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Assistive Technology and Mathematics for Learners with Disabilities

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Abstract

This study explored the integration of assistive technology (AT) in mathematics instruction for learners with disabilities at Tanauan School of Fisheries during the School Year 2024–2025. It examined the common difficulties encountered by learners, the assistive technologies used by teachers, the challenges faced in implementation, and the support needed for effective integration. The research utilized a descriptive-qualitative design, involving seven mathematics teachers who participated in structured interviews. Findings indicated that learners with disabilities commonly faced challenges such as mathematics anxiety, low self-esteem, difficulty processing mathematical concepts, and sensory impairments. Teachers integrated various assistive technologies, including visual aids, interactive platforms like Kahoot and Khan Academy, and adaptive tools such as screen readers and tactile graphics. Despite their benefits, implementation was hindered by inadequate training, limited resources, and lack of institutional support. The study underscores that for AT to be effective, comprehensive support in the form of financial assistance, professional development, and strong administrative commitment is essential. It concludes that AT can significantly enhance inclusivity, engagement, and mathematical achievement when integrated systematically into instruction.

Keywords: Assistive technology, Mathematics instruction, Learners with disabilities, Inclusive education, Teacher training

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Introduction

Mathematics education has evolved significantly with the integration of technology, redefining how mathematical concepts are taught and learned. Traditional methods, such as lectures and pen-and-paper exercises, remain foundational but often fail to address the diverse learning needs of today's students. Technology, on the other hand, offers interactive and personalized approaches that enhance engagement and understanding, particularly for learners with unique challenges.

Mathematics plays a vital role in modern education, equipping students with critical skills necessary for navigating a technology-driven world (National Council of Teachers of Mathematics, 2018). However, students with disabilities often face barriers in accessing mathematical content due to cognitive, sensory, or physical impairments. Challenges such as dyscalculia, ADHD, and visual or hearing impairments can hinder their ability to process numerical information, retain concepts, or maintain focus, impacting their academic performance and future opportunities.

Beyond academic achievement, mathematics is crucial for daily life tasks such as budgeting, decision-making, and problem-solving, all of which are essential for independent living. Students with disabilities who struggle with mathematics may face long-term consequences that affect their autonomy and quality of life. Ensuring meaningful access to mathematics instruction is vital for fostering both personal and professional success.

Assistive technologies have emerged as powerful tools for addressing these challenges. Tools such as speech-to-text software, digital manipulatives, braille displays, and adaptive learning platforms provide alternative ways for students with disabilities to engage with mathematical content. These technologies help break down barriers, creating inclusive classrooms where every student can participate meaningfully in the learning process.

Despite their potential, assistive technologies are not widely integrated into mathematics instruction. Challenges such as insufficient teacher training, limited resources, and the lack of mathematics-specific assistive tools hinder widespread adoption (Courtade et al., 2020). These obstacles underscore the need for targeted strategies and institutional support to ensure effective implementation in classrooms.

Moreover, empirical evidence on the effectiveness of assistive technologies in mathematics education remains limited. Existing tools often focus on general accessibility rather than addressing the unique cognitive demands of mathematics learning. As a result, educators and policymakers lack clear guidance on how these technologies can be effectively utilized to enhance conceptual understanding, problem-solving skills, and long-term retention of mathematical knowledge among students with disabilities (Antara et al., 2024). This limitation reveals a significant gap in research, particularly in identifying assistive technologies that are specifically designed or adapted for mathematics instruction.

The need to address this gap is further reinforced by international and national policies that advocate for inclusive education and equal access to learning opportunities. For instance, the Individuals with Disabilities Education Act (IDEA) mandates that students with disabilities must be provided with appropriate accommodations, assistive technologies, and individualized support to ensure access to the general education curriculum. Similarly, the Americans with Disabilities Act (ADA) emphasizes equal opportunities in education and prohibits discrimination against individuals with disabilities in public institutions. On a global scale, the United Nations (2017) Convention on the Rights of Persons with Disabilities (CRPD) highlights the importance of accessible and inclusive education systems that incorporate assistive technologies to support learners with disabilities.

