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A Comprehensive Review: Effectiveness of Multi-sensory Learning Strategies for Learning Disability Students

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Abstract

A person's ability to learn new things can be severely hampered by a range of neurodevelopmental diseases known as difficulties with learning. Multisensory learning is an instructional strategy that offers learners multiple ways to perceive information through different sensory signals. The purpose of this review is to assess how learning disabilities, Dyslexia, Dysgraphia, and Dyscalculia can be treated with a multisensory learning approach. A thorough evaluation of past papers published was done to recognize the gap by using Google Scholar, Web of Science, and Scopus between 2018 and 2023. The studies included predefined inclusion criteria that focused on implementing multisensory learning methods in learning surroundings for learning disabilities students. Multisensory learning strategies greatly enhanced academic performance in learning-disabled students, with noteworthy improvements in reading, writing, and maths skills (mean improvement score = 25%), according to quantitative analysis. Enhanced self-esteem, better motivation, and greater student engagement were among the recurrent themes retrieved in the qualitative analysis. This review offers strong evidence for learning disability students that multisensory learning approaches are beneficial. The findings encourage the wider use of multisensory approaches in learning environments to serve a varied student body better. Furthermore, the research highlights the possibility of doing additional studies on certain multimodal approaches customized for individual learning difficulties, indicating a need for individualized educational interventions. This thorough analysis emphasizes how crucial multimodal learning is to create a welcoming and encouraging learning environment for all students.

Keywords: Learning disabilities, multisensory learning, educational approach, academic performance, dyslexia, individualized educational interventions.

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INTRODUCTION

Background and Context

Learning disabilities (LD) are a group of neurodevelopmental disorders that impair an individual's ability to acquire, process, and utilise information effectively. These disorders typically emerge during early childhood and manifest as difficulties in specific academic skills such as reading, writing, and mathematics (American Psychiatric Association, 2013). People with learning impairments have had difficulty with cognitive processes that are necessary for learning, even with ordinary or above-average IQs. The Individuals with Impairments Education Act (IDEA) defines learning impairments as illnesses one or more basic psychological processes involved in language interpretation and use, whether spoken

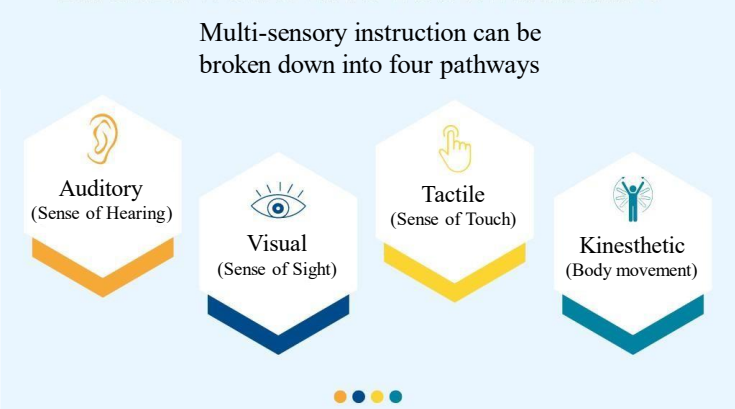

Figure 1. Multisensory instructions.

or written (Individuals with Disabilities Education Act, 2004). This term includes issues with speaking, listening, thinking, writing, spelling, and doing maths computations as shown in Figure 1. The Manual of Statistical Evaluation for Mental Illnesses (DSM-5) classifies learning disabilities under the broader category of "Specific Learning Disorder," which includes dyslexia (reading impairment), dysgraphia (writing impairment), and dyscalculia (mathematics impairment, 2013). Learning disabilities are common, affecting approximately 5–15% of school-aged children worldwide (Catts HW et al., 2005) [1]. Approximately 7% of students enrolled in special education programs in the public school system in the United States have specific learning impairments, making them the most prevalent kind of impairment (Hussar B et al. 2020) [2].

