Enhancing Literacy for Dyslexic Learners: A Review of Structured, Multisensory, and Technological Approaches

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Abstract

Dyslexia is a lifelong learning disorder that affects reading, writing, and spelling, primarily due to difficulties with phonological processing. This literature review explores key interventions designed to support dyslexic learners, with a focus on structured literacy programs like Orton-Gillingham and Wilson Reading System, which provide systematic, explicit instruction in phonological awareness and reading fluency. Multisensory approaches, engaging sight, sound, and movement, further strengthen literacy skills by helping learners form stronger connections between sounds and letters. Additionally, technology-assisted tools such as text-to-speech and speech-to-text software, along with programs like Lexia, offer personalized, adaptive learning experiences, fostering greater independence and confidence. The review underscores the importance of early identification and ongoing support, as early intervention can significantly improve both academic performance and emotional well-being. However, long-term support is crucial to sustaining these gains throughout a learner's education. Despite progress, gaps in current research remain, particularly in addressing the needs of adult dyslexic learners, developing culturally responsive interventions, and scaling individualized programs for wider application. In conclusion, this review

highlights the need for early screening, effective interventions, and the integration of technology to improve educational outcomes for dyslexic learners. It calls for further research into scalable, culturally adaptive models and the long-term impact of interventions to ensure dyslexic learners receive the comprehensive support they need across diverse educational settings.

Keywords: Dyslexia, Structured literacy, Multisensory learning, Educational interventions, Technology-assissted tools

Introduction

Dyslexia is a multifaceted, neurological learning disorder that deeply impacts an individual's ability to read, write, and spell. These challenges arise from deficits in phonological awareness and processing, making it difficult to recognise and decode written text (Catts et al., 2024). Dyslexia persists throughout life, manifesting in ongoing difficulties with tasks such as word decoding, reading fluency, comprehension, and retaining verbal information. Despite advances in understanding the neurobiological underpinnings of dyslexia, there remains a significant gap in educational strategies and interventions to support dyslexic learners effectively (Roitsch & Watson, 2019). This paper seeks to address this gap by exploring various educational principles, strategies, and interventions aimed at improving learning outcomes for individuals with dyslexia, particularly in structured educational settings.

At the heart of dyslexia are challenges in phonological processing, which encompass difficulties in identifying, manipulating, and recalling sound-letter correspondences (Snowling, Hulme, et al., 2020). Consequently, dyslexic learners face persistent obstacles in reading fluency, comprehension, and vocabulary acquisition. These challenges extend to broader cognitive functions, such as working memory, processing speed, and long-term information retrieval(Peng et al., 2022). Research indicates that dyslexic learners often exhibit slower verbal working memory, which hinders their ability to hold and manipulate language-based information in real time(Ullman et al., 2020). Additionally, rapid automatic naming—quickly identifying familiar objects or letters—further exacerbates these challenges in processing and recalling written and spoken language (Snowling, Hayiou-Thomas, et al., 2020). These deficits underscore the importance of early diagnosis and tailored interventions to mitigate the long-term impact on both academic and social development.

Consistently, research highlights the crucial role of early identification and intervention in managing dyslexia effectively. Early detection greatly increases the chances of positive academic outcomes by enabling timely and targeted support that addresses the specific needs of dyslexic learners (Snowling, Hayiou-Thomas, et al., 2020). Diagnostic tools, such as the Woodcock Reading Mastery Tests-Revised (WRMT-R) (Jiang et al., 2024; Woodcock, 1973) and the Clinical Evaluation of Language Fundamentals (CELF-5) (Sepulveda et al., 2021; Wiig et al., 2013), assess key phonological skills, language proficiency, and reading abilities (Rahul & Ponniah, 2021). For instance, Bowyer Crane (Bowyer-Crane et al., 2008) found that early interventions focused on phoneme awareness and letter-sound correspondence led to measurable improvements in reading and spelling abilities among at-risk children. These findings underscore the essential role early, structured intervention plays in preventing persistent academic difficulties and ensuring that learners with dyslexia receive the support they need to thrive (Tarvainen et al., 2020).

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However, while early intervention is vital, many dyslexic learners require long-term, ongoing support (Sanfilippo et al., 2020). Dyslexia is not a condition that can be 'cured' through short-term interventions; it necessitates sustained educational strategies and psychosocial care (Rahul & Ponniah, 2021). Personalised educational plans, tailored to the specific needs, strengths, and learning styles of dyslexic learners, have proven to be highly effective in promoting academic success (Ozernov-Palchik et al., 2019). These plans typically incorporate multisensory instructional methods, structured literacy programmes, and repeated practice, all aimed at helping learners achieve fluency in reading and writing tasks (Butler, 2022). Flexibility is key in these approaches, allowing educators to adjust teaching methods based on each learner's progress and challenges (Rahul & Ponniah, 2021).

Multisensory teaching approaches, which engage the auditory, visual, kinesthetic, and tactile senses, have been particularly effective in supporting dyslexic learners (Kelly & Phillips, 2022). By involving multiple sensory pathways, these approaches strengthen the connections between sounds, letters, and meanings, making it easier for learners to process and retain language-based information. Research demonstrated that learners who received multisensory instruction experienced significant improvements in phonological awareness, reading fluency, and comprehension compared to those taught using traditional literacy methods (Joshi et al., 2002; Parisi et al., 2022). This underscores the effectiveness of multisensory techniques in addressing the core difficulties of dyslexia and supporting learners in overcoming these challenges.

Similarly, structured literacy approaches play a pivotal role in dyslexia education by offering explicit, systematic, and sequential instruction in phonology, morphology, syntax, and semantics (Fallon & Katz, 2020). Programmes such as the Wilson Reading System (Wilson, 1988), Lindamood Phoneme Sequencing Program (Lindamood & Lindamood, 1998), and Direct

Instruction Reading (Carnine et al., 1997), guide dyslexic learners in decoding and processing language through repetition and practice, ultimately enhancing reading fluency, comprehension, and overall language proficiency(Rahul & Ponniah, 2021).