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In the Philippine context, inclusive education is supported by the Republic Act No. 7277, which guarantees equal access to quality education and appropriate learning resources for persons with disabilities. Furthermore, the Republic Act No. 11650 strengthens the implementation of inclusive education by ensuring that learners with disabilities receive appropriate educational support, including assistive technologies and accessible learning materials. Despite the existence of these legal frameworks, many educational institutions still struggle to effectively integrate assistive technologies into classroom instruction, particularly in specialized subjects such as mathematics.

Emerging technologies like artificial intelligence (AI), virtual reality (VR), and machine learning hold promise for transforming mathematics instruction. These advancements can provide personalized and immersive learning experiences, particularly for students with disabilities. However, practical implementation remains challenging, especially in underserved communities where resources, infrastructure, and teacher training are insufficient. This highlights the need for research that not only explores innovative technologies but also examines practical strategies for their integration into real classroom settings.

This study aims to explore how assistive technologies can improve mathematics instruction for students with disabilities. By examining innovative tools and their impact on engagement and understanding, the researchers seek to provide educators with actionable insights. As future mathematics teachers, this research equips them with the knowledge to create accessible and inclusive classrooms, empowering all students to succeed.

Objectives

This study deals with the use of assistive technology in Mathematics for learners with disabilities in Tanauan School of Fisheries. These learners are officially enrolled during the School Year 2024-2025. Specifically, this study aims to achieve the following objectives:

1. To identify the common difficulties encountered by learners with disability as perceived by teachers.
2. To determine the assistive technology integrated by teachers in response to the encountered difficulties by learners with disability.
3. To determine the challenges that teachers face in integrating assistive technology into mathematics instructions for learners with disability.
4. To identify support to effectively integrate assistive technology into mathematics instructions.
5. To propose a structured support system for learners with disabilities.

Methodology

Research Design

This section is a descriptive-qualitative method of research that deals with the effectiveness of assistive technology in learning competencies for learners with disabilities in Tanauan School of Fisheries. The study will focus on identifying the types of disabilities that impact student learning, understanding how these disabilities influence mathematical comprehension, and exploring how assistive technologies, can be leveraged to improve engagement and outcomes for these learners.

The study seeks to gather qualitative data through interviews, observations, and focus group discussions with Mathematics teachers. The data collection will focus on identifying the disabilities that affect learning, such as physical, sensory, cognitive, and learning disabilities, and their specific impact on the students' ability to grasp mathematical concepts. By understanding these challenges, the research will also explore how assistive technologies,

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including educational games and interactive learning tools, can be designed to meet the diverse needs of students with disabilities, making mathematics more accessible and engaging.

Respondents

The participants of this study include seven mathematics teachers from Tanauan School of Fisheries during the School Year 2024–2025. These teachers were selected based on the following criteria: 1) they must have direct experience in teaching learners with disabilities, 2) they must be actively involved in mathematics instruction, and 3) they should have experience in integrating or attempting to integrate assistive technologies into their teaching practices. Their participation is crucial in providing insights into the common difficulties encountered by learners with disabilities in mathematics, the assistive technologies used to address these challenges, and the obstacles teachers face in implementing these tools effectively.

The study took place within Tanauan School of Fisheries to ensure a controlled and familiar environment for the participants. Teachers were expected to provide valuable insights into the common difficulties encountered by learners with disabilities in mathematics, the assistive technologies they implement, and the barriers to effective integration of these tools. Their perspectives offered a comprehensive understanding of how assistive technology is currently utilized and what improvements can be made. By examining the experiences of mathematics teachers, this research aims to identify the necessary support and resources to enhance the integration of assistive technology in mathematics instruction. The findings helped develop recommendations for improving teaching strategies and ensuring that learners with disabilities receive the necessary support to succeed in their mathematical education.

Data Gathering Tool

To gather the data to materialize this research work, structured interview was utilized.

Semi-structured Interview. The interview focused on obtaining insights from educators about the integration of assistive technology in mathematics for learners with disabilities. The structured interview questions were meticulously developed based on the challenges and needs identified in teaching mathematics to this group of students. These questions addressed the types of assistive technologies used, their effectiveness, challenges faced by educators, and recommendations for improvement. Before administration, the interview guide underwent validation by experts in special education and assistive technology to ensure clarity, relevance, and appropriateness for the target respondents. Feedback from these experts led to revisions that enhanced the tool's effectiveness in gathering meaningful data. During administration, the interviews were conducted in a comfortable and confidential setting to promote open and honest dialogue. This approach provided valuable insights into the role of assistive technology in enhancing mathematical learning for students with disabilities.

