

Enhancing Mathematics Assessment for Students with High Support Needs through Multisensory Integration: A Literature Review

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Abstract

Students with high support needs encounter formidable obstacles in learning, especially in Mathematics, posing challenges for assessing their progress. Traditional assessment methods often prove inadequate due to the diverse physical and cognitive conditions of these students, necessitating more flexible approaches. This study explores multisensory integration—utilizing visual, auditory, kinesthetic, and tactile elements—as a robust alternative for both formative and summative assessments. Multisensory techniques facilitate comprehensive learning experiences by engaging multiple sensory pathways, enhancing cognitive processing, and improving retention of complex mathematical concepts. Teachers benefit from these methods by gaining more accurate insights into student progress, accommodating diverse learning styles effectively. Extensive research supports multisensory approaches in special education, underscoring their capacity to bolster engagement and foster inclusive learning environments. Visual aids clarify abstract concepts, auditory cues reinforce learning through repetition, kinesthetic activities promote hands-on understanding, and tactile resources aid sensory processing. Tailoring these methods to individual needs ensures personalized learning experiences often absent in traditional frameworks. Future research should prioritize longitudinal studies to assess sustained impacts and focus on enhancing teacher training to optimize implementation. Integrating technology further expands the potential of multisensory learning, promising substantial advancements in educational efficacy. In conclusion, multisensory integration stands as a promising avenue for improving Mathematics education for students with high support needs abilities, offering educators tools to elevate learning outcomes and cultivate dynamic, inclusive classrooms.

Keywords: Student with High Support Needs, Assessments, Multisensory Approach, Mathematics

Introduction

The transformation in the education system is evident not only through the adoption of new teaching methods and skills but also in the evolution of assessment types (De Marco et al., 2015; Martinez et al., 2019). Leading international organizations such as UNESCO, the OECD, and the World Bank, which play pivotal roles in shaping educational policies globally, have

advocated for the implementation of diverse assessment types to enhance learning outcomes (Sadid-Zadeh, D'Angelo, & Gambacorta, 2018; Tedesco, 2016; World Bank, 2019; Gallardo K., 2021). This approach is reinforced by scholars like Biggs (2003), and Svensater & Rohlin (2023), who emphasize the importance of formative assessments in bolstering the summative performance of students. According to these researchers, formative assessments are critical indicators of summative assessment outcomes. However, there remains a significant gap in research regarding the efficacy of formative and summative assessments for students with special educational needs who exhibit high support needs

A UNESCO study estimates that approximately 500 million people globally suffer from intellectual and sensory-motor disabilities, which hinder their full participation in societal activities (Leshchii et al., 2022). Students with special education needs often experience learning disabilities, which are neuropsychological disorders that impede their performance in subjects like mathematics, reading, writing, spelling, and speaking (Rashidi et al., 2020). These high support needs SEN students, who have cognitive impairments that do not align with their biological age—such as global developmental delay, Down syndrome, intellectual disability, autism, Attention Deficit Hyperactivity Disorder (ADHD), and other specific learning disabilities—require tailored educational approaches (MOE, 2014). Thus, research focusing on students with high support needs, particularly in mathematics, is crucial.

Over the past few decades, an increasing number of studies have concentrated on mathematics education for children with special educational needs (Myers, Jun, Brownell, & Gagnon, 2015; Marita & Hord, 2017; Fung & Wang, 2020). Mathematics is a fundamental subject for students because mathematics skills are essential for performing daily tasks such as shopping, cooking, and time management (Faragher & War, 2005; Schnepel & Aunio, 2022). Previous studies have drawn from various sources to demonstrate the multiple ways children can develop their mathematics skills (Aunola et al., 2004; Bull et al., 2008; Durand et al., 2005; Jordan et al., 2006, 2007; Locuniak & Jordan, 2008; Passolunghi et al., 2007; Smedt et al., 2009). These studies have not only included typical students but have also involved SEN students (Baharom et al., 2022). Nonetheless, there is a dearth of research specifically addressing the assessment approaches for high support needs SEN students in mathematics, aiming to evaluate their skills more comprehensively.