In addition to these instructional strategies, overlearning—practising skills beyond mastery—is crucial in reinforcing literacy skills for dyslexic learners(Minoofam et al., 2022). Repeated practice ensures that language rules are not only acquired but also retained and applied across different contexts. Overlearning fosters automaticity, enabling dyslexic learners to internalise and use language skills confidently and fluently (Shaywitz & Shaywitz, 2020).

In recent years, technology-assisted interventions have emerged as powerful tools in supporting dyslexic learners, offering personalised solutions that address specific reading, writing, and spelling difficulties (Lerga et al., 2021). Assistive technologies such as text-to-speech (TTS) and speech-to-text (STT) software provide learners with alternative ways to process and produce language, compensating for phonological processing deficits. These tools not only improve literacy skills but also reduce cognitive load, allowing students to focus on comprehension rather than decoding (Matre, 2024). Additionally, computer-assisted instructional programs, like *Lexia Core5 Reading* program and *Read&Write*, have been shown to significantly enhance phonological awareness, reading fluency, and comprehension through structured and adaptive learning environments (Base, 2023; Matre, 2024). Beyond academic improvements, these technologies foster a greater sense of independence, self-confidence, and motivation, which are critical for long-term engagement and success in learning (Lerga et al., 2021). However, challenges remain in ensuring equitable access to these technologies and in providing adequate training for educators to integrate these tools effectively into their teaching practices (Dawson et al., 2019).

This paper explores the most effective educational interventions for supporting dyslexic learners. By reviewing current research on teaching methodologies, learning strategies, and assistive technologies, it aims to provide a comprehensive understanding of how to best support dyslexic learners in structured educational environments. The primary focus is on the importance of early identification, personalised educational plans, and integrating modern technologies to foster academic success and positive long-term learning outcomes for individuals with dyslexia.

Theoretical Framework and Models of Dyslexia

Understanding dyslexia through different theoretical frameworks is essential for developing effective educational interventions. Several key models explain the cognitive, linguistic, and

neurological factors that contribute to dyslexia, each offering insights into the nature of the disorder and informing targeted educational strategies. Among the most widely accepted theories is the Phonological Deficit Hypothesis, which posits that dyslexia primarily stems from difficulties in phonological processing — the ability to recognize and manipulate the sound structures of language (Peng et al., 2022).Dyslexic learners often struggle with phonemic awareness, a skill crucial for decoding words. According to Snowling (Snowling, Hulme, et al., 2020), these phonological deficits underlie many of the reading difficulties experienced by dyslexic individuals, such as issues with word recognition, reading fluency, and spelling accuracy.

The Phonological Deficit Hypothesis has significant implications for education, where phonics-based instruction becomes central to intervention strategies. Programs like Orton-Gillingham (Orton, 1966) and the Wilson Reading System (Wilson, 1988) employ systematic, explicit instruction to improve phonological awareness and word decoding skills, especially when implemented early in a child's education (Catts et al., 2024). However, while this model addresses key aspects of dyslexia, it does not account for the full range of cognitive and perceptual challenges faced by dyslexic learners, leading researchers to explore additional theories.

In addition to phonological processing, theories around visual and auditory processing provide further insights. Visual processing theories suggest that some dyslexic learners struggle with tracking letters and words on a page or perceiving their orientation, which may be linked to deficits in the magnocellular pathway responsible for processing spatial information (Stein, 2023). Some educational interventions for visual processing deficits, such as coloured overlays or lenses, have been suggested to reduce visual stress (Evans, 2021; Evans & Allen, 2016). Meanwhile, auditory processing theories propose that some dyslexic individuals have difficulty processing rapid sequences of sounds, affecting their ability to decode spoken language into phonetic components (ElShafaei et al., 2022). Programs like Fast ForWord, which focus on improving auditory discrimination, target these challenges. However, both visual and auditory processing theories are generally viewed as supplementary to the phonological model, as neither fully explains the broad reading difficulties experienced by dyslexic learners (Norton et al., 2019).

The cognitive and neurological perspectives offer a more comprehensive understanding of dyslexia by integrating findings from cognitive neuroscience, which reveal structural and functional differences in the brains of dyslexic individuals. Neuroimaging studies show atypical activation patterns in brain areas responsible for reading and language processing, such as the left temporoparietal cortex (Shaywitz & Shaywitz, 2020). Cognitive models, like the double-deficit hypothesis (Carioti et al., 2021; Wolf & Bowers, 1999), suggest that in addition to phonological deficits, many dyslexic learners struggle with rapid automatic naming (RAN), the

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ability to quickly name familiar objects or letters. It is also highlighted that learners who exhibit both phonological and RAN deficits often experience more severe reading challenges, necessitating multifaceted interventions (Norton et al., 2019).

Educational approaches informed by cognitive and neurological research emphasize the need for individualized, evidence-based interventions (Mather & Wendling, 2024). Programs like Lindamood-Bell's Visualizing and Verbalizing combine phonological training with cognitive processing strategies, using multisensory instruction to strengthen both language and cognitive skills (Sultana, 2021). Additionally, neuroplasticity research shows that with targeted intervention, the brain can develop alternative neural pathways, offering potential for long-term improvements in reading skills (Wolf et al., 2024).

These theoretical models offer critical insights into educational interventions for dyslexia. While the Phonological Deficit Hypothesis highlights the importance of phonics instruction, visual and auditory processing theories underscore the need for interventions that address perceptual deficits, often complementing phonological approaches. The cognitive and neurological perspectives provide a broader understanding of how dyslexia impacts not only language skills but also other cognitive functions, such as working memory, processing speed, and rapid naming. Together, these models suggest that effective educational strategies must be flexible and personalized to accommodate the diverse needs of dyslexic learners.

