. The study follows the PRISMA guidelines and involves a systematic search of empirical articles published between 2019 and 2025 across several databases such as Scopus, Web of Science, ERIC and Google Scholar. A total of 19 articles that met the inclusion criteria were selected and analysed using thematic analysis. The findings identified four main themes include the effectiveness of assistive technology on the literacy skills of students with dyslexia, the role of multisensory approaches in supporting the learning styles of students with dyslexia, the contribution of assistive technology and multisensory approaches in enhancing student's motivation and engagement, the challenges associated with implementing technology in special education for students with dyslexia. The implications of this study indicate that the appropriate use of technology and multisensory approaches has the potential to improve the quality of learning for students with dyslexia. In addition to benefiting students, the use of technology also supports special education teachers in planning more effective and engaging teaching strategies and instructional interventions.

Keywords: Dyslexia, Educational Technology, Multisensory, Teaching and Learning, Special Education

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1. INTRODUCTION

Dyslexia is a specific learning disorder that affects 3M skills (reading, writing and spelling skills) and remains a significant challenge within educational systems worldwide (Ch'ng & Jong, 2024; Rahul & Ponniah, 2021). As literacy skills are fundamental to academic success, persistent difficulties in phonological processing, decoding and reading fluency can substantially limit student's access to curriculum content despite average or above-average intellectual ability (Johnston, 2019; Yang, 2022). When inadequately addressed, these challenges increase the risk of academic underachievement, disengagement and reduced self-confidence highlighting the importance of effective instructional interventions for students with dyslexia.

Despite advances in inclusive education, instructional practices in many classrooms continue to rely heavily on text-based approaches that insufficiently accommodate the diverse learning profiles of students with dyslexia (Schaur & Koutny, 2024). This mismatch between learner needs and instructional design underscores the need for flexible and evidence-based teaching strategies, particularly within

special education contexts where instructional effectiveness directly influences long-term learning outcomes.

Educational technology has increasingly been identified as a potential means of reducing learning barriers for students with dyslexia. Assistive technologies such as text-to-speech systems, screen readers, speech-recognition software and mobile learning applications have demonstrated potential in supporting literacy development and independent learning (Reid et al., 2013; Schaur & Koutny, 2024). However, research indicates that technology alone does not guarantee improved outcomes, its effectiveness depends on meaningful pedagogical integration that aligns with learner's cognitive and emotional needs (Aarthi & Hema, 2025; Pradeep, 2023). This highlights the need to examine not only whether technology is used but how it is implemented in instructional practice.

In parallel, multisensory instructional approaches have long been recognised as effective in supporting students with dyslexia by engaging multiple sensory modalities, including visual, auditory, tactile and kinaesthetic channels (Indrarathne, 2022; Majzub et al., 2012). Multisensory Structured Language Teaching (MSLT) in particular, offers systematic and explicit instruction that strengthens sound-symbol associations and supports literacy development (Nijakowska, 2013; Tammasse et al., 2025). Beyond academic gains, multisensory approaches have also been linked to improvements in learner motivation, engagement and self-efficacy (Gosiewska-Turek, 2025).

More recent research has explored the integration of technology with multisensory approaches to create more engaging and personalised learning environments for students with dyslexia. Interactive and digital learning applications incorporating multisensory elements have shown promise in enhancing learner motivation and participation (Jamali et al., 2019; Saputra et al., 2018). Nevertheless, findings across studies remain fragmented with variations in research design, educational context and outcome measures limiting the generalisability of results.

In addition, the implementation of technology-enhanced and multisensory instruction presents practical challenges, including limited teacher training, insufficient resources and inadequate institutional support (Lim et al., 2022; Przybysz & Hahn, 2018). The complexity of dyslexia as a learning disorder further complicates instructional planning and differentiation (Johnston, 2019). These challenges point to the need for a comprehensive synthesis of existing evidence to guide effective practice.

Accordingly, this study employs a systematic literature review (SLR) guided by PRISMA principles to synthesize empirical research published between 2019 and 2025 on the use of technology and multisensory approaches in teaching students with dyslexia. The review examines the effectiveness of assistive technologies on literacy development, the role of multisensory approaches in learning, their influence on motivation and engagement and the challenges associated with implementation. By consolidating current evidence, this study aims to inform instructional practice, teacher preparation and future research ultimately supporting more inclusive and effective educational experiences for students with dyslexia.

2. RESEARCH METHODOLOGY

This study examines technology-based interventions for children with dyslexia through a systematic literature review (SLR). The SLR method was selected due to its capacity to provide a structured, transparent and comprehensive synthesis of empirical evidence, enabling the consolidation of findings across diverse intervention approaches and research designs (Peters et al., 2019). To enhance methodological rigor and reporting transparency, the review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework which offers a standardized procedure for study identification, screening, eligibility assessment and inclusion (Joveini et al., 2024).

2.1. Literature Search Strategy

Article searches were conducted using the Scopus, Web of Science (WoS), ERIC and Google Scholar databases. Scopus was selected as the primary database for this study because it offers several advantages for conducting systematic literature reviews (SLRs), particularly in education and multidisciplinary research. Its comprehensive coverage spans a wide range of disciplines and includes both journal articles and conference proceedings, enabling researchers to access a broad spectrum of scholarly literature (Gupta et al., 2025). As part of the search strategy, Boolean operators and truncation were used to incorporate synonyms and variant terms, thereby ensuring the retrieval of studies employing different terminologies (Joveini et al., 2024).

Selecting appropriate and well-structured keywords is fundamental to the quality of a systematic literature review because keywords directly influence which evidence is retrieved and which studies may be unintentionally overlooked. Carefully selected search terms improve precision by narrowing the results to studies that closely address the research question, while simultaneously enhancing recall by capturing relevant synonyms and related concepts across disciplines and databases (Cleary et al., 2009; Rao & Moon, 2021). In PRISMA-aligned reviews, keyword development should be explicitly documented to ensure a transparent and reproducible search process, including the final search strings, database-specific search fields, search limits and any database-specific adaptations (Briscoe, 2018; Phillips et al., 2024).