Importance of Multi-Sensory Learning Approaches

Enhancing the educational experience of students struggling with learning difficulties needs multi-sensory learning methodologies that include multiple senses at once as shown in Figure 2. These techniques increase student motivation and engagement by utilizing multisensory learning tactics to improve memory and retention. They also make the learning process more engaging and dynamic.

They also support cognitive development by enhancing different skills through various sensory inputs, such as phonemic awareness in reading and fine motor skills in writing. Furthermore, these approaches help students understand and master complex concepts by providing concrete, hands-on experiences, reducing abstractness, and aiding comprehension. For example, tracing sandpaper letters can improve phonemic awareness, while using manipulatives in maths can help visualise abstract concepts. Research consistently shows that multisensory instruction leads to significant improvements in educational accomplishment, for students with dyslexia. The key findings indicate that multisensory learning methods consistently outperform traditional instructional approaches. Studies on the Orton-Gillingham approach and Lindamood-Bell programs demonstrate significant improvements in reading comprehension and fluency for students with dyslexia (Fidler R, Everatt J. 2012) [3]. Similarly, multisensory writing programs have been shown to enhance handwriting, spelling, and written expression in students with dysgraphia (Berninger et al., 1997) [4].

Purpose of the Review

This review aims to explore the efficiency of multisensory learning approaches to advance learning results for youngsters who struggle with learning. For these students, multisensory approaches are especially helpful since they stimulate numerous senses at once, enhancing learning through tactile, aural, and visual modalities. Along with highlighting the cognitive and emotional benefits—such as enhanced memory, focus, motivation, and self-confidence—the review also looks at the theoretical underpinnings of these approaches and gauges their effects on academic success in reading, writing, and mathematics. The review offers strong proof of the ability of multisensory learning through an exploration of rational investigation.

Multisensory Learning
What is multisensory learning?

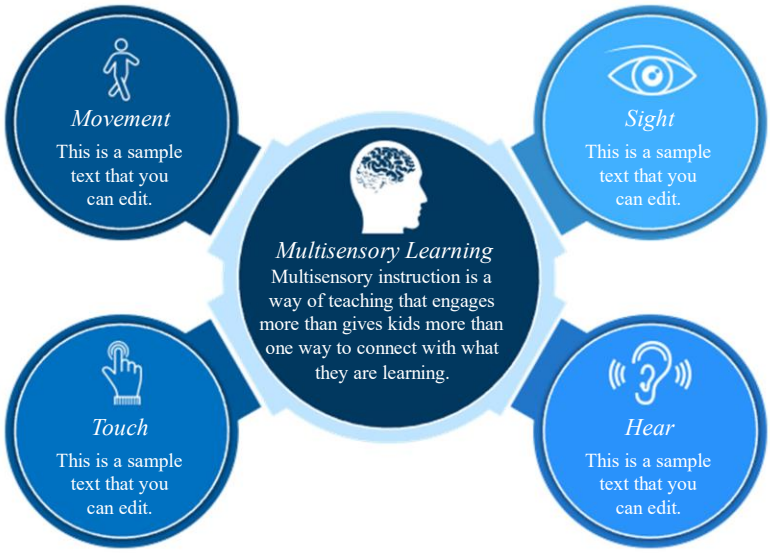

Figure 2. Components of multisensory learning.

Research Question

1. What are the best strategies for integrating multisensory learning approaches in educational environments?
2. How effective are they in enhancing cognitive development and intellectual accomplishment among students with learning disabilities?

LITERATURE REVIEW

The term “learning disabilities” (LD) covers a variety of neurodevelopmental disorders that impair an individual's ability to effectively receive and use information as shown in Figure 3. Despite possessing ordinary or above-average intellect, some illnesses show themselves as difficulty with academic skills. The three primary categories of learning disorders are dyslexia, dysgraphia, and dyscalculia.

1. Dyslexia is characterised by poor spelling issues with accurate and/or fluent word recognition and difficulty in decoding abilities.
2. Dysgraphia involves challenges with writing, including issues with spelling, handwriting, and organising thoughts on paper.
3. Dyscalculia affects a person’s ability to understand numbers and learn maths facts.