In addition to these theoretical insights, it is crucial to recognize that dyslexic learners face a range of challenges beyond reading difficulties. Many experience working memory deficits, which impact their ability to hold and manipulate information during language tasks, as well as slow processing speed and difficulties with rapid naming, all of which hinder reading fluency and verbal expression. These cognitive barriers often lead to academic underperformance, despite learners' intellectual potential, and are compounded by emotional difficulties like anxiety and low self-esteem. Addressing these broad challenges requires interventions that go beyond phonological training to incorporate cognitive and emotional support. In the next section, we will explore these challenges in greater depth, examining their impact on academic performance and personal development.

Challenges Faced by Dyslexia Learners

Dyslexic learners face a broad spectrum of challenges that go beyond the well-known difficulties with reading, writing, and spelling (Catts et al., 2024). These challenges can be grouped into cognitive, linguistic, and emotional domains, each of which plays a crucial role in shaping the learner's academic performance and personal development (Rahul & Ponniah,

2021). This section delves deeper into these challenges, highlighting the specific difficulties dyslexic learners encounter and their long-term impact on academic and social success.

- **Phonological Processing Deficits**

At the heart of dyslexia lies a fundamental difficulty with phonological processing, which refers to the ability to recognize and manipulate the sound structures of language (Peters et al., 2020). Many dyslexic learners struggle with phonemic awareness, a key skill for decoding words and grasping the relationships between sounds and letters (Žovinec et al., 2023). These deficits in phonological processing hinder reading fluency, word recognition, and spelling accuracy (Catts et al., 2024). Without timely and targeted interventions, these challenges persist, affecting a learner's ability to develop foundational literacy skills that are essential for more complex academic content as they progress through school (Peng et al., 2022; Vellutino et al., 2004).

This issue is further compounded in traditional educational environments, where reading and writing are often the primary means of instruction (Chen, 2021). While phonics-based interventions—which emphasize sound-letter correspondences—can alleviate some of these challenges, many dyslexic learners still face difficulties, particularly when they are required to rapidly decode text under time pressure. This adds another layer of difficulty, often complicating their academic journey (Bowyer-Crane et al., 2008; Snowling, Hayiou-Thomas, et al., 2020).

- **Working Memory Issues**

In addition to phonological processing difficulties, dyslexic learners often struggle with working memory—the cognitive system responsible for holding and manipulating information temporarily (Kızılaslan & Tunagür, 2021). Working memory is vital for tasks like reading comprehension, following multi-step instructions, and problem-solving. Research shows that dyslexic learners typically have weaker working memory, making it harder to retain and process language-based information efficiently (Peng et al., 2022).

For instance, a dyslexic learner might find it challenging to retain several pieces of information while decoding a sentence, leading to slower reading and reduced comprehension (Catts et al., 2024). These working memory limitations can significantly slow down the learning process, creating obstacles in academic settings where students are expected to quickly absorb and process large amounts of information(Alloway & Carpenter, 2020). Effective interventions that target both working memory and phonological deficits have been shown to provide more comprehensive support, addressing these interconnected cognitive challenges (Ullman et al., 2020).

- **Emotional and Motivational Challenges**

The cognitive and linguistic difficulties faced by dyslexic learners often take a toll on their emotional well-being. Many students with dyslexia experience anxiety, frustration, and low self-esteem as they struggle with reading and writing tasks (Sanfilippo et al., 2020). These emotional responses can lead to disengagement from academic activities, particularly when learners feel overwhelmed or incapable of keeping up with their peers (Rahul & Ponniah, 2021). Over time, these feelings can spiral into a broader sense of academic inadequacy, reinforcing negative self-perceptions and reducing their motivation to engage with schoolwork (Rahul & Ponniah, 2021).

Moreover, the social implications of these emotional challenges can be profound. Many dyslexic learners avoid participating in activities like reading aloud or contributing to classroom discussions for fear of making mistakes, which may lead to social isolation and further emotional difficulties (Ozernov-Palchik et al., 2019). Without adequate support, the emotional stress associated with dyslexia can have lasting impacts, reducing learners' motivation, increasing dropout rates, and limiting career opportunities in adulthood (Tarvainen et al., 2020).

- **Long-Term Academic and Social Implications**

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The combined effects of phonological deficits, working memory challenges, and emotional struggles have significant long-term academic and social consequences for dyslexic learners (Rahul & Ponniah, 2021). Academically, students with dyslexia are at a higher risk of underperforming in literacy-heavy subjects, which can have a detrimental impact on their overall academic trajectory. These difficulties often persist into higher education and even into professional settings, where reading and writing are integral to communication and success (Shaywitz & Shaywitz, 2020).

Socially, dyslexic learners may experience feelings of alienation or embarrassment due to their literacy difficulties. This often leads to reduced participation in group activities, fostering a cycle of avoidance that further erodes self-confidence and deepens their disengagement from learning (Anuradha, 2022). Without interventions that address both the cognitive and emotional dimensions of dyslexia, these learners are at a higher risk of long-term negative outcomes, such as diminished academic achievement, lower self-esteem, and restricted career prospects (Peng et al., 2022).

Recognizing the complex challenges faced by dyslexic learners underscores the need for comprehensive interventions. Traditional one-dimensional approaches often fall short of addressing the full range of cognitive and emotional struggles dyslexic individuals experience. Increasingly, multisensory approaches have been identified as an effective solution. These strategies engage multiple senses—visual, auditory, kinesthetic, and tactile—allowing learners to process language in a more accessible and meaningful way. By addressing not only phonological and working memory deficits but also fostering emotional and motivational engagement, multisensory approaches offer a promising path forward. In the next section, we

will explore how these multisensory interventions are designed and implemented, and their pivotal role in improving both academic outcomes and learners' confidence, ultimately leading to lasting success.

Educational Interventions: Multisensory Approaches

Multisensory approaches have gained widespread recognition as highly effective strategies for supporting dyslexic learners, offering alternative ways to engage with and retain language (Becker, 2023). These approaches are grounded in cognitive and educational research, utilizing multiple senses—such as visual, auditory, kinesthetic, and tactile pathways—to enhance learning. By engaging various sensory modalities, multisensory methods help dyslexic learners strengthen the connections between sounds, letters, and meanings, significantly improving their ability to process and retain language-based information (Butler, 2022).