Mathematics Learning Strategies for Life Routines

Children with mathematics learning difficulties often exhibit a variety of weaknesses, some disproportionate, alongside unexpected strengths (Huijsmans et al., 2020; Dowker, 2015; Gifford & Rockcliffe, 2012). Learning developmental disorders can be particularly detrimental, especially when critical skills like mathematics are compromised, which are essential in today's modern society (Benavides-Varela et al., 2020; Ritchie & Bates, 2013; Duncan et al., 2007). Mathematical problem solving is a key area in mathematics education, designed to prepare students to function effectively in modern society (Gravemeijer et al., 2017; Klang et al., 2021). Numerous studies indicate that problem-solving skills are closely related to reading comprehension (Dabarera, Renandya, & Zhang, 2014; Guven & Cabakcor, 2013; Pape, 2004), interest and attitudes towards mathematics (Pimta, Tayruakham, & Nuangchalerm, 2009; Spada et al., 2008), epistemological beliefs (Erdamar & Alpan, 2013; İflazoğlu-Saban & Güzel-Yüce, 2012), and intelligence levels (Stankov, 2000; Veenman, Wilhelm, & Beishuizen, 2004).

Mathematics is an integral part of the communication component in the high support needs in High school standard curriculum (MOE, 2019). The communication component aims to equip students with verbal or non-verbal communication skills, foster relationships with family and the community, and enhance their ability to use information and communication technology confidently, thereby improving their quality of life. To achieve these goals, assessments can be carried out through various methods such as informal testing, group discussions, dialogues with teachers, reflective questions, and monitoring through classroom activities (Can Daşkın & Hatipoğlu, 2019; Bacquet, 2020). Interactive learning, which integrates elements of various subjects, is crucial in creating an engaging educational environment. Such an environment centers students in the learning process, a key objective in the transformation of education (Radovic et al., 2020). Modern and interactive teaching aids, which allow students to explore the learning process, are vital in enhancing mathematics learning and developing problem-solving skills (Furberg, 2016). Research by Taleba and Hassanzadehb (2015), demonstrates that interactive learning environments in mathematics positively impact student achievement and knowledge retention.

Mathematics achievement and mastery are influenced by various internal and external factors, including academic self-concept, cognitive abilities, peer popularity, and teacher support (Niehaus et al., 2012; Veas et al., 2015). School practices that encourage parental involvement in mathematics learning at home have been shown to improve student performance (Sheldon & Epstein, 2005). The Communication Mathematics Composition includes four main topics: numbers and operations, money, time, and measurements. These topics are closely related to everyday applications, allowing parents to engage their children in household chores and practice mathematics skills in daily life. To further enhance the educational experience for students with high support needs, particularly those with special educational needs, it is crucial to tailor formative and summative assessments to their unique needs. Such assessments can provide continuous feedback and personalized learning experiences, improving their overall learning trajectory and outcomes. Additionally, exploring diverse and holistic assessment methods will ensure educational practices are inclusive and effective, catering to the diverse learning profiles of students.

Holistic Assessment through Formative and Summative Approach

Assessment in education aims to measure cognitive, affective, and psychomotor domains to reach a comprehensive understanding of student learning (Bhat & Bhat, 2019). Michael Scriven (1967), defined assessment as the process of making value judgments about educational outcomes (Fitzpatrick, Sanders, & Worthen, 2004; Karagol & Adiguzel, 2022). Effective assessment considers a variety of learning-related activities (Perrotta & Whitelock, 2017). According to the Malaysian Ministry of Education (MOE, 2019), formative assessment is used to monitor and improve learning during instruction, while summative assessment evaluates learning at the end of a learning period. Assessment in education encompasses authentic assessment, self-assessment, portfolio-based assessment, daily tests, mid-year tests, end-of-year tests, competency improvement tests, district-level tests, and centralized examinations (Salamah, 2019).

For the past six decades, educational assessments have been categorized into formative and summative types. Scriven's seminal work (1967), provided foundational explanations and discussions on this classification, which remain relevant today (Scriven, 1967; Gallardo, 2021).

Formative assessment uses student data to enhance teaching and learning, while summative assessment uses data to evaluate learning outcomes (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 2014). Formative assessments are typically informal and continuous, conducted during teaching and learning sessions, whereas summative assessments are formal, cumulative, and conducted after instruction (Dixson & Worrell, 2016). A study by Chikwe and Atteng (2021), examined assessment strategies for evaluating the learning achievement of students with disabilities in Rivers State. Their findings revealed no significant difference in the implementation of formative assessments by special education and primary teachers. Similarly, summative assessments showed no significant difference between the two groups of teachers. Despite the intention to balance formative and summative assessments, the study participants focused predominantly on summative assessment. This imbalance highlights the need for teachers to maintain a proper balance between formative and summative assessments, as both are crucial for achieving learning goals.