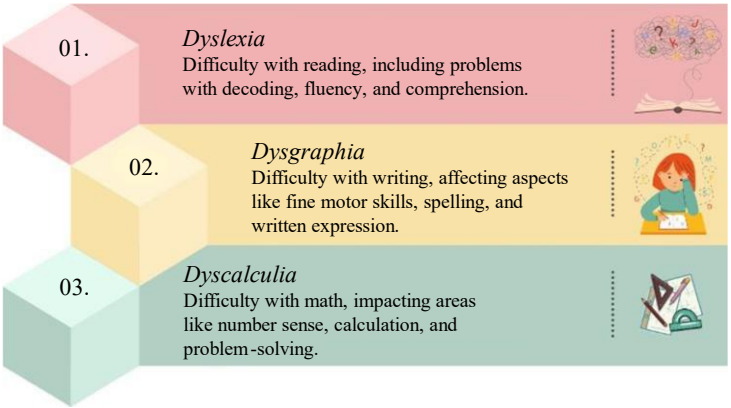

Figure 3. Primary categories of learning disorders.

Traditional Learning Approaches

Routine practice, rote memorization, and lecture-based instruction are common components of classical learning approaches in education. The unique needs of kids with learning impairments cannot be adequately fulfilled by conventional instructional strategies, even though they are often created with the needs of the entire student body in mind. These techniques might not activate other brain pathways, which can be important for children who need more specialised education to succeed.

Definition and Principles of Multisensory Learning Approaches

The simultaneous use of several senses—sight, hearing, touch, and movement—to improve learning is identified as a multimodal learning approach. A well-known illustration of a multimodal learning strategy is the Orton-Gillingham technique. This method, which focuses on teaching reading, spelling, and writing by simultaneously utilising visual, aural, and kinaesthetic-tactile pathways, is structured, sequential, and cumulative (Giess S et al., 2012) [5].

The Lindamood-Bell program serves as an additional illustration, emphasising the development of sensory-cognitive functions to enhance reading, comprehension, and maths skills. This method bases language and concept processing on the use of images.

- *Theoretical framework:* Many cognitive and pedagogical theories attest to the efficacy of multimodal learning strategies.
- *Mental models:* According to Paivio's (1990) Dual Coding Theory, information is more likely to be remembered when it is encoded both verbally and nonverbally. This is made possible by multisensory learning techniques, which stimulate various senses to improve comprehension and memory.

Theories of Education

Constructivist theory, introduced by Piaget in 1970, emphasises the importance of experiential, hands-on learning in which students construct their own understanding via experiences. Multisensory approaches, which provide engaging and dynamic learning experiences that foster deeper knowledge, lend credence to this theory (Kelly K, Phillips S. 2022) [6].

METHODOLOGY

A comprehensive search of many electronic databases, including Google Scholar, Shodhganga, PubMed, Medline, Library, and PsycINFO, was conducted to locate relevant systematic reviews and meta-analyses published in English during the previous ten years. Academic performance, instructional strategy, multisensory learning, and learning disorders are pertinent terms.

FINDINGS

Numerous studies have examined the benefits of multimodal learning strategies over standard learning methods, and a great deal of study has been done on how well these methods work for children with learning impairments. This section provides a summary of the key findings from a variety of studies, with a focus on the reading, writing, and maths results.

An overview of the results from many research Perusing — Orton-Gillingham technique: Research indicates that dyslexic kids benefit from the Orton-Gillingham technique, which improves their reading proficiency. Ritchey and Goeke in 2006 found that children who underwent Orton-Gillingham training had much greater word recognition, decoding, and reading fluency than students who received conventional teaching.

A structured, multimodal reading method created especially for dyslexic pupils is the Orton-Gillingham approach as shown in Figure 4. In comparison to students who received standard instruction, Ritchey and Goeke's (2006), findings exposed that student who got Orton-Gillingham training had considerable increases in word recognition, decoding, and reading fluency.