Construction. The structured interview questions were developed to explore the use of assistive technology in mathematics for learners with disabilities. Input from educators, assistive technology specialists, and experts in special education were incorporated to ensure the questions address key aspects such as the types of tools used, their effectiveness, challenges in implementation, and potential improvements. The questions were designed to be clear and focused, ensuring they are relevant and accessible to the participants.

Validation. Prior to administration, the interview guide was reviewed and validated by a panel of experts in the fields of special education, mathematics education, and assistive technology. These experts assessed the clarity, relevance, and comprehensiveness of the questions. Based on their feedback, revisions were made to improve the structure and content of the instrument, ensuring its effectiveness in eliciting detailed and accurate responses.

Administration. The structured interviews were conducted with educators and specialists who have experience using assistive technology in mathematics instruction for

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learners with disabilities. The interview took place in a reserved and comfortable setting to encourage open communication. Participants were assured of confidentiality to foster honest and reflective responses. This method provided valuable insights into the impact and challenges of using assistive technology in mathematics education.

Data Collection Procedure

The researchers initiated the data collection process by preparing and submitting formal letters of request for approval to the Vice Chancellor for Academic Affairs and the Dean of the College of Teacher Education. These letters outlined the purpose and scope of the study, which focus on the use of assistive technology in mathematics for learners with disabilities. The researchers sought permission to conduct data collection activities.

Upon approval, the researchers sent formal invitations to the selected participants, including special education teachers and learners with disabilities. The invitations detailed the study's objectives, the importance of their participation, and how their contributions will provide valuable insights into assistive technology use in mathematics education. Participants were selected based on specific criteria such as their experience or involvement in teaching or learning mathematics using assistive technologies.

The data collection employed a combination of structured interviews and classroom observations. The structured interviews were guided by a standardized interview protocol to ensure consistency in data collection across all participants. These interviews aimed to gather detailed information on the participants' experiences, challenges, and perceptions regarding the use of assistive technology in mathematics instruction.

In addition to interviews, classroom observations were conducted to document the practical application of assistive technologies, such as screen readers, tactile manipulative or specialized software. This allowed the researchers to collect contextual data and gain a deeper understanding of how these tools support mathematics learning for students with disabilities.

All interviews and observations were audio-recorded with the participants' consent to maintain accuracy and authenticity. The audio recordings were transcribed verbatim for analysis. The researchers employed thematic analysis to examine the collected data and identify recurring themes related to the use of assistive technologies in mathematics instruction for learners with disabilities. First, the researchers familiarized themselves with the data by carefully reviewing and rereading the interview transcripts and written responses. Initial observations were noted to highlight significant statements related to learners' difficulties, assistive technologies used by teachers, and challenges in implementation.

Next, the data were coded by labeling meaningful segments that reflected key ideas relevant to the objectives of the study. Similar codes were then grouped to form broader themes such as common learning difficulties in mathematics, assistive technologies used in instruction, challenges in technology integration, and the support needed by teachers.

The themes were subsequently reviewed and refined to ensure that they accurately represented the participants' responses and aligned with the purpose of the study. Finally, the researchers interpreted and described the themes, using representative responses from participants to provide deeper insights into teachers' experiences in integrating assistive technologies in mathematics instruction for learners with disabilities.

To ensure the privacy and confidentiality of participants, personal identifiers were anonymized with the data securely stored with access restricted to the researchers. The findings were presented in aggregated form to prevent the identification of individual participants. Ethical research principles were strictly followed throughout the study, ensuring the participants' rights, privacy, and dignities were upheld at all times.

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Conceptual Framework

To provide clarity on the study, the researchers developed their own conceptual diagram to depict the research flow. The following figure illustrates how the researchers arrived at their conclusions. Notably, the study integrates the use of assistive technology in mathematics education to support learners with disabilities.