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Multisensory learning taps into the brain's natural ability to absorb information through different sensory inputs, making it particularly beneficial for learners who struggle with traditional instructional methods (Supriatna & Ediyanto, 2021). For instance, auditory learners benefit from hearing sounds and words aloud, while visual learners may gain from seeing letters or words represented in colours or charts. Kinesthetic learners, who learn best through hands-on activities, can engage in exercises such as tracing letters in sand or using physical manipulatives to reinforce letter-sound associations (Kelly & Phillips, 2022).

One of the most effective and widely recognized multisensory programs is the Orton-Gillingham approach (Orton, 1966), which was specifically designed to support students with dyslexia. This method, developed in the 1930s, employs a structured, sequential approach to teaching reading and writing by integrating auditory, visual, and kinesthetic modalities (Stevens et al., 2021). For example, learners might trace letters in the air while simultaneously saying the corresponding sound, reinforcing the connection between its visual representation and auditory cue (Orton, 1966). Similarly, the Wilson Reading System also employs a multisensory approach, breaking language down into smaller, manageable parts while emphasizing repeated practice of sound-letter correspondences. Students participating in the Wilson Reading System show significant improvements in reading fluency, comprehension, and phonological awareness (Butler, 2022).

Research consistently supports the effectiveness of multisensory instruction. found that dyslexic learners who received multisensory instruction showed significant gains in reading fluency and comprehension compared to those taught with traditional methods (Parisi et al., 2022). The researchers attribute these improvements to the fact that multisensory techniques

engage learners through multiple pathways, enabling them to build stronger neural connections involved in reading and language processing.

In addition to formal programs like Orton-Gillingham and Wilson, educators are increasingly incorporating multisensory strategies into everyday classroom practices. For example, teachers may use coloured markers to differentiate vowel sounds or rhythmic clapping to help students break words into syllables. These simple yet effective strategies align with the principles of multisensory learning, offering alternative routes for processing language (Joshi et al., 2002).

A well-documented case study by Butler (Butler, 2022) demonstrated the success of the Orton-Gillingham method in a classroom of dyslexic learners, revealing that students not only improved their reading and spelling skills but also gained increased confidence in their academic abilities. By integrating tactile, auditory, and visual stimuli, students found language learning more engaging and accessible. Similar success has been documented in studies on the Wilson Reading System (Wilson, 1988), which has been particularly effective in improving decoding and word recognition skills (Fallon & Katz, 2020).

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Beyond academic improvements, multisensory approaches positively impact learners' emotional and motivational engagement. By making learning more interactive and less intimidating, these methods can reduce the anxiety and frustration commonly experienced by dyslexic learners, while also enhancing their sense of accomplishment (Shaywitz & Shaywitz, 2020). This emotional engagement is crucial for long-term success, as fostering a positive learning experience helps build confidence and resilience in dyslexic learners.

In summary, multisensory approaches offer a comprehensive method for addressing the multifaceted challenges faced by dyslexic learners. Programs like Orton-Gillingham and the Wilson Reading System, as well as everyday classroom strategies, provide learners with multiple sensory pathways to better understand and retain language-based information (Rahul & Ponniah, 2021). The substantial body of research supporting the effectiveness of these methods demonstrates significant improvements in reading fluency, comprehension, and phonological awareness. Moreover, multisensory approaches not only target the cognitive difficulties associated with dyslexia but also promote emotional well-being and motivation, empowering learners to achieve lasting academic success.

While multisensory approaches are highly effective, they achieve even greater results when integrated into a structured literacy framework. Structured literacy emphasizes explicit, systematic instruction, offering dyslexic learners the consistency and step-by-step teaching they need to develop foundational literacy skills. In the next section, we will explore how Structured Literacy and Explicit Instruction work in tandem with multisensory techniques to provide a

comprehensive approach to helping dyslexic learners overcome their literacy challenges and achieve long-term success.

Structured Literacy and Explicit Instruction

Structured literacy approaches have become a cornerstone in supporting dyslexic learners by providing them with explicit, systematic, and sequential instruction tailored to their unique needsc(Spear-Swerling, 2022). These approaches focus on breaking down language into its fundamental components—phonology, morphology, syntax, and semantics—ensuring that learners receive clear, step-by-step guidance in building their reading skills. Unlike traditional reading instruction, which often relies on natural exposure to text, structured literacy leaves nothing to chance. It ensures that every critical aspect of reading is taught explicitly, helping dyslexic learners progress at a pace that suits their abilities (Mather & Wendling, 2024).

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The key principles of structured literacy emphasize direct instruction in phonological awareness, decoding, spelling, and reading comprehension (Fallon & Katz, 2020). Each skill is introduced in a logical sequence, allowing learners to master one concept before moving on to the next. This method proves especially effective for dyslexic learners, who may struggle with the complex, layered processes involved in reading and writing. Structured literacy breaks these processes down into manageable steps, enabling learners to build their skills progressively and confidently (Moats & Brady, 2000; Smith et al., 2021). Additionally, the repetition and practice inherent in these programs reinforce understanding and improve retention, which is critical for students with learning difficulties.

Several well-known programs exemplify structured literacy in action, including the Lindamood Phoneme Sequencing Program (LiPS) (Lindamood & Lindamood, 1998) and Lindamood-Bell Visualizing and Verbalizing (Bell & Lindamood, 1991). The LiPS program is designed to address phonological awareness by helping students recognize and manipulate individual sounds in words (Colon, 2005). This is a crucial skill for dyslexic learners, who often struggle with identifying and using the sounds of language. LiPS teaches learners to become aware of the physical sensations associated with sound production, helping them decode and spell more effectively (Freeman, 2023).

Meanwhile, Lindamood-Bell Visualizing and Verbalizing takes a more holistic approach by engaging both phonological and cognitive skills. The program uses imagery to enhance comprehension, encouraging learners to create mental pictures of language concepts. This technique helps students better understand and retain what they read by linking visual and verbal cues, making language more concrete and accessible (Sultana, 2021).