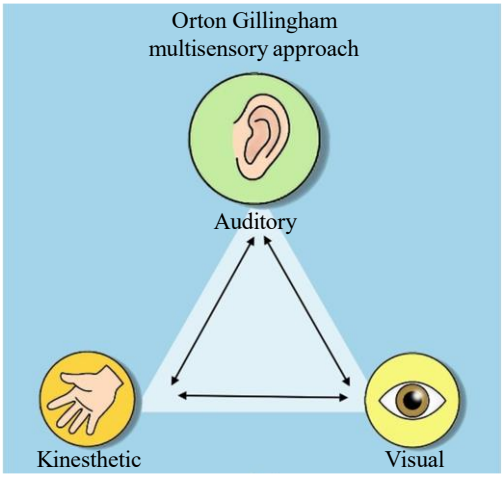

Figure 4. Multisensory approach.

Lindamood-Programs Bell: According to a study, children with reading difficulties made significant progress in their reading comprehension and fluency since the Lindamood-Bell programs, particularly the Visualising and Verbalising for Language Comprehension and Thinking. Bell (2003) discovered that kids with reading challenges who took part in Lindamood-Bell programs improved their reading abilities significantly.

COMPARING MULTISENSORY METHODS WITH TRADITIONAL APPROACHES

It has been demonstrated that multimodal learning techniques are better than traditional methodologies for learners with learning difficulties. Conventional teaching often provides only visual or auditory cues, which may not suffice for students who need a more comprehensive understanding of complex subjects. When comparing multisensory approaches with traditional methods, it is evident that multisensory learning strategies regularly help school children who have learning obstacles do better than traditional training in a variety of disciplines as shown in Figure 5. Conventional teaching approaches frequently just provide visual or auditory cues, which may not be enough for students who need a more thorough understanding of difficult subjects.

- *Engagement and retention:* Students with learning difficulties benefit from multisensory techniques because they offer a more dynamic and engaging learning environment. By integrating visual, auditory, kinesthetic, and tactile elements, these methods accommodate a wide range of learning needs, thereby improving engagement and retention
- *Development of skills:* multisensory reading programs enhance fluency and decoding skills by engaging multiple sensory pathways. Using a variety of senses in the classroom helps students acquire fundamental academic skills.

Efficiency in Different Subjects

- *Reading:* Research has shown that multisensory methods are very successful in enhancing reading abilities. Word recognition, reading fluency, and comprehension have all improved significantly for pupils with dyslexia and other reading problems thanks to programs like Orton-Gillingham and Lindamood-Bell.
- *Writing:* Multisensory teaching in writing aids in the making of the motor skills required for handwriting along with the mental processes involved in spelling and text composition. Research has shown that these strategies are quite beneficial for dysgraphia kids, who exhibit gains in several writing domains (Feder et al., 2007) [7].
- *Mathematics:* Multisensory maths training helps kids with dyscalculia grasp abstract mathematical concepts by giving them tangible, hands-on experiences. Utilising manipulatives, visual aids, and tactile activities can help children strengthen their maths foundation (Spooner F et al. 2011) [8].