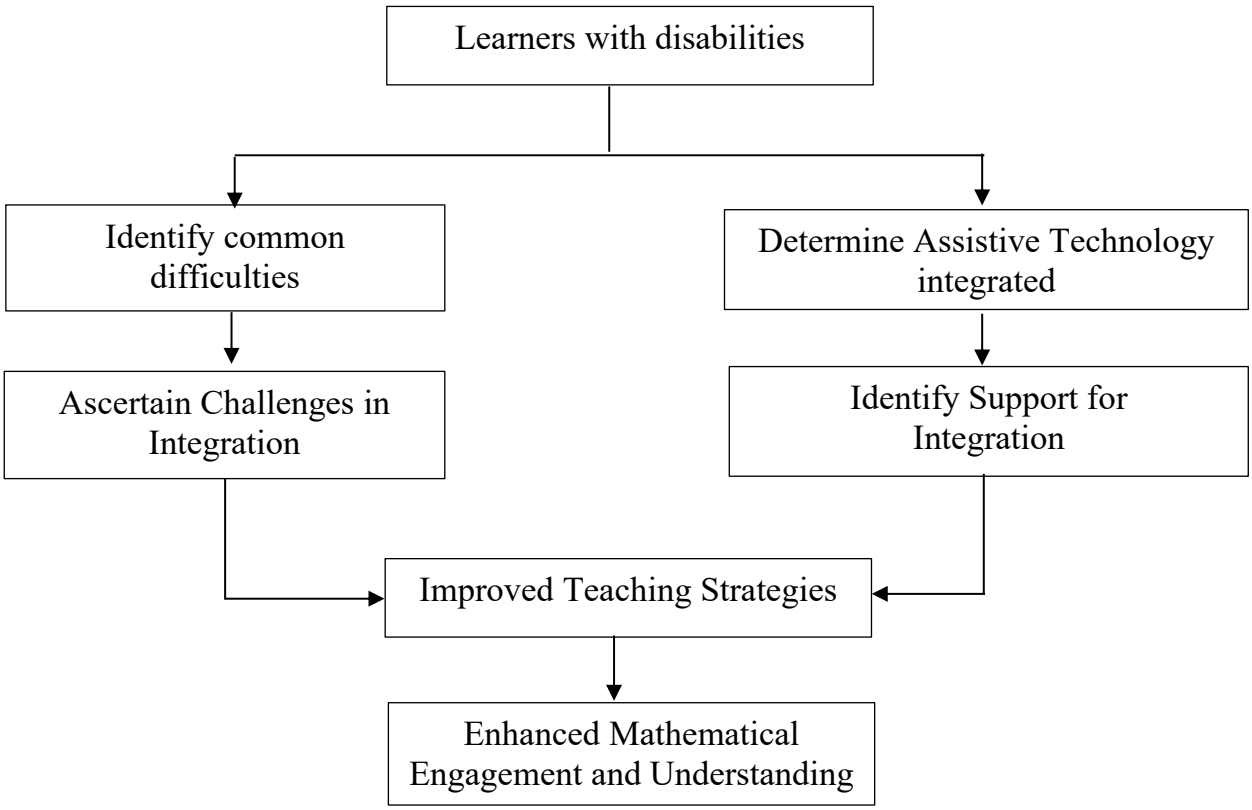


Figure 1 Research Paradigm

The figure presented illustrates the conceptual framework of the study, outlining the systematic process followed by the researchers to achieve the desired outcomes. This framework offers a structured approach to addressing the needs of learners with disabilities, focusing on the integration of assistive technology in mathematics to enhance both engagement and understanding.

The first stage of the research process centers on learners with disabilities. It emphasizes the importance of providing these learners with access to assistive technologies, ensuring equitable educational opportunities and levelling the playing field. By equipping students with the necessary tools, this stage aims to remove barriers to learning, allowing them to fully participate in mathematical education.

The second stage focuses on the integration of assistive tools to create a more inclusive and adaptive learning environment. This stage is built upon individualized teaching approaches that cater to the specific needs of learners with disabilities. By recognizing the strengths, challenges, and potential of each student, educators can develop personalized learning plans that foster both academic and personal growth. These tailored approaches ensure that each learner receives the support needed to succeed.

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The final stage of the framework emphasizes improved mathematical engagement and understanding. It measures the extent to which learners achieve their educational goals, demonstrating their progress in acquiring both knowledge and skills. This stage reflects the outcomes of the integration of assistive technology and individualized instruction, highlighting the impact on learners' overall mathematical performance.

This framework underscores the importance of a holistic approach to supporting learners with disabilities. By combining assistive technology, ethical accessibility, and individualized teaching strategies, educators can cultivate an environment where all students have the opportunity to succeed academically and thrive socially.