Today's education faces challenges related to sustainable development, particularly in assessment methods and tools (Zhang et al., 2023). Chikwe and Atteng (2021), also noted a bias in assessment strategies practiced by mainstream and special education teachers, affecting student development. This bias underscores the need for improved strategies and methods in assessment. Teachers must diversify their skills to identify and address the various learning disabilities and difficulties faced by special education students (Almughyiri, 2022). The transformation in the education system is not only reflected in new teaching methods and skills but also in the types of assessments conducted (De Marco et al., 2015; Martinez et al., 2019). Simmons and Sharp (2019), emphasized that special education teachers must adopt a holistic approach in assessing students, considering their behavior, knowledge, and skills to enhance the effectiveness of assessments. This approach involves using sensory, auditory, kinesthetic and tactile functions to stimulate learning and information retrieval (Jeyasekaran, 2015; Ziadat, 2021). Additionally, Mohammed (2013), highlighted the importance of intervention strategies and methods involving parents, teachers, and researchers to support special education students with mental, auditory, visual, and motor disabilities.

Formative assessments are particularly valuable for special education students, as they provide ongoing feedback and opportunities for personalized learning adjustments. These assessments can be conducted through various activities, including group discussions, teacher-student dialogues, reflective questions, and continuous classroom monitoring (Bacquet, 2020). By integrating formative assessments into daily instruction, teachers can better understand each student's unique needs and tailor their teaching strategies accordingly. Interactive learning environments also play a crucial role in the educational transformation. Modern and interactive teaching aids allow students to explore the learning process actively, thereby enhancing their engagement and understanding (Furberg, 2016). Studies have shown that interactive learning environments positively impact student achievement and knowledge retention in mathematics (Taleba & Hassanzadehb, 2015). These environments foster a student-centered approach, where learners are actively involved in the learning process, making education more dynamic and effective (Radovic et al., 2020).

Furthermore, parental involvement is essential for improving student performance in mathematics. School practices that encourage parents to engage in their children's

mathematics learning at home have been found to enhance student outcomes (Sheldon & Epstein, 2005). In the document includes topics such as numbers and operations, money, time, and measurements, all of which have practical applications in daily life. By involving children in household chores that require mathematics skills, parents can reinforce their children's learning in meaningful and practical ways.

Multisensory Approach in Assessment

The Orton-Gillingham (OG) Approach (Orton-Gillingham Academy, 2023; Stevens et al., 2023) is a specialized instructional methodology designed to enhance reading, writing, and spelling proficiency through multisensory approach. This approach integrates sight, hearing, touch, and movement to create a comprehensive and engaging educational experience. According to the OG-Training-Manual (2019), the OG approach is characterized by its direct, explicit, multisensory, structured, sequential, diagnostic, and prescriptive nature. This method's adaptability allows educators to tailor their teaching strategies to meet the diverse needs of their students, which is particularly beneficial for those with mild mental deficiencies (Nozhaizian, 2021).

One of the key strengths of the Orton-Gillingham Approach is its adaptability across various educational contexts. For example, methods such as the glass analysis method and the multisensory using through visual, auditory, kinesthetic, and tactile method, developed by Fernald and Orton-Gillingham, have been shown to significantly improve reading skills in children with learning disabilities (Prasetyaningrum & Faradila, 2019). Multisensory integration, as emphasized in the, allows students to utilize multiple brain functions to form clear and lasting memories of difficult-to-remember information (Ani Derderian, 2013). This comprehensive approach is particularly beneficial for children with learning disabilities, including dyslexia, dyscalculia, and dysgraphia, who often exhibit normal intelligence but struggle with specific sensory functions related to reading, mathematics, and writing (Kakia & Kougioumtzis, 2016; Nicolson et al., 2011; Reddy et al., 2019; Sofology, 2014; Bonti et al., 2020; Sofologi et al., 2021).

In the United States, it has been observed that high support needs students with mild intellectual disabilities frequently encounter difficulties in initiating and completing written assignments (Roitsch et al., 2020). Additionally, these students may face challenges in language and communication within the classroom (Nik Hassan et al., 2016; Yee Ni & Mokhtar, 2023). Relying solely on one sensory function is inadequate for these students, as they possess other sensory capabilities that can be harnessed for learning. Theoretical perspectives from educational psychologists such as Jean Piaget (1958), Jerome Bruner (1973), and Lev Vygotsky (1978) underscore the importance of employing diverse methods to convey mathematical concepts. Children of the same chronological age may exhibit varying mental ages, necessitating the use of multisensory teaching techniques (Van de Walle, 2007; Kamii & Rummelsburg, 2008; Clement, 1999; Rains et al., 2008).

For instance, a study by Hiebert (1988), highlighted the need for students to grasp basic mathematical concepts before progressing to more complex processes. Teachers can introduce concepts such as additive operations through hands-on demonstrations with physical objects like beans, followed by verbal repetition and physical manipulation by the students. This approach caters to visual, tactile, and kinesthetic learners (Rains et al., 2008).