Searches of the Scopus, Web of Science (WoS) and ERIC databases were conducted using key concepts, including “dyslexia”, “multisensory”, “educational technology”, “teaching and learning” and “special education”. Searches of Google Scholar were conducted using the main Malay keywords, including “*disleksia*”, “*multisensori*” and “*teknologi*”. The use of a broad range of keywords helped ensure that relevant studies were not overlooked because of differences in terminology. Additional keyword variations, including synonymous and closely related terms, were incorporated into the search strategy and combined using Boolean operators (AND, OR) to maximise the comprehensiveness of the search.

2.2. Screening and Selection Process

Specific inclusion and exclusion criteria were established to ensure that the systematic literature review was focused, methodologically rigorous and informed by the highest-quality empirical evidence. Only empirical studies published between 2019 and 2025 were included to reflect current practices in special education and emerging research trends (Nagro et al., 2023; Kamal et al., 2025). In addition, only articles published in English or Malay were considered to ensure consistency in data interpretation throughout the review. Consistent with the principles of evidence-based reviews, empirical studies were prioritised because they generate data-driven findings through systematic investigation, thereby providing a stronger basis for evidence synthesis and interpretation (Singh, 2017). To ensure alignment with the objectives of the review, eligible studies were required to examine issues related to special education teachers, particularly their roles, professional practices and professional development (Nagro et al., 2023). In contrast, systematic literature reviews were excluded to avoid duplication of evidence and the overrepresentation of secondary studies that might influence the overall conclusions of the review (Keles et al., 2024; Muñoz-Oyarce et al., 2023). Conceptual papers were also excluded because, although they provide valuable theoretical perspectives, they do not present empirical evidence and are therefore less suitable for addressing evidence-based research questions (Singh, 2017). Conference proceedings were excluded because they frequently report preliminary findings and generally do not undergo the same level of peer review as journal articles, limiting their suitability for drawing robust conclusions (Fernandes & Amato, 2013). Collectively, these inclusion and exclusion criteria ensured that the review remained

current, relevant and methodologically rigorous while providing a reliable synthesis of empirical evidence relating to issues affecting special education teachers.

2.3. Article Selection Process

The article screening process in a systematic literature review (SLR) is a structured, multi-stage procedure designed to ensure the relevance, methodological rigour and transparency of the included studies. In accordance with established methodological guidelines, the screening process typically comprises three stages: title screening, abstract screening and full-text screening, based on predefined inclusion and exclusion criteria (Prill et al., 2021; Singh, 2017). This staged approach enables reviewers to efficiently exclude clearly irrelevant studies at an early stage, thereby reducing the number of records requiring further assessment (Mateen et al., 2013). During the abstract screening stage, reviewers assess the relevance and methodological suitability of each study in greater detail. The use of independent dual screening further reduces the risk of selection bias and enhances the reliability of the screening process (Polanin et al., 2019). Full-text screening is subsequently conducted to confirm the eligibility of each study and ensure that only studies meeting the predefined inclusion criteria are included in the final review while maintaining methodological rigour (Prill et al., 2021). To improve the efficiency and consistency of the screening process, recent methodological advances have highlighted the value of semi-automated and artificial intelligence (AI)-assisted tools in supporting human reviewers, particularly in large-scale reviews, without compromising screening accuracy (Holland et al., 2025; van Dinter et al., 2021; Pilz et al., 2024; Trad et al., 2025). Throughout the screening process, all screening decisions and reasons for exclusion should be documented systematically to enhance transparency, reproducibility and accountability, in accordance with best-practice guidance for systematic literature reviews (Kamal et al., 2025).