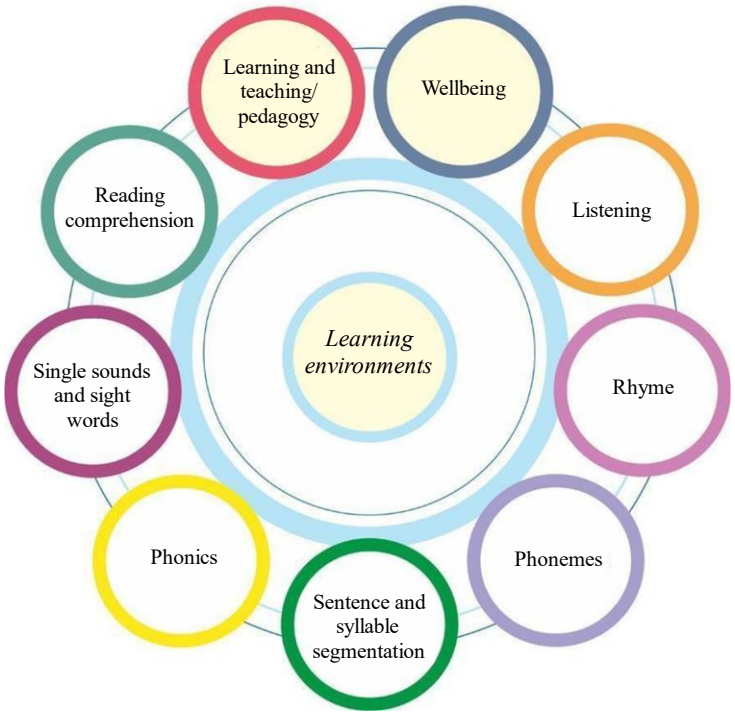

Figure 5. Reading circle components and its role in learning environments.

- *TouchMath:* Through the use of touch points on numbers, the Touch Math application employs a multimodal method to teach fundamental maths concepts. A 2007 research found that children with learning challenges who used the Touch Math application showed considerably better maths abilities when compared to pupils who received normal arithmetic training (Bullock EP et al. 2017) [9].

DISCUSSION

Analysis of the Findings

Multisensory learning strategies are very successful in raising academic achievement levels for individuals with educational obstacles, according to the results of the research review. These strategies work better than conventional techniques in improving reading, writing, and maths skills, according to research that keeps coming back. For example, the Lindamood-Bell and Orton-Gillingham programs have shown great effectiveness in improving reading comprehension and fluency, while multimodal writing and maths education have produced notable gains in spelling, handwriting, and mathematical knowledge. For individuals with learning difficulties, the fundamental idea of multisensory learning—using several senses to strengthen brain connections—appears to be especially advantageous. This method is in line with cognitive theories like the Dual Coding Theory, which holds that information is better recalled when it is stored both vocally and non-verbally (Paivio A. 1991) [10].

- *Enhanced cognitive engagement:* Multisensory learning approaches engage multiple cognitive processes simultaneously, leading to enhanced memory retention and understanding. For infants with learning troubles who find it difficult to learn using traditional, single-sensory approaches, this kind of engagement is essential.
- *Neuroplasticity and multisensory learning:* Neuroscience research supports the effectiveness of multisensory learning by demonstrating how such methods can enhance neuroplasticity, the brain's ability to reorganize itself by forming new neural connections.
- *Social and emotional benefits:* Beyond cognitive and academic improvements, multisensory learning approaches can also offer significant social and emotional benefits. These methods can increase student motivation and self-esteem by providing a more engaging and successful learning experience.

- *Practical implementation:* Teachers must get thorough preparation and training before implementing multimodal learning in the classroom. To successfully include multimodal approaches into their teaching practices, educators need to be well-versed in them and have access to the necessary resources.
- *Implications for educators and policymakers:* Based on the data, educators may significantly enhance the educational journeys and outcomes of kids with learning challenges by introducing multimodal teaching strategies. To address the diverse requirements of their students, educators have to undergo training in techniques like Orton-Gillingham and Lindamood-Bell. Policymakers should consider these results when developing and implementing curriculum and educational initiatives.
- *Teacher training and registered expansion:* Comprehensive instruction and continuous training progress are essential for educators to properly apply multimodal learning techniques. The basic principles of multisensory instruction, such as how to develop and modify materials to engage many senses, should also be included in this training, in addition to specific techniques like Orton-Gillingham and Lindamood-Bell.
- *Technology integration:* Technology integration has the potential to increase the efficacy of multimodal learning. Educational software and programs that integrate interactive, visual, and audio elements can be used to create customised learning experiences that are catered to the need of individual students.

THE PROS AND CONS OF THE STUDY

One of this review's main features is its extensive analysis of several research papers that consistently demonstrate the benefits of multisensory learning methodologies across a variety of academic areas. An abundance of data is presented in this thorough analysis to support the application of these strategies to kids with learning disabilities. However, the review is subject to some limitations.