The research supporting structured literacy is robust. Studies found that students receiving structured literacy instruction demonstrated significant improvements in decoding, fluency, and reading comprehension compared to those taught using less structured methods (Fallon & Katz, 2020). The clear, explicit nature of structured literacy ensures that dyslexic learners receive the targeted support they need, resulting in measurable progress. The difference between structured literacy and traditional reading instruction is stark (Spear-Swerling, 2019): while traditional methods may assume that students will naturally pick up reading skills through exposure, structured literacy makes no such assumptions. Instead, it provides direct teaching of each component of language, ensuring that no aspect of reading is left unaddressed (Smith et al., 2021).

Beyond the academic benefits, structured literacy also has a positive impact on learners' confidence and motivation (Spear-Swerling, 2019). The methodical, step-by-step approach allows dyslexic students to experience success in small, incremental steps, building their self-esteem as they master each new skill. This sense of accomplishment is critical, as many dyslexic learners face significant emotional challenges linked to their difficulties with reading (Mather & Wendling, 2024). By providing a structured path to success, these programs not only improve literacy skills but also foster emotional resilience.

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While structured literacy programs like LiPS and Visualizing and Verbalizing have proven highly effective on their own, they can be further enhanced through the use of technology. Digital tools and programs such as Lexia and Read&Write offer personalized, computer-assisted instruction that complements structured literacy by providing additional practice and adaptive learning paths tailored to each student's progress (Lerga et al., 2021). In the next section, we will explore how Technology-Assisted Interventions can complement structured literacy approaches by offering innovative, tailored solutions to further enhance the learning experience for dyslexic students.

Technology-Assisted Interventions

In recent years, technology has revolutionized how educators support dyslexic learners, offering innovative tools that address the specific challenges they face in reading, writing, and spelling (Javed et al., 2024). Assistive technologies and digital tools have opened up new pathways for students to engage with content, allowing them to process language in ways that suit their individual needs (Modi & Singh, 2022). These technologies not only ease the burden of decoding and writing but also empower dyslexic learners to focus on understanding and

mastering content, leading to improved academic performance and greater confidence (Matre, 2024).

One of the most effective assistive technologies for dyslexic learners is text-to-speech (TTS) software, which converts written text into spoken words. For learners who struggle with decoding, TTS allows them to absorb complex material through listening, a skill they often find much easier (Bhola, 2022). This technology helps students stay engaged with reading tasks and participate more fully in academic discussions without being limited by their reading difficulties (Dawson et al., 2019). Another essential tool is speech-to-text (STT) software, which converts spoken language into written text. This enables dyslexic students to bypass the challenges of spelling and handwriting, allowing them to focus on expressing their thoughts more clearly and confidently (Bhola, 2022).

In addition to these tools, computer-assisted instructional programs like Lexia and Read&Write have become indispensable for many dyslexic learners (Anjum & Bhatti, 2022). Lexia provides adaptive learning, focusing on essential literacy skills like phonological awareness, fluency, and comprehension. The program adjusts based on each learner's progress, offering personalized instruction that supports students at their own pace (Lerga et al., 2021). Read&Write is another powerful tool, offering features like TTS, word prediction, and grammar support, helping students produce written work with more ease and independence. These programs not only reinforce the structured literacy skills dyslexic learners need but also offer the flexibility and repetition that are crucial for mastery (Base, 2023).

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The effectiveness of these technologies is well-documented. Research shows that students using Lexia and Read&Write experience significant gains in phonological awareness, reading comprehension, and overall literacy skills (Lerga et al., 2021). The individualized nature of these tools allows learners to revisit challenging concepts as needed, creating a supportive environment where they can build their skills without pressure. Additionally, the ability to use these technologies both in school and at home extends learning beyond the classroom, giving students extra opportunities to practice and strengthen their reading abilities (van der Leij, 2020).

Beyond academic improvements, technology offers important emotional and motivational benefits for dyslexic learners. Traditional methods of reading and writing can often leave students feeling frustrated and discouraged, contributing to a lack of engagement and low self-esteem (Matre, 2024; Spear-Swerling, 2019). However, assistive technologies provide a sense of independence, enabling students to tackle assignments and access materials without constant support (Anjum & Bhatti, 2022). This boost in autonomy can lead to greater confidence, increased motivation, and a more positive attitude toward learning (Lerga et al., 2021). The interactive and engaging nature of these digital tools also makes learning more

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enjoyable, helping to reduce the anxiety often associated with reading and writing tasks (Lerga et al., 2021).

Despite these clear benefits, challenges remain in ensuring that all students have equitable access to assistive technologies (Khan, 2020). Many schools may struggle with acquiring the necessary hardware and software, and educators need proper training to effectively incorporate these tools into their teaching. Overcoming these barriers is crucial to providing all dyslexic learners with the resources they need to succeed (Dawson et al., 2019).

Although technology plays a key role in supporting dyslexic learners, its impact is maximized when combined with early identification and sustained, long-term support (Kaye et al., 2022). Identifying dyslexia early and integrating assistive technologies into personalized learning plans can ensure that learners receive the comprehensive help they need from the outset. In the next section, we will explore the importance of early identification and long-term support and how timely interventions can make a lasting difference in the educational journey of dyslexic students.

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The Role of Early Identificatin and Long-Term Support

Early identification and sustained intervention are essential in supporting dyslexic learners throughout their educational journey (Sanfilippo et al., 2020). The earlier dyslexia is diagnosed, the sooner targeted interventions can be applied, leading to significantly better long-term outcomes. Research consistently shows that early intervention not only improves reading and writing skills but also has positive effects on the emotional and psychological well-being of dyslexic learners (Snowling, Hulme, et al., 2020). This section highlights the importance of early screening, compares the benefits of early versus delayed intervention, and emphasizes the need for continued support throughout primary, secondary, and higher education.