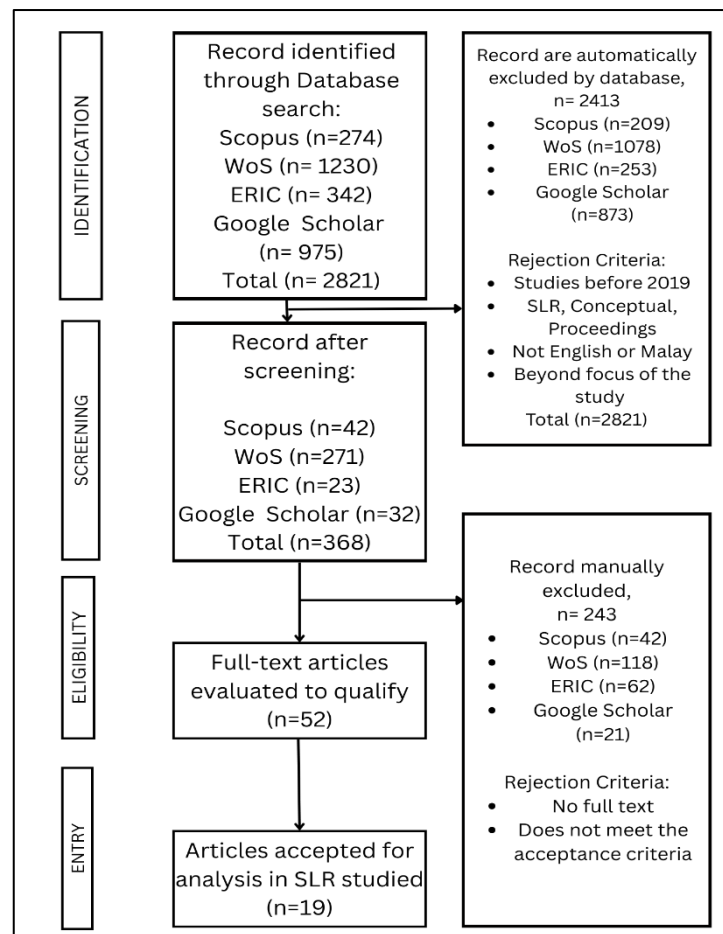


Figure 1: PRISMA 2020 Flow Diagram of Study Selection

This figure illustrates the application of the PRISMA 2020 guidelines to the processes of study identification, screening, eligibility assessment and study inclusion. An extensive search of the Scopus, Web of Science (WoS), ERIC and Google Scholar databases initially identified 2,821 records. During the identification stage, 2,413 records were automatically excluded according to the predefined eligibility criteria, including publications published before 2019, non-empirical study designs (systematic literature reviews, conceptual papers and conference proceedings), articles published in languages other than English or Malay, and studies that were not relevant to the review objectives. Following the identification stage, 368 records remained for title and abstract screening. Of these, 243 records were manually excluded because they contained insufficient information or did not satisfy the inclusion criteria. Subsequently, 52 full-text articles were assessed for eligibility. Following detailed evaluation, 19 studies met all inclusion criteria and were included in the final systematic literature review. The methodological rigour, transparency, reproducibility and accountability of the study selection process are clearly demonstrated through the PRISMA flow diagram, which provides a transparent and systematic account of each stage of the selection process.

3. RESEARCH FINDINGS

Based on the keywords “*Dyslexia*”, “*Educational Technology*”, “*Multisensory*”, “*Teaching and Learning*” and “*Special Education*”, a total of 19 articles passed the screening process and were selected for synthesis. A thematic analysis was conducted on all selected empirical articles and four main themes representing the use of technology in teaching students with dyslexia were synthesised. These themes were identified based on the types of technology used, the focus on learning outcomes and similarities in findings from previous studies.

3.1. Effectiveness of Assistive Technology on the Literacy Skills of Students with Dyslexia

The analysis found that eight selected articles focused on the use of assistive technologies such as text to speech applications, speech recognition tools, digital reading software and reading support aids. These studies consistently reported significant improvements in the basic literacy skills of students with dyslexia with a particular focus on reading, writing and numeracy skills especially in terms of reading accuracy, reading fluency, word recognition and text comprehension (Mohamad et al., 2025).

Assistive technology was found to be effective in providing individualised, adaptive and repetitive learning support which aligns with the needs of students with dyslexia who require consistent practice in phonological processing. The immediate feedback features offered by assistive technology enable students with dyslexia to identify reading errors and correct them directly. These capabilities indirectly enhance student's confidence and enjoyment during the learning process. In addition, several studies have reported the effectiveness of Augmented Reality (AR) based technologies in improving the literacy and writing skills of students with dyslexia where visual interactions supported by AR technology help students develop language understanding in a more meaningful and contextual manner.

In Malaysia, a local study by Ramlan et al. (2023) involving the use of speech recognition technology in Malay language learning also reported improvements in pronunciation accuracy and reading comprehension among students with dyslexia. These findings indicate that assistive technologies developed in accordance with language context and local needs have high potential to support learning and enhance the literacy skills of students with dyslexia.

3.2. Multisensory Approaches Supporting the Learning Styles of Students with Dyslexia

The analysis found that four articles emphasized the use of technology based multisensory approaches in teaching students with dyslexia. These studies indicated that technologies integrating visual, auditory and kinaesthetic elements within multisensory approaches are able to support the diverse learning styles of students with dyslexia and enhance their understanding of basic 3M skills through more concrete and meaningful learning experiences.

Furthermore, the use of animations, sounds, touchscreen interactions and physical movement helps students with dyslexia strengthen the association between letter symbols, sounds and word meanings during teaching and learning sessions (Rowena Langbis, 2021). Norarifah Ali (2021) reported that the use of technology supported multisensory instructional tools helps students with dyslexia recognize letters and construct syllables more effectively. These findings reinforce the view that technology based multisensory approaches constitute one of the significant pedagogical strategies in special education.

3.3. Use of Assistive Technology and Multisensory Approaches in Enhancing the Motivation and Engagement of Students with Dyslexia

The analysis found that five articles involved studies that utilized mobile learning and digital game based learning. These studies reported that the use of mobile applications and digital games increased the levels of motivation, engagement and interest of students with dyslexia in the teaching and learning process (Nguyen et al., 2025). Interactive elements such as animations, digital rewards and progressive challenges help create a more enjoyable and less stressful learning environment for students with dyslexia.

Through the use of assistive technology, students with dyslexia demonstrated better readiness to engage in learning activities when tasks were presented in the form of games rather than traditional tasks which often lead to boredom and cognitive fatigue. Furthermore, mobile learning allows students to learn at their own pace and can be conducted outside formal school hours (Mohamad et al., 2025). This

flexibility provides students with dyslexia opportunities to revisit learning without pressure and supports the development of their intrinsic motivation and self-confidence.

3.4. Challenges in Implementing Technology in Special Education for Students with Dyslexia

Although the analysis of findings indicates numerous benefits of technology in teaching, six articles reported various challenges in implementing technology in special education. Among the main challenges identified were limitations in technological facilities, the level of teacher readiness and a lack of professional training related to the integration of technology in teaching students with dyslexia (Lim et al., 2022). The findings also reported that special education teachers face difficulties in selecting technologies that are appropriate to the levels and needs of students with dyslexia. Furthermore, time constraints and workload pressures also affect the consistent use of technology in teaching and learning within the classroom.

In addition, issues related to access to digital devices and technological infrastructure also pose barriers particularly for schools with limited financial resources. Therefore, the findings indicate that the effectiveness of technology use does not depend solely on the availability of technology itself but is also influenced by other factors such as school system support, teacher training and educational policies that support comprehensive technology integration. Effective implementation of assistive technology and multisensory approaches for students with dyslexia can have a positive impact on their literacy, motivation and engagement.