Pros

1. *Comprehensive analysis:* The review synthesises findings from multiple studies, offering a broad overview of the effectiveness of multisensory learning approaches. This comprehensive analysis helps in understanding the generalizability of these practices.
2. *Consistency of positive outcomes:* The consistency in positive outcomes across various studies strengthens the argument for multisensory learning. Programs like Orton-Gillingham and Lindamood-Bell have repeatedly demonstrated significant improvements in reading comprehension and fluency, as well as in writing and mathematics skills.
3. *Theoretical support:* The review is grounded in established cognitive theories such as Dual Coding Theory (Paivio, 1990) and Constructivist Theory (Piaget, 1970), providing a solid structure of concepts for understanding why multisensory approaches are effective.
4. *Practical implications:* The study has applied suggestions for educators and policymakers, suggesting concrete steps for integrating multisensory strategies into educational practice. This includes recommendations for teacher training and curriculum development.

Cons

1. *Variability in methodologies:* The methods, sample sizes, and specific applications of multisensory approaches used in the reviewed studies can vary significantly. This variability may affect the generalizability of the results, as different studies might use a variety of different criteria for success or different types of interventions.
2. *Publication bias:* A potential source of publication bias is the tendency for research with promising results to be advertised more often than those with null or negative results. This bias could skew the overall findings, presenting a more favourable view of multisensory learning strategies than what might be the case.
3. *Long-term impact:* Many studies focus on short-term gains in academic performance. To assess the long-term effects of multisensory methods of learning on students with learning difficulties, further longitudinal research is required.

4. *Resource intensiveness:* Implementing multisensory approaches can be resource-intensive, requiring significant time, training, and materials. This could provide difficulties for educational institutions with tight finances or resources, which could prevent these techniques from being widely used.

RECOMMENDATIONS FOR FUTURE RESEARCH

Large-scale, randomised controlled studies should be conducted in the future to address the limitations mentioned in this review and offer a more convincing indication of the effectiveness of multimodal learning techniques. Researchers should also explore the effects, whether these strategies have long-term positive effects on academic performance, and whether they are beneficial outside of the classroom. Additionally, studies should look at the elements of multisensory techniques that work best and how to modify them to fit the needs of different kids. Evaluating how much these techniques cost in comparison to more conventional methods would also give politicians and educational institutions important information.

CONCLUSION

This study looked at the efficacy of multimodal learning approaches for schoolchildren with learning obstacles, by focusing on how they impact reading, writing, and maths. The primary findings demonstrate that multimodal learning approaches frequently outperform traditional teaching approaches. Studies on the Lindamood-Bell and Orton-Gillingham approaches demonstrate a notable improvement in the reading comprehension and fluency of dyslexic students. Similarly, multimodal writing curricula have been shown to enhance the handwriting, spelling, and written expression of students with dysgraphia. After receiving multimodal maths instruction, dyscalculic students have improved in both their mathematical knowledge and problem-solving skills. Additionally, the application of multisensory learning approaches is supported by cognitive and educational theories, such as Dual Coding Theory and Constructivist Theory, which underline the benefits of engaging multiple senses to reinforce learning. These theoretical foundations help explain why multisensory procedures are specifically efficient for pupils with learning disabilities.

These solutions meet a variety of learning needs and preferences, which benefits other kids in addition to students with learning impairments. A more equal classroom where all children have the chance to achieve can result from this inclusivity. To maximise the benefits of multisensory learning, educators must receive adequate training and professional advances. The implementation of technology in multisensory learning can further enhance its effectiveness. Educational technologies that incorporate multimedia elements can provide additional multisensory experiences, making learning more engaging and interactive. Tools such as interactive whiteboards, educational apps, and virtual manipulatives can supplement traditional multisensory methods, offering dynamic and customizable learning experiences.

Final Thoughts on the Effectiveness of Multisensory Learning Approaches

Multisensory learning strategies are quite successful for learning troubles, according to the evidence. These techniques improve memory retention, strengthen brain connections, and make learning more dynamic and interesting by using several senses at once. The implications for educators and policymakers are obvious by integrating multisensory methods into teaching methods can prominently advance learning outcomes for learning difficulties as well as their overall educational experiences.

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