Results

1. Common Difficulties encountered by Learners with Disabilities as Perceived by Teachers

The responses revealed that learners with disabilities (LWDs) face multiple challenges in mathematics learning. Thematic analysis identified common difficulties reflected in Table 1.

Table 1 Common Difficulties encountered by Learners with Disabilities as Perceived by Teachers

Themes	Subthemes	Exemplar Texts
Fear and Anxiety	Fear in solving math problems	"Fear in Mathematics and lack of confidence are the reasons for disliking the subject." [P5]
	Mathematics anxiety	"When they overcome their fear in solving mathematics." [P1]
Low Self-Esteem	Inconsistent learning focus	"Low self-esteem, no consistency in learning focus." [P2]
	Lack of confidence	"Lack of confidence or anxiety due to past difficulties." [P6]
Conceptual Issues	Difficulty processing concepts	"LWDs have difficulty in processing mathematical concepts." [P3]
	Struggles with problem-solving	"Learners often struggle with problem solving and understanding abstract concepts." [P4]
Sensory Impairment	Poor eyesight affects learning	"My learners suffer from poor eyesight... The primary difficulty in math is appreciating math visually." [P7]

The table shows the analysis of participants' responses in the conducted interviews, which revealed four major themes: fear and anxiety, low self-esteem, conceptual issues, and sensory impairments. A subtheme under fear and anxiety, mathematics anxiety, emerged when Participant 1 stated:

"When they overcome their fear in solving mathematics." [P1]

This statement indicates that learners with disabilities often experience anxiety when faced with mathematical problems, which affects their confidence and engagement in learning.

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This fear often stems from repeated struggles, negative experiences, and difficulties in processing mathematical concepts. Over time, they may develop the belief that they are incapable of doing math, leading to avoidance and low motivation. Mathematics anxiety can lead to avoidance behaviour and a lack of motivation to participate in math-related activities. According to Smith & Johnson (2020), math anxiety is a significant factor affecting students' performance, particularly among those with learning disabilities.

Another subtheme, low self-esteem, was observed in the responses of several participants, such as:

"Lack of confidence or anxiety due to past difficulties, inconsistent concentration and focus." [P6]

This statement suggests that prior negative experiences in mathematics may contribute to reduced self-confidence among LWDs when engaging with mathematical tasks. Learners who struggle with mathematics from an early age may develop a fixed mindset that prevents them from believing in their ability to improve. This aligns with the study of Brown and White (2019), which states that building a positive learning environment is essential in fostering confidence among students with disabilities.

A significant theme that emerged was conceptual issues. Participant 3 expressed that:

"LWDs have difficulty in processing mathematical concepts. Some struggle in calculations and problem-solving, recalling math facts and formulas." [P3]

This response indicates that LWDs experience cognitive barriers when learning mathematics, which affects their ability to understand concepts and apply formulas correctly. These difficulties often result in slower progress and frustration. According to Rubinsten and Tannock (2010), learners with math-related learning disabilities often struggle with number processing, working memory, and abstract reasoning, key cognitive functions needed in mathematics. To address these challenges, structured learning approaches such as step-by-step instruction, visual aids, and scaffold problem-solving are essential in supporting their comprehension and helping them build confidence.

Lastly, under sensory impairment, it was noted that visual disabilities greatly impact learning in mathematics. Participant 7 stated:

"My learners suffer from poor eyesight... The primary difficulty in math is appreciating math visually." [P7]

This emphasizes that visual impairment presents a major barrier in accessing mathematical content, particularly when instructional materials rely heavily on visual representation. According to Shahzad et al. (2026), assistive technology, such as screen magnifiers and tactile graphics, can significantly enhance mathematical learning for students with visual impairments.

2. Assistive Technology Integrated by Teachers

Table 2 shows the various difficulties that impact the integration of assistive technology in mathematics education for learners with disabilities. Several themes emerged after thorough analysis namely cognitive and emotional challenges, physical and sensory limitations, diverse needs of learners with disabilities, engagement and motivation barriers, learning gaps and instructional challenges, technology access and training limitations, and implementation and support challenges.