4. DISCUSSION

4.1. Effectiveness of Assistive Technology on the Literacy Skills of Students with Dyslexia

The findings of the study indicate that the use of assistive technologies such as digital reading applications, text to speech systems and speech recognition technology has a significant impact on improving the literacy skills of students with dyslexia. This effectiveness can be observed through improvements in reading efficiency, fluency and levels of text comprehension when technology is applied consistently and tailored to individual student needs. Mohamad et al. (2025) found that assistive technology confirms learning support that is flexible, repetitive and individual focused thereby supporting the literacy development of students with dyslexia.

From the perspective of cognitive learning theory, the effectiveness of assistive technology can be explained through its role in reducing the cognitive load experienced by students with dyslexia during reading. Students with dyslexia commonly face challenges in phonological processing and word recognition which can negatively affect overall reading comprehension. The use of technologies such as text to speech and speech recognition enables students to receive immediate feedback on pronunciation and reading errors thereby supporting more effective self-correction processes (Tejero et al., 2020). This mechanism allows students to focus more on understanding the meaning of the text without being overly burdened by the technical aspects of reading.

Moreover, digital reading applications provide students with dyslexia greater autonomy to control their learning pace according to their abilities compared to conventional teaching approaches that are uniform in nature (Ignaico et al., 2024). The ability to repeat readings, adjust text display, and listen to word pronunciations repeatedly enables students with dyslexia to build comprehension gradually and in a more structured manner. These findings support the view of Mohamad et al. (2025) who emphasized that assistive technology functions as a supportive medium that strengthens self-directed learning among students in special education.

Ramlan et al. (2023) found that the use of Malay language based reading technology not only improved the reading accuracy of students with dyslexia but also strengthened their self-confidence during reading activities. This finding indicates that the effectiveness of assistive technology is more

optimal when its development and implementation take into account language, cultural aspects and local needs. Therefore, adapting technology to the local context is an important factor in ensuring the success of literacy interventions for students with dyslexia.

4.2. Multisensory Approaches Supporting the Learning Styles of Students with Dyslexia

The findings of the analysis also indicate that technology supported multisensory approaches constitute an effective teaching strategy in special education for students with dyslexia. This approach involves the integration of visual, auditory and kinaesthetic elements through digital platforms enabling students with dyslexia to process information using multiple sensory channels. Rowena Langbis (2021) reported that multisensory approaches strengthen literacy understanding and support more meaningful learning among students with dyslexia.

Technology based multisensory approaches do not merely add learning stimulation but function to reinforce the relationship between letter symbols, sounds and meaning. Through the use of interactive elements such as animations, audio pronunciations and dynamic visuals, students with dyslexia are able to develop phonological and orthographic understanding in a more systematic manner. Rowena Langbis (2021) explained that processing information through multiple senses simultaneously can enhance memory capacity and support longer term retention of learning.

A study by Norarifah Ali (2021), which involved the use of Malay language instructional materials based on a multisensory approach, found that students with dyslexia demonstrated significant improvements in letter recognition, syllable construction and early reading skills. These findings demonstrate that technology based multisensory approaches are not only relevant at the international level but also have substantial potential for wider implementation in special education in Malaysia particularly in the teaching of Malay language literacy.

4.3. Use of Assistive Technology and Multisensory Approaches in Enhancing the Motivation and Engagement of Students with Dyslexia

The subsequent discussion focuses on the use of mobile learning and digital games as mediums to enhance the motivation and level of engagement of students with dyslexia. The findings indicate that students with dyslexia demonstrate greater active engagement in learning when instructional content is delivered through mobile applications and interactive educational games (Ignacio et al., 2024).

Tan et al. (2022) found that game elements such as reward systems, immediate visual feedback and progressive levels of challenge help reduce the learning related stress often experienced by students with dyslexia. This approach enables students to focus on the learning process without excessive concern over making mistakes thereby contributing to increased intrinsic motivation and self-confidence. Such a fun and non-threatening learning environment indirectly supports more effective and sustained learning for dyslexic students.

In addition, the flexibility offered by mobile learning allows students with dyslexia to access learning materials outside formal instructional hours thereby supporting self-directed learning and self-repetition according to individual needs. Mohamad et al. (2025) reported that mobile technology based learning is able to enhance the long term engagement of students with dyslexia particularly when supported by the roles of teachers and parents.

4.4. Challenges in Implementing Technology in Special Education for Students with Dyslexia

Despite many research findings indicating the strong potential of technology in supporting the learning of students with dyslexia, various challenges remain in the use of technology and multisensory approaches for this group of learners. Lim et al. (2022) stated that among the main issues identified are

limitations in technological facilities, a lack of professional training and the level of teacher readiness to integrate technology effectively into teaching. Special education teachers often face difficulties in selecting and using appropriate technologies due to limited exposure, training and technical support. In addition, teacher's workload and time constraints also contribute to inconsistent use of technology in the classroom.

Furthermore, in the implementation of digital games in the classroom, one challenge faced by teachers is when the focus and learning objectives are placed more on motivation rather than student's long term academic achievement (Tan et al., 2022). This concern may result in delayed development or overly slow improvement in student's literacy skills. Augmented reality technology has been found to have potential in supporting the literacy and writing development of students with dyslexia through visual and interactive information delivery. This approach aligns with the principles of multisensory learning and has the potential to reduce student's cognitive load during language learning. However, Aborokbah (2021) and Najadat (2025) noted that most augmented reality and innovative technologies used are still at the prototype or early research stages. Therefore, further research is strongly needed to evaluate the actual effectiveness of these technologies in the context of special education at both international and Malaysian levels (Najadat, 2025; Ramlan et al., 2023).