Early screening and intervention allow for the detection of dyslexia before reading difficulties become entrenched (Schelbe et al., 2022). Identifying these challenges early on opens the door to phonics-based instruction, multisensory approaches, and other interventions that can make a meaningful difference in a child's literacy development. Learners who receive early support often show significant gains in phonological awareness, reading fluency, and comprehension (Jiang et al., 2024). Diagnostic tools, such as the Woodcock Reading Mastery Tests-Revised (WRMT-R) (Woodcock, 1987) and the Clinical Evaluation of Language Fundamentals (CELF-5) (Wiig et al., 2013), are instrumental in assessing key literacy skills and guiding early interventions (Rahul & Ponniah, 2021).

Numerous studies underscore the critical difference between early and delayed intervention. Early intervention has been shown to mitigate many of the long-term academic struggles typically associated with dyslexia. For instance, Bowyer Crane (Bowyer-Crane et al., 2008) found that children at risk for dyslexia who received early phonological training exhibited marked improvements in reading and spelling compared to those who did not. On the other hand, delayed interventions, which are often implemented later in primary school, tend to be less effective, as they must overcome more deeply ingrained reading difficulties (Sanfilippo et al., 2020). These findings reinforce the necessity of addressing dyslexia at the earliest possible stage to prevent prolonged academic struggles.

While early intervention is crucial, long-term support is equally important. Dyslexia is a lifelong condition, and learners require continuous, evolving support as they progress through different educational stages. Interventions that may be effective in primary school need to be adapted as students move into secondary and higher education, where literacy demands become more complex (Dietrichson et al., 2021; Elbro & Petersen, 2004). Structured literacy programs, assistive technologies, and multisensory learning methods must be part of a sustained strategy to help dyslexic learners thrive academically (Butler, 2022). Long-term support not only enhances literacy skills but also boosts confidence, helping learners navigate increasing academic challenges with greater ease.

However, maintaining long-term intervention programs can be challenging. Schools often lack the resources to provide individualized instruction and ongoing support as learners advance through their education (Sanfilippo et al., 2020). Many schools struggle with securing the funding and trained personnel needed to maintain these programs. Additionally, as students progress to higher education, their need for autonomy increases, yet they still require tailored support to meet the growing literacy demands of their coursework. Without continued intervention, dyslexic students are at risk of falling behind academically, even if they have already received early support (Rahul & Ponniah, 2021).

In conclusion, early identification and long-term support are foundational to the success of dyslexic learners. Early screening enables educators to intervene before difficulties worsen, while sustained support ensures that students receive the necessary assistance as they face more complex academic challenges. Going forward, research should continue to refine early diagnostic tools and develop sustainable models for long-term intervention, ensuring that dyslexic learners are supported at every stage of their educational journey.

Challenges and Gaps in Current Research

While considerable progress has been made in dyslexia research and educational interventions, there are still significant gaps that need to be addressed to improve outcomes for all dyslexic learners. These gaps highlight the need for further research, particularly in areas like adult dyslexic learners, culturally responsive interventions, scalability of programs, and the long-term impact of these interventions.

One major gap is the limited research on adult dyslexic learners. Most studies and interventions focus on children, leaving a lack of understanding about how dyslexia affects adults in higher education and the workplace. Adult learners often face different challenges, such as navigating complex literacy demands in professional settings or managing the emotional impact of undiagnosed dyslexia from earlier life stages (Coşkun & Dikilitas, 2022). More research is needed to explore interventions specifically tailored to adults, addressing both their educational and workplace needs.

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Another crucial area is the lack of culturally responsive interventions. Most current research and intervention strategies are designed within Western contexts, which may not apply to learners from diverse cultural and linguistic backgrounds. For example, dyslexic students who speak non-alphabetic languages, such as Chinese, may encounter different challenges compared to those who speak alphabetic languages like English (Wang et al., 2023). This highlights the need for research that explores how dyslexia manifests across various languages and cultures and how interventions can be adapted to meet these diverse needs.

Additionally, a significant challenge in dyslexia education is scaling individualized interventions. Programs like structured literacy and multisensory approaches have proven highly effective, but they are resource-intensive, requiring one-on-one or small-group instruction. Scaling these interventions in larger, under-resourced classrooms is difficult (Sanfilippo et al., 2020). Research is needed to develop scalable solutions that can maintain the effectiveness of individualized instruction while being adaptable to diverse educational settings.

Finally, there is a pressing need for longitudinal studies that evaluate the long-term effectiveness of dyslexia interventions. Most existing research focuses on short-term improvements in reading and literacy skills, but little is known about whether these gains last over time. Longitudinal studies are essential for understanding how early interventions affect learners' long-term academic success and career outcomes (Snowling, Hulme, et al., 2020). This research is crucial for shaping future intervention strategies that provide lasting benefits.

In conclusion, while progress has been made, there are still critical gaps in dyslexia research that need attention. Expanding our understanding of adult learners, developing culturally responsive interventions, creating scalable models, and conducting longitudinal

studies are all vital steps toward ensuring that dyslexic learners of all ages and backgrounds receive the support they need.

Conclusion and Recommendations

This literature review highlights the critical role that early identification, structured literacy, multisensory learning, and technology-assisted tools play in supporting dyslexic learners. These interventions have proven highly effective in addressing the unique cognitive, linguistic, and emotional challenges faced by dyslexic students, contributing significantly to improved academic outcomes, enhanced self-esteem, and a greater sense of empowerment in their learning journeys.

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One of the key findings of this review is the significant impact of structured literacy programs like Orton-Gillingham and Wilson Reading System, which provide explicit, systematic instruction in phonological awareness, decoding, and reading fluency. These programs, when combined with multisensory approaches that engage sight, sound, and movement, offer dyslexic learners the tools to process and retain language more effectively. This step-by-step guidance strengthens literacy foundations, leading to improved reading and writing skills.

Technology-assisted tools, such as text-to-speech and speech-to-text software, along with programs like Lexia and Read&Write, provide an additional layer of support by offering personalized, adaptive learning experiences. These technologies allow dyslexic learners to work at their own pace, reduce the cognitive load of reading and writing, and focus on comprehension and critical thinking. This fosters greater independence and boosts confidence.