A study by Prasetyaningrum and Faradila (2019), aimed to improve early reading skills in children with mild intellectual disabilities using the multisensory approach. This study employed an ABA design consisting of three phases: Baseline (A1), Treatment (B) with the multisensory approach, and Post-Intervention (A2) (Latipun, 2015). The participants were students from grades 3 and 4 at Sumber Dharma Malang Special Primary School, aged 8-11, with low early reading skills and IQs ranging from 55 to 70. The study found that the multisensory method significantly improved the students' initial reading skills.

The multisensory approach developed by Fernald and Orton-Gillingham also proves effective in mathematics. A study by Gamal Khalifa et al (2021), explored the impact of a multisensory approach, Touch Mathematics, on enhancing mathematics skills in children with mild intellectual disabilities. Touch Mathematics, which involves tactile and kinesthetic learning strategies, was found to improve the timing and accuracy of mathematical calculations, including addition, subtraction, multiplication, and division (Scott, 1993; Wisniewski & Smith, 2002). This approach is beneficial for students struggling with traditional mathematics strategies, providing an alternative pathway to mastering computational techniques (Scott, 1993).

Discussion

Teachers play a pivotal role in the educational journey of students, being the closest implementation agents from planning lessons to evaluating and reflecting on students' achievements and experiences. Competent teachers are crucial for the successful application of multisensory integration approaches in mathematics, particularly for students with high support needs in special education. To meet the evolving educational needs, teachers must continually enhance their knowledge, understanding, and skills. Stakeholders such as the Ministry of Education Malaysia, the Department of Education, and school management can significantly support this development by organizing practical training courses and workshops. These initiatives can introduce new ideas and inputs essential for assessment. Additionally, collaboration with external parties, such as intervention officers and academic experts, can further bolster teacher competence.

Formative and summative classroom assessments empower schools and teachers to choose the type of assessment activities at the school level, fostering creativity in selecting methods and instruments based on the desired learning outcomes (MOE, 2019b). The selection and construction of assessment items are critical for enhancing the quality of evaluations. To align with the transformation of 21st-century education, incorporating technology and having adequate teaching and learning resources in schools are essential. The creativity and versatility of assessment instruments can reduce the reliance on traditional materials like worksheets, providing more holistic and integrated evaluations that reflect practical applications of knowledge.

The multisensory approach requires diverse materials to assess and evaluate students with high support needs more effectively. This method supports a comprehensive understanding of students' abilities by engaging multiple senses, which is particularly beneficial for high support needs students. By integrating visual, auditory, kinesthetic, and tactile modalities, teachers can create a more inclusive and effective learning environment. This approach aligns

with the goals of providing practical, knowledge-based education to high support needs students.

This study highlights the necessity of using a multisensory integrated assessment approach in functional mathematics for students. Future research could focus on developing a model or assessment module tailored to this population, employing multisensory integration. Additionally, further academic studies could adopt a comprehensive quantitative and qualitative approach to understand better the need for such methods in assessing high support needs students. Recommendations for future research might include exploring pedagogical practices and curriculum content implementation among special education teachers who work with high support needs students. The implementation of a multisensory approach in assessments requires teachers to have strong pedagogical skills and a deep understanding of curriculum content. This ensures that assessments are not only aligned with educational standards but also cater to the unique needs of high support needs students. By continually refining their practices and staying informed about new developments in special education, teachers can provide more effective and meaningful assessments.

Conclusion

In conclusion, assessment is pivotal for evaluating the effectiveness of educational programs. By employing various strategies, we ensure that assessment methods are continuously updated and improved. The primary goal of teaching low-functionality mathematics is to enhance communication and practical application in daily life. Teachers play a vital role in achieving the national curriculum objectives, which aim to prepare students for post-school life. With the government granting educators the flexibility to conduct formative and summative assessments, integrating multisensory approaches in teaching becomes essential. Although students with high support needs may struggle with critical thinking, they can still learn effectively through experiential methods. To accurately gauge their mastery, multisensory integration can be successfully applied in subjects like mathematics and Malay language composition, aligning with curriculum goals. Therefore, teachers must continually enhance their competencies to adapt to educational transformations and meet diverse student needs. By doing so, they ensure that assessments remain both manageable and successful, ultimately contributing to the overall effectiveness of educational programs and better preparing students for their futures. Continuous professional development for teachers is crucial in maintaining the relevance and efficacy of assessments, thus fostering an inclusive and supportive learning environment for all students.

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