In conclusion, the use of technology in special education teaching for students with dyslexia has the potential to produce positive impacts on student's literacy skills, motivation and engagement. Assistive technology, mobile learning, digital games and technology based multisensory approaches have been identified as effective teaching strategies when implemented systematically and supported by teacher training and comprehensive educational policies. However, the effectiveness of technology use does not rely solely on technological innovation but is also influenced by teacher readiness, school system support and suitability to the local context. Therefore, technology integration in special education should be implemented holistically and continuously to ensure that students with dyslexia receive optimal and inclusive learning support.

5. IMPLICATIONS OF THE STUDY

5.1. Teachers

Most of the research supports the notion that instructional strategies based on multisensory approaches and assistive technology can dramatically improve literacy outcomes for students with dyslexia. The ability to increase a language (phonological awareness) to read has been improved, helping students become more self-directed (Clement & Tosin, 2025; Pothuri & Kumar, 2025), through the assistive technology tools that support text-to-speech and educational applications. Multisensory approaches to instruction including engaging visual, auditory, kinesthetic and tactile modalities show positive results. A study found that these interventions not only enhanced reading skills but also led to a decrease in disruptive behaviours by increasing student engagement (Langbis, 2025). The evidence is of moderate to strong strength.

Some researchers do report academic gains in the area although the scale and number of gains varies a lot from skill to skill. Importantly, changes are frequently the greatest in the foundational skills such as decoding and word reading rather than in the higher-order skills such as reading fluency or comprehension indicating that teachers should develop accuracy and phonological skills over speed (Eryilmaz & Balci, 2025). Meanwhile, teachers must also move from the role of facilitator of technology-rich learning to one of tech-rich learners. Instead of simply teaching every instruction, effective teachers will guide students through teaching using tools that give the student individual practice and feedback. This methodology has already demonstrated similar gains to traditional instruction in at least one study (Middleton et al., 2025).

There are some major challenges, however. A great number of general educators feel ill-prepared to use specialized practices in dyslexia (Langbis, 2025). Multisensory materials may go unfunded due to time or resource shortage. A number of authors also cite socio-emotional barriers. Students may hold back from using the assistive technology in the classroom due to the stigma or even frustration of using the assistive technology. Teachers, then, also need to address students' emotional wellness, normalize assistive technology use as a matter of course and foster a growth mindset with students around dyslexia. Indeed, in long-term observation, a student's self-acceptance of their dyslexia and the assistive tools is essential to maintain the use (Almgren Bäck et al., 2024). Teachers need to build a supportive classroom environment and point out any stigma clearly. Like Clement and Tosin (2025) who found enhanced self-esteem and decreased classroom anxiety when assistive technology was accepted as standard in learning.

5.2. School Administrators

Implementing assistive technologies and multisensory strategies at school level demands robust administrative support. We find it important to be properly resourced and equipped in every one of these studies. Technical problems can be serious for assistive technology-based learning (Mohamad et al., 2025), so administrators must also make sure that schools have quality hardware (e.g., tablets and computers) and access to reliable internet or network. Such use of online platforms was linked to gains in dyslexic students' visual-perceptual and phonological skills during the COVID-19 pandemic, but only if these tools could be accessed without disruptions (Al-Dokhny et al., 2022).

Equitable access is crucial. Mohamad et al. (2025) point out that without redress for the digital divide, the returns from e-learning and mobile assistive applications will be uneven. Administrators should fund assistive tools for under-privileged classrooms and offer technical assistance to keep them properly functioning. Organizational continuity and planning are also important despite infrastructure. In Sweden, a five-year follow-up study revealed dyslexic students frequently cease using assistive technology when moving between levels or devices for reasons that extended beyond the immediate physical space and were often compounded by variability in support or access to the tools at hand (Almgren Bäck et al., 2024). This indicates that school leadership needs to have consistent policies for assistive technology. For example, when tablets are distributed, similar or compatible tools can be made available when students go to secondary school in addition to transfer of data or continuity of accounts. Administrators should assign frequent time for teachers to work together and plan lessons that would be differentiated.

Multisensory teaching materials development, tailored interventions and adaptation may be time consuming according to some authors (Langbis, 2025; Pujangga et al., 2024). Teacher preparation could be eased with some special designating dedicated periods or professional learning communities specifically for educators to share approaches, thereby alleviating the burden of preparation. In addition, strong school-home partnerships are stressed as central to success. In the Indonesian context, Pujangga et al. (2024) found that technology-supported reading interventions were more effective when the schools involved the parents and caregivers in helping to bring the practices home. The administrators would conduct workshops for parents on reading applications or assistive technologies and have them provided with a steady hand beyond the classroom. And it is important that school leaders be open to innovative models of service delivery.

One research demonstrated that a virtual co-teaching avatar could deliver a similarly structured dyslexia intervention to a single human specialist, potentially identifying a scalable pathway to overcome specialist teacher shortages (Middleton et al., 2025). Although such models using technology remain emergent, administrators might trial them to offer extra support to additional students. It is important to recognize that these recommendations come from a range of studies, varying from high-resource settings, such as Singapore (Tan et al., 2022), to lower-resource settings and often short-term trials. Administrators, therefore, should make changes on a trial basis and seek data in the context of

their school environment. By doing so, they can see the changes seen elsewhere and gains in both reading engagement or behavioral problems. To summarize, administration is enabled by the investments in infrastructure, scheduling and training. They facilitate the conditions whereby teachers and students really benefit from effective dyslexia interventions with fidelity.