For educators, integrating these evidence-based methods into everyday teaching is crucial. Teachers need ongoing professional development to stay updated on the latest research and intervention strategies, enabling them to implement structured literacy programs and assistive technologies effectively. Creating inclusive learning environments where dyslexic students feel understood and supported is essential for improving educational outcomes.

At the policy level, it is vital to ensure that all dyslexic learners have access to these interventions, regardless of their school's resources. Policymakers should prioritize funding for specialized literacy programs and assistive technologies, particularly in under-resourced schools. Early dyslexia screening should also be embedded in national education policies to ensure timely intervention and prevent long-term academic difficulties. A standardized framework for

screening and intervention would help ensure that students receive the support they need from an early stage.

Future research should focus on developing more culturally responsive interventions that address the diverse linguistic and cultural needs of learners worldwide. Research should also expand to adult dyslexic learners, particularly in professional and higher education settings, where literacy demands differ significantly. Additionally, scalable models for individualized instruction are needed to ensure high-quality interventions can be implemented in larger, under-resourced classrooms.

Finally, longitudinal studies are essential to understanding the long-term impact of dyslexia interventions. Current research focuses mainly on short-term gains, but little is known about the sustainability of these improvements over time. Long-term studies would provide insights into how early interventions affect academic, career, and personal outcomes, ensuring that dyslexic learners receive ongoing support for lasting success.

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In conclusion, while much progress has been made in dyslexia research and interventions, ongoing efforts are needed to address existing gaps. By focusing on early identification, enhancing educational practices, and expanding research into culturally responsive and scalable solutions, we can create more inclusive environments that enable dyslexic learners to reach their full potential in academic and professional settings.

References

Anjum, M. A. I., & Bhatti, Z. I. (2022). **EFFICIENCY OF COMPUTER ASSISTED READING MATERIALS FOR IMPROVING PAKISTANI DYSLEXIC STUDENTS'READING SKILLS.** *Jahan-e-Tahqeeq*, *5*(1), 367–375.

Base, P. E. (2023). *Lexia® Core5® Reading Efficacy Research.*

Becker, S. M. (2023). *Multisensory Strategies for Literacy in Secondary General Education.* University of Wyoming.

Bhola, N. (2022). **Effect of text-to-speech software on academic achievement of students with dyslexia.** *Integrated Journal for Research in Arts and Humanities*, *2*(4), 51–55.

Bowyer-Crane, C., Snowling, M. J., Duff, F. J., Fieldsend, E., Carroll, J. M., Miles, J., Götz, K., & Hulme, C. (2008). **Improving early language and literacy skills: Differential effects of an oral language versus a phonology with reading intervention.** *Journal of Child Psychology and Psychiatry*, *49*(4), 422–432.

Butler, K. (2022). **A Hypothesis of Reading Instruction as a Cause of Dyslexia.** *Journal of Education and Learning*, *11*(2), 54–62.

Carioti, D., Masia, M. F., Travellini, S., & Berlingeri, M. (2021). **Orthographic depth and developmental**

dyslexia: **A meta-analytic study.** *Annals of Dyslexia*, *71*(3), 399–438.

Carnine, D., Silbert, J., Kameenui, E. J., & Tarver, S. G. (1997). *Direct instruction reading.* **Merrill Columbus, OH.**

Catts, H. W., Terry, N. P., Lonigan, C. J., Compton, D. L., Wagner, R. K., Steacy, L. M., Farquharson, K., & Petscher, Y. (2024). **Revisiting the definition of dyslexia.** *Annals of Dyslexia*, 1–21.

Dawson, K., Antonenko, P., Lane, H., & Zhu, J. (2019). **Assistive technologies to support students with dyslexia.** *Teaching Exceptional Children*, *51*(3), 226–239.

ElShafaei, R. A., Kozou, H., Maghraby, R., & Hamouda, N. (2022). **Impact of central auditory processing rehabilitation on literacy and phonological awareness skills in dyslexic children with central auditory processing disorder: a quasi-experimental interventional study.** *Senses and Sciences*, *9*(2).

Evans, B. J. W. (2021). *Pickwell's binocular vision anomalies.* Elsevier Health Sciences.

Evans, B. J. W., & Allen, P. M. (2016). **A systematic review of controlled trials on visual stress using Intuitive Overlays or the Intuitive Colorimeter.** *Journal of Optometry*, *9*(4), 205–218.

Fallon, K. A., & Katz, L. A. (2020). **Structured literacy intervention for students with dyslexia: Focus on growing morphological skills.** *Language, Speech, and Hearing Services in Schools*, *51*(2), 336–344.

Javed, S., Muniandy, M., Lee, C. K., & Husni, H. (2024). **Enhancing teaching and learning for pupils with dyslexia: A comprehensive review of technological and non-technological interventions.** *Education and Information Technologies*, *29*(8), 9607–9643.

Jiang, X., Ma, X., Sanford, R., & Li, X. (2024). **Adapting to changes in communication: the orbitofrontal cortex in language and speech processing.** *Brain Sciences*, *14*(3), 264.

Joshi, R. M., Dahlgren, M., & Boulware-Gooden, R. (2002). **Teaching reading in an inner city school through a multisensory teaching approach.** *Annals of Dyslexia*, *52*, 229–242.

Kaye, E. L., Lozada, V., & Briggs, C. (2022). **Early identification of and intervention for children with and without dyslexia characteristics: A comparison study.** *Literacy Research and Instruction*, *61*(3), 298–313.

Kelly, K., & Phillips, S. (2022). *Teaching literacy to learners with dyslexia: A multisensory approach.* Sage Publications UK.

Khan, S. (2020). **Understanding issues in dyslexic learners' pedagogy, the role of assistive technology, and its challenges'.** *The Internafional Journal of Educafional Researchers*, *11*(3), 1–7.

Lerga, R., Candrlic, S., & Jakupovic, A. (2021). **A Review on Assistive Technologies for Students with Dyslexia.** *CSEDU (2)*, 64–72.

Lindamood, P., & Lindamood, P. (1998). *The Lindamood Phoneme Sequencing Program for Reading, Spelling, and Speech: The LiPS Program. [Multimedia Kit].* ERIC.