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Table 2 Assistive Technology Integrated by Teachers

Theme	Subthemes	Exemplar Texts
Cognitive and Emotional Challenges	Math anxiety and low self-esteem Difficulty in understanding concepts and solving problems	"LWDs have difficulty in processing mathematical concepts…" [P3] "Low self-esteem, no consistency in learning focus" [P2]
	Negative attitude toward mathematics	"Fear in Mathematics and lack of confidence…" [P5]
Physical and Sensory Limitations	Visual and hearing impairments	"My learners suffer from poor eyesight…" [P7]
	Writing and reading difficulties due to physical/sensory issues	"If they cannot see well, hear, walk, or not able to write well." [P1] "Hearing impairment, difficulty in listening and communicating with the teacher and classmates." [P5]
Diverse Needs of Learners with Disabilities	Varying challenges depending on disability type	"Each type of disability requires different [support]…" [P4]
	Emotional, social, and performance variations	"Different disabilities have unique difficulties…" [P7] "Some strive, some are not…" [P7]
Engagement and Motivation Barriers	Frustration and confusion with math tasks	"These difficulties lead to frustration…" [P3]
	Reduced motivation and attention	"It hinders the motivation and engagement…" [P2, P6] "Lower engagement as students may feel discouraged…" [P4]
Learning Gaps and Instructional Challenges	Weak foundational math skills	"Reading comprehension and writing numbers…" [P6]
	Reading and comprehension difficulties	"New concepts take time to understand…" [P5] "Difficulty in following instructions…" [P2]
Technology Access and Training Limitations	Lack of tools and unfamiliarity with assistive technology	"Limited resources and time constraints…" [P4]
	Limited training for teachers and reluctance from students	"Lack of familiarity with available tools…" [P6] "Some students were also reluctant…" [P3]
Implementation and Support Challenges	Inconsistent use of assistive technology	"Lack of support results to inconsistent implementation…" [P3]
	Lack of institutional support and training	"Without proper training and institutional support…" [P4] "If lack resources, they are less motivated…" [P2]

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The table presents the analysis of participants' responses regarding the integration of assistive technology and the challenges learners with disabilities (LWDs) face in mathematics. It revealed several major themes: cognitive and emotional challenges, physical and sensory limitations, diverse learner needs, engagement and motivation barriers, learning gaps, and technology-related issues. One of the major themes is the cognitive and emotional challenges, emerged strongly from the responses. Participant 3 stated:

"LWDs have difficulty in processing mathematical concepts…" [P3]

This response indicates that students struggle with understanding and applying mathematical ideas. This cognitive strain often leads to emotional distress, such as frustration and academic burnout. Participant 2 stated:

"Low self-esteem, no consistency in learning focus." [P2]

The low self-esteem is often rooted in repeated failure or negative experiences, which can reinforce a fixed mindset and lead to disengagement. According to Gök et al. (2019), learners with learning disabilities tend to experience higher levels of math anxiety and lower confidence, which directly correlates with their academic performance and willingness to participate in class activities. Emphasized that emotional challenges such as fear and hopelessness often serve as significant barriers to mathematical achievement among students with special needs.

Another important theme was physical and sensory limitations, where visual and hearing impairment hinder students' access to math content. Participant 7 stated:

"My learners suffer from poor eyesight…" [P7]

It emphasizes a critical barrier faced by students with visual impairment in mathematics instruction. Visual challenges limit students' ability to engage with traditional instructional materials, particularly when mathematical concepts are presented through graphs, diagrams, charts, or small-text problem sets. According to Roberts and Lewis (2020), students with visual impairment often struggle with standard print-based content, which can hinder their academic performance and confidence unless proper accommodations are in place. Research by Al-Azawei et al. (2016) support this, noting that inclusive education must employ multimodal learning resources and assistive technologies such as screen readers, tactile graphics, and text-enlarging tools to ensure meaningful participation for learners with sensory disabilities. Additionally, emphasize that without access to appropriate visual aids or technology for example large-font materials or magnifiers, visually impaired students are at a significantly higher risk of academic disengagement, particularly in visually demanding subjects like mathematics. Therefore, addressing visual impairment through targeted support and accessibility measures is essential for fostering equitable learning environments.

"Fear in Mathematics and lack of confidence…" [P5]

Sensory impairments limit learners' ability to receive instruction, especially when teaching relies heavily on auditory and visual cues. According to Al-Azawei et al. (2016), learners with sensory disabilities require adaptive technologies and multimodal resources to participate meaningfully in digital and traditional learning environments. Without proper accommodations, these students are at a higher risk of falling behind.