5.3. Teacher Training Programmes

The research synthesis found that many of the challenges teachers encounter when supporting learners with dyslexia stem from insufficient training. Therefore, teacher education programmes and ongoing professional development initiatives should incorporate both the theoretical knowledge and the practical skills required to implement evidence-based intervention strategies for learners with dyslexia. A consistent finding across the reviewed studies is that teachers require a comprehensive understanding of phonemic awareness, phonics and morphological knowledge to support literacy development effectively. These components are consistently identified as the foundation of evidence-based reading interventions (Eryilmaz & Balçı, 2025; Asri et al., 2025). For example, a mobile application developed in Malaysia, based on the Orton–Gillingham approach and Structured Literacy principles, was designed in consultation with experts to address the learning needs of learners with dyslexia. The application organises instruction into structured modules focusing on phonology, syllables and meaning (Asri et al., 2025). This example reflects the pedagogical knowledge and instructional expertise that teachers require to deliver effective literacy instruction.

Teacher education programmes should ensure that pre-service teachers receive comprehensive preparation in evidence-based reading approaches, including the Orton–Gillingham approach, multisensory phonics instruction and other Structured Literacy practices. Such preparation should include compulsory coursework on the science of reading and specific learning difficulties, together with supervised opportunities to implement multisensory instructional strategies during teaching placements. In addition to pedagogical knowledge, teachers should also develop confidence and competence in using assistive technologies to support learners with dyslexia. Iliska and Gudonienė's (2025) analysis identified several key features of inclusive digital tools, including text-to-speech functionality, dyslexia-friendly fonts and content segmentation. These findings suggest that teacher education programmes should provide systematic training in the selection, implementation and integration of assistive technologies within classroom practice. Professional development programmes should further equip teachers with practical skills in using commonly adopted assistive technologies, such as screen readers, speech-to-text software and specialised educational applications, thereby ensuring that newly qualified teachers enter the profession with a sound foundation in assistive technology literacy.

Other studies indicate that teachers who have not received adequate training often underutilise, or fail to recognise, the assistive technologies and instructional accommodations available to support learners with dyslexia (Mohamad et al., 2025). Preparing teachers for the practical realities of classroom implementation is therefore equally important. For example, one study found that mainstream teachers experienced difficulties in providing multisensory support for learners with dyslexia because of behavioural management challenges and time constraints (Langbis, 2025). Consequently, teacher education programmes should equip pre-service teachers with strategies for differentiating instruction in mixed-ability classrooms, managing classroom behaviour effectively and developing multisensory teaching materials. Practical workshops, simulations and authentic classroom-based activities can further strengthen these competencies. For instance, training programmes may require teachers to design lesson plans incorporating low-cost multisensory resources, such as sandpaper letters and digital applications, while participating in role-play activities that simulate teaching learners with dyslexia who experience frustration during learning.

Several studies also recommend incorporating empathy and perspective-taking into teacher education programmes. Alcalde-Llargo et al. (2025) reported that adults who participated in a virtual

reality (VR) simulation of dyslexia, *The Magic Potion* game, demonstrated significantly higher levels of empathy towards learners with dyslexia. Similarly, exposure to simulations or first-hand accounts from individuals with dyslexia can enhance teachers' understanding of the emotional challenges associated with learning difficulties. Greater empathy may subsequently foster increased patience, persistence and responsiveness in classroom practice, enabling teachers to better understand why some learners experience anxiety, frustration or resistance during learning and to provide more appropriate educational support.

The need to strengthen teacher education programmes is supported by the consistent identification of teacher-related barriers across the reviewed studies, although direct experimental evidence evaluating teacher training interventions remains limited. Nevertheless, the convergence of recommendations across the literature provides a strong rationale for teacher education institutions and certification bodies to revise their curricula. Such revisions should also consider differences in educational contexts. In settings where access to assistive technologies is limited, teacher preparation may place greater emphasis on designing and producing low-cost multisensory teaching materials using locally available resources. Conversely, in technology-rich educational environments, greater attention may be given to integrating digital literacy tools, educational software, literacy games and artificial intelligence (AI)-supported learning applications into classroom practice (Fung et al., 2025). Ultimately, well-prepared teachers are more likely to implement evidence-based instructional strategies with confidence and consistency. Achieving this goal, however, requires sustained systemic investment in teacher preparation and continuing professional development.

5.4. Education Policymakers

As a result, at the policy level, the findings across these studies support the institutionalisation of support for learners with dyslexia by ministries of education and other regulatory authorities. A key implication is the need to prioritise funding and ensure equitable access to assistive technologies. The benefits of assistive technologies and specialised instructional approaches identified in the literature can only be realised on a large scale if schools are adequately equipped with the necessary resources, infrastructure and teacher training. Policymakers should therefore consider allocating dedicated funding or grants to support the implementation of inclusive educational technologies, particularly in schools with limited resources. This recommendation is consistent with the systematic review by Mohamad et al. (2025), which identified the digital divide as a major barrier to effective technology integration.

Many rural and low socioeconomic status (SES) schools lack access to assistive technologies and reliable internet connectivity, placing learners with dyslexia at a significant disadvantage. One possible policy initiative would be to provide assistive technology devices to learners identified with dyslexia or other learning disabilities through nationwide funding schemes. In addition to hardware, governments could subsidise subscriptions to literacy software and digital audiobooks. The rationale for such investment is supported by evidence demonstrating that learners with dyslexia show greater reading engagement and improved literacy independence when provided with assistive technologies, including text-to-speech applications and specialised electronic books (Clement & Tosin, 2025; Tan et al., 2022).

Another important policy implication concerns the establishment of accessibility standards and implementation guidelines for educational materials. As noted by Iliska and Gudonienė (2025), many mainstream digital learning platforms are not designed to accommodate the needs of learners with dyslexia, thereby limiting their accessibility and learning outcomes. Policymakers, including curriculum development agencies and educational technology authorities, could require newly developed digital learning materials to comply with dyslexia-friendly design principles, including appropriate font selection, adjustable text size and spacing, and integrated reading support features. These requirements could be incorporated into national educational technology standards or aligned with internationally recognised accessibility frameworks, such as the Web Content Accessibility Guidelines (WCAG), while

remaining responsive to local educational contexts. Establishing such standards would not only improve accessibility for learners with dyslexia but would also enhance the readability and usability of digital learning materials for all learners.