Mather, N., & Wendling, B. J. (2024). *Essentials of dyslexia assessment and intervention.* **John Wiley & Sons.**

Matre, M. E. (2024). *Speech as a writing tool: An exploratory study of speech-to-text technology in lower secondary education.*

Minoofam, S. A. H., Bastanfard, A., & Keyvanpour, M. R. (2022). **RALF: an adaptive reinforcement learning framework for teaching dyslexic students.** *Multimedia Tools and Applications*, *81*(5), 6389–6412.

19

Modi, N., & Singh, J. (2022). **A survey of research trends in assistive technologies using information modelling techniques.** *Disability and Rehabilitation: Assistive Technology*, *17*(6), 605–623.

Norton, E. S., Gabrieli, J. D. E., & Gaab, N. (2019). **12 Neural Predictors of Developmental Dyslexia.** *Developmental Dyslexia across Languages and Writing Systems*, 253.

Orton, J. L. (1966). *The Orton-Gillingham approach.* Orton Dyslexia Society.

Ozernov-Palchik, O., Norton, E. S., Wang, Y., Beach, S. D., Zuk, J., Wolf, M., Gabrieli, J. D. E., & Gaab, N. (2019). **The relationship between socioeconomic status and white matter microstructure in pre-reading children: A longitudinal investigation.** *Human Brain Mapping*, *40*(3), 741–754.

Parisi, A., Bellinzona, F., Di Lernia, D., Repetto, C., De Gaspari, S., Brizzi, G., Riva, G., & Tuena, C. (2022). **Efficacy of multisensory technology in post-stroke cognitive rehabilitation: A systematic review.** *Journal of Clinical Medicine*, *11*(21), 6324.

Peng, P., Zhang, Z., Wang, W., Lee, K., Wang, T., Wang, C., Luo, J., & Lin, J. (2022). **A meta-analytic review of cognition and reading difficulties: Individual differences, moderation, and language mediation mechanisms.** *Psychological Bulletin*, *148*(3–4), 227.

Rahul, D. R., & Ponniah, R. J. (2021). **Educational Insights into Dyslexia.** *Rupkatha Journal on Interdisciplinary Studies in Humanities*, *13*(4). https://doi.org/10.21659/RUPKATHA.V13N4.35

Roitsch, J., & Watson, S. M. (2019). **An overview of dyslexia: definition, characteristics, assessment, identification, and intervention.** *Science Journal of Education*, *7*(4).

Sanfilippo, J., Ness, M., Petscher, Y., Rappaport, L., Zuckerman, B., & Gaab, N. (2020). **Reintroducing dyslexia: Early identification and implications for pediatric practice.** *Pediatrics*, *146*(1).

Sepulveda, E. M., Resa, P. L., & García, N. P. (2021). **Language evaluation in developmental language disorder: celf 4 vs Celf 5.** *International Linguistics Research*, *4*(2), p46–p46.

Shaywitz, S. E., & Shaywitz, J. (2020). *Overcoming dyslexia: Completely revised and updated.* Hachette UK.

Snowling, M. J., Hayiou-Thomas, M. E., Nash, H. M., & Hulme, C. (2020). **Dyslexia and developmental language disorder: Comorbid disorders with distinct effects on reading comprehension.** *Journal of Child Psychology and Psychiatry*, *61*(6), 672–680.

Snowling, M. J., Hulme, C., & Nation, K. (2020). **Defining and understanding dyslexia: past, present and future.** *Oxford Review of Education*, *46*(4), 501–513.

Spear-Swerling, L. (2019). **Structured literacy and typical literacy practices: Understanding differences to create instructional opportunities.** *Teaching Exceptional Children*, *51*(3), 201–211.

Stein, J. (2023). Theories about developmental dyslexia. *Brain Sciences*, *13*(2), 208.

Stevens, E. A., Austin, C., Moore, C., Scammacca, N., Boucher, A. N., & Vaughn, S. (2021). **Current state of the evidence: Examining the effects of Orton-Gillingham reading interventions for students with or at risk for word-level reading disabilities.** *Exceptional Children*, *87*(4), 397–417.

Sultana, S. T. (2021). *Effectiveness of using visualization and verbalization (v/v) technique in reading comprehension skill of children with autism in Bangladesh.* Bangladesh Health Professions Institute, Faculty of Medicine, the University ….

20

Supriatna, A., & Ediyanto, E. (2021). **The implementation of multisensory technique for children with dyslexia**. *Indonesian Journal of Disability Studies*, *8*(1), 279–293.

Tarvainen, S., Stolt, S., & Launonen, K. (2020). **Oral language comprehension interventions in 1–8-year-old children with language disorders or difficulties: A systematic scoping review.** *Autism & Developmental Language Impairments*, *5*, 2396941520946999.

Ullman, M. T., Earle, F. S., Walenski, M., & Janacsek, K. (2020). **The neurocognition of developmental disorders of language.** *Annual Review of Psychology*, *71*(1), 389–417.

van der Leij, A. (2020). **Effects of computer-assisted instruction on word and pseudoword reading of reading-disabled students.** In *Current directions in dyslexia research* (pp. 251–267). Garland Science.

Wiig, E. H., Secord, W. A., & Semel, E. (2013). *Clinical evaluation of language fundamentals: CELF-5*. **Pearson.**

Wilson, B. A. (1988). *Wilson Reading System: Program Overview*. **Wilson Language Training.**

Wolf, M., & Bowers, P. G. (1999). **The double-deficit hypothesis for the developmental dyslexias.** *Journal of Educational Psychology*, *91*(3), 415.

Wolf, M., Gotlieb, R. J. M., Kim, S. A., Pedroza, V., Rhinehart, L. V, Tempini, M. L. G., & Sears, S. (2024). **Towards a dynamic, comprehensive conceptualization of dyslexia.** *Annals of Dyslexia*, 1–22.

Woodcock, R. W. (1973). *Woodcock reading mastery tests*.

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