Policy should also promote long-term and translational research. Most interventions reported in the literature are pilot projects or short-term studies. Few have monitored learners' progress over an extended period, and even fewer have examined how successful interventions can be implemented and sustained at scale. Education ministries and research councils should therefore support longitudinal studies and school-wide implementation trials to evaluate long-term learner outcomes and system-level impacts. The importance of such research is reflected in the findings of Middleton et al. (2025), who demonstrated that technology could help address shortages of specialist teachers, and Almgren Bäck et al. (2024), who identified the factors influencing sustained assistive technology use over a five-year period. Such studies provide valuable insights into challenges that may not be captured through short-term evaluations. Continued investment in longitudinal research and teacher professional development is therefore essential to ensure that educational policies and practices remain evidence-informed.

Furthermore, educational policy should remain responsive to emerging technological developments. Artificial intelligence (AI) tools, such as ChatGPT, present both opportunities and challenges for educational practice. Fung et al. (2025) provide an instructive example through their evaluation of a ChatGPT-based writing assistant (CHATTING). Their findings indicate that the system improved student engagement and motivation in writing tasks but also resulted in lower formal writing performance and increased levels of unintentional plagiarism when students relied excessively on AI-generated content. These findings suggest that educational policy must evolve alongside technological innovation. Policymakers should therefore establish clear frameworks to guide the ethical and responsible use of AI in educational settings. AI has considerable potential to personalise learning for learners with dyslexia by providing immediate feedback and generating individualised practice activities. However, without appropriate policy guidance and educational oversight, excessive reliance on AI may undermine the development of essential literacy and critical thinking skills.

More broadly, many studies advocate embedding support for learners with dyslexia within national inclusive education policies. Such policies may include mandatory screening for dyslexia and other reading difficulties during the early years of primary education, together with equitable access to appropriate educational accommodations. It is also important to recognise that the studies included in this review were conducted across diverse national contexts, including Malaysia, Saudi Arabia, Lithuania, Spain, Singapore and Vietnam. Differences in educational systems, policy priorities and cultural perspectives on special education may influence the applicability of these findings. Consequently, policymakers should adapt international evidence to local educational contexts. In countries with high teacher-to-student ratios and limited access to specialist support services, policy priorities may include scalable educational technologies, strengthened teacher education programmes and multi-tiered systems of support.

In summary, policymakers play a pivotal role in expanding the implementation of evidence-based practices and addressing systemic barriers to inclusive education. Through equitable funding, accessibility standards, teacher education, continued research and clear guidance on emerging technologies, educational authorities can create conditions in which the benefits of assistive technologies and multisensory approaches extend beyond isolated pilot initiatives into mainstream educational practice. Although these recommendations are informed by the current evidence base, policy should remain flexible and evidence-informed, recognising that ongoing research is essential for refining strategies to support learners with dyslexia across diverse educational contexts.

6. LIMITATIONS OF THE STUDY

This systematic literature review acknowledges several limitations that should be considered when interpreting the findings from the 19 articles analysed. The review was limited to articles published between 2019 and 2025, focusing on recent developments in educational technology and multisensory approaches. Most studies analysed focused on short-term effects and specific educational contexts, limiting understanding of long-term effectiveness and applicability across diverse settings. The sample of 19 articles, while systematically selected through PRISMA guidelines, represents a focused corpus that may not capture the full breadth of interventions currently being employed globally.

The thematic analysis identified four distinct themes with uneven distribution: eight articles addressed assistive technology effectiveness, four examined multisensory approaches, five focused on motivation and engagement, and six reported implementation challenges. This unequal distribution may have influenced the depth of analysis within each theme. The geographic and linguistic diversity of the selected articles showed limitations in contextual representation. While two Malaysian studies (Ramlan et al., 2023; Ali, 2022) provided important local context for Malay language interventions, the majority originated from other contexts. This limits the generalizability of findings to educational systems with different infrastructure capabilities, linguistic characteristics and cultural approaches to special education. Furthermore, the articles demonstrated limited coverage beyond primary and secondary education levels. Research examining integration of these approaches at the higher education level and their effects on adult learners with dyslexia remains limited.

A significant limitation concerns the maturity level of technologies examined. Aborokbah (2021) and Najadat (2025) noted that most augmented reality and innovative technologies are still at prototype or early research stages. This means several findings reflect potential effectiveness rather than proven outcomes from mature, widely available technologies. The 19 articles employed diverse methodological approaches including experimental designs, qualitative studies and mixed-methods research. This methodological heterogeneity created challenges for direct comparison and synthesis of findings. The studies varied in sample sizes, intervention durations, outcome measures and analytical approaches, making it difficult to draw definitive conclusions about relative effectiveness.

The challenges theme revealed significant limitations regarding implementation contexts. Lim et al. (2022) identified limitations in technological facilities, teacher readiness levels and insufficient professional training as major barriers. These implementation challenges suggest that effectiveness findings may reflect optimal conditions rather than typical real-world settings where resource constraints and infrastructure gaps are common. In addition, Tan et al. (2022) noted that emphasis on motivation may overshadow long-term academic achievement when digital games are implemented in classrooms, potentially resulting in delayed literacy skill development. The review also identified insufficient attention to user-centred design in technology development. Among the 19 articles, limited research examined how technologies were designed with direct input from students with dyslexia, their teachers and families. This limits confidence that the technologies examined truly address authentic needs rather than assumptions about what might be helpful.

7. RECOMMENDATIONS FOR FUTURE RESEARCH

Based on the analysis of the 19 articles and research gaps identified in this systematic literature review, several directions for future investigation are recommended.

7.1. Longitudinal Research on Long Term Effectiveness

Most studies reviewed focused on short-term effects and specific educational contexts, limiting understanding of long-term effectiveness. Future research should conduct longitudinal studies that track students with dyslexia over multiple academic years. Such studies should examine whether literacy improvements, motivational benefits and engagement increases are sustained over time or require

ongoing intervention. These investigations would provide evidence about the durability of intervention effects and inform decisions about optimal intervention intensity and duration.

7.2. Expansion to Higher Education and Adult Learners

Research related to integration of these approaches at the higher education level and their effects on adult learners with dyslexia remains limited. Future investigations should examine how assistive technologies and multisensory approaches support academic literacy, disciplinary reading and writing, and professional skill development for college students and adult learners. This would extend the evidence base beyond the primary and secondary education focus evident in the reviewed articles.

7.3. Cross-contextual and Multilingual Research

While the review included Malaysian studies examining Malay language interventions (Ramlan et al., 2023; Ali, 2022), future research should expand to include more diverse educational systems, languages and cultural contexts. Studies examining how orthographic characteristics of different languages influence the effectiveness of specific assistive technologies would address important questions about cross-linguistic applicability. The discussion noted that assistive technology effectiveness is more optimal when development and implementation take into account language, cultural aspects and local needs. Future research should build on this finding through comparative studies across languages with varying orthographic transparency.

7.4. Technology Validation and Maturity Research

Aborokbah (2021) and Najadat (2025) noted that most augmented reality and innovative technologies remain at prototype or early research stages. Future research should include rigorous validation studies of augmented reality, virtual reality and other emerging technologies as they mature from prototype to production stages. These studies should employ robust experimental designs with adequate sample sizes, appropriate control conditions and validated outcome measures to establish efficacy beyond proof-of-concept demonstrations.

7.5. User-centered Design Research

Future research should employ participatory design methodologies that involve students with dyslexia, their teachers and families directly in technology development and refinement. This research should systematically investigate the authentic challenges students face and co-design solutions that address real barriers to learning. User-centered design research would ensure technologies are pedagogically sound, practically usable and meaningfully supportive from students' perspectives.

7.6. Implementation Research

Lim et al. (2022) identified critical barriers including limitations in technological facilities, lack of professional training and teacher readiness levels. Future research should examine effective models of teacher professional development, sustainable technology integration strategies and school-wide systemic support structures. Research should investigate how to overcome difficulties special education teachers face in selecting and using appropriate technologies and compare different professional development approaches to identify which models most effectively build teacher capacity while addressing time constraints and workload pressures.

7.7. Research Balancing Motivation and Academic Achievement

Tan et al. (2022) raised concern that digital game implementation may prioritize motivation over students' long-term academic achievement, potentially resulting in delayed literacy skill development. Future research should examine optimal designs for educational games and mobile applications that

simultaneously enhance motivation while producing measurable literacy gains. Studies should investigate how to structure interventions that balance engagement features with instructional rigor.

7.8. Broader Outcomes Research

While the reviewed articles identified four main themes focused on literacy skills, learning styles, motivation and implementation challenges, future research should expand outcome measures to include social-emotional development, peer relationships, academic self-concept and long-term educational and career trajectories. This would provide a more comprehensive understanding of how technology and multisensory approaches influence broader developmental and life outcomes.

8. CONCLUSION

This systematic literature review examined 19 empirical studies published between 2019 and 2025 that investigated the use of technology-enhanced instruction and multisensory approaches for students with dyslexia. Overall, the findings demonstrate that assistive technologies, mobile learning applications, digital games and technology-based multisensory approaches can make a significant contribution to improving literacy development, learner motivation and engagement. Collectively, the evidence suggests that technology, when integrated appropriately into instructional practice, can enhance the quality and inclusiveness of learning experiences for students with dyslexia.

The reviewed studies consistently reported that assistive technologies improve reading accuracy, fluency, comprehension and pronunciation by providing personalised and adaptive learning experiences tailored to individual learner needs. Similarly, technology-supported multisensory approaches were found to reinforce the relationship between letters, sounds and meaning through the simultaneous engagement of multiple sensory modalities. Furthermore, mobile learning and game-based applications created more interactive, flexible and learner-centred environments, thereby enhancing students' motivation, confidence and interest in learning.

Despite these positive outcomes, the review also identified several challenges that may hinder the effective implementation of technology in educational settings. Common barriers included limited access to technological infrastructure, insufficient teacher training, time constraints and inadequate technical support. These findings indicate that technology alone cannot guarantee improved learning outcomes. Rather, its effectiveness depends on teachers' pedagogical readiness, institutional support and the provision of sustained professional development. Studies conducted in Malaysia further emphasised the importance of adapting technological interventions to local linguistic, cultural and educational contexts to maximise their effectiveness.

The review also identified several gaps in the existing literature. There remains a need for longitudinal research to examine the long-term effectiveness of technology-based interventions, as well as studies involving higher education and adult learners with dyslexia. In addition, further empirical evaluation of emerging technologies is required, particularly those that remain at an early stage of development. Future research should also adopt user-centred design principles and place greater emphasis on implementation processes to ensure that technological innovations address authentic classroom needs and can be effectively integrated into educational practice.

In conclusion, technology has considerable potential to enhance literacy learning for students with dyslexia when it is systematically integrated into evidence-based instructional practices and supported by appropriate teacher training, institutional commitment and educational policy. A holistic, context-sensitive and sustainable approach to technology integration is therefore essential to promote inclusive, meaningful and equitable learning opportunities for students with dyslexia.

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