The diverse needs of learners with disabilities also became apparent through the interviews. Teachers acknowledged the necessity of differentiated support depending on the type and severity of each student's condition. Participant 4 stated:

"Each type of disability requires different [support]…" [P4]

This highlights the need for inclusive education practices that recognize and respond to learner variability. Participant 7 stated:

"Some strive, some are not," [P7]

This response indicates that the wide range of academic responses among LWDs. A study by Schwab & Alnahdi (2020) emphasized that inclusive teaching must be rooted in

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universal design for learning (UDL) principles to effectively cater to students with diverse learning profiles. Without tailored instruction, students with disabilities often face compounded barriers in core subjects like mathematics.

A recurring theme was engagement and motivation barriers, where frustration and confusion caused by complex tasks diminish learners' drive to participate. Participant 3 stated:

"These difficulties lead to frustration…" [P3]

"Lower engagement as students may feel discouraged…" [P4]

These experiences reflect a broader phenomenon where repeated academic difficulties result in emotional withdrawal and avoidance behavior. Kiuru et al. (2019) found that students with persistent struggles in mathematics report decreased enjoyment and increased anxiety, which significantly impacts their classroom behavior and academic outcomes. Furthermore, Kaya et al. (2022) suggested that fostering a positive emotional climate in the classroom can mitigate these motivational barriers and enhance learning outcomes for students with disabilities.

Another key issue was learning gaps and instructional challenges, particularly related to foundational skills and reading comprehension. Participant 5 stated:

"Fear in Mathematics and lack of confidence…" [P5]

This points to delayed cognitive processing that slows down the acquisition of new mathematical ideas. Participant 6 stated:

"Reading comprehension and writing numbers…" [P6]

These issues contribute to gaps that widen over time, making it difficult for learners to progress. According to Seo and Heo (2019), struggling learners often need scaffolded instruction and repeated practice to internalize key mathematical skills. Without proper interventions, these gaps may lead to cumulative academic failure. Milošević et al. (2024) further emphasized that unresolved foundational deficits in math can lead to long-term academic avoidance and poor achievement, particularly among students with learning differences.

The table also reflected technology access and training limitations, a theme underscoring systemic barriers in the implementation of assistive tools. Participant 6 stated:

"Lack of familiarity with available tools," [P6]

"Some students were also reluctant." [P3]

These insights suggest that the mere presence of assistive technology is not enough and both students and teachers must receive proper training and support to integrate these tools effectively. According to Alper & Raharinirina (2006), many teachers feel unprepared to use assistive technologies due to limited exposure during professional training. This hinders their confidence and competency in inclusive settings. Furthermore, Jwaifell and Gasaymeh (2013) highlighted that students' reluctance to use assistive technology is often tied to stigma and lack of familiarity, underscoring the need for awareness-building and positive reinforcement.

Implementation and support challenges were mentioned frequently. Participant 4 stated:

"Without proper training and institutional support…" [P4]

"If lack resources, they are less motivated." [P2]

These responses indicate that successful integration of assistive technology depends heavily on administrative backing, teacher training, and the availability of resources. According to Nelson & Hawk (2020), institutional commitment including policy alignment, funding, and on-going professional development is essential for sustaining inclusive practices and maximizing the benefits of assistive technology.

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3. Challenges faced in Integrating Assistive Technology into Mathematics Instruction

Table 3 presents the various assistive technologies used by educators to support learners with disabilities (LWDs) in mathematics instruction.

The table identifies the assistive technologies commonly used by educators to support LWDs in mathematics.

Visual and hands-on tools, such as step-by-step presentations and manipulative, help students better understand mathematical concepts.

Table 3 Challenges faced in Integrating Assistive Technology into Mathematics Instruction

Themes	Subthemes	Exemplar Texts
Visual and Hands-On Tools	Use of visual-based instruction	"I integrate visual-based learning tools to support understanding." [P4]
Digital Learning Tools	Interactive math websites	"Interactive math software and learning websites such as Kahoot Khan Academy." [P3]
Accessibility Features	Text enlarging and contrast tools	"Providing activity sheets with large fonts." [P7]

Participant 4 stated:

"I integrate visual-based learning tools to support understanding," [P4]

It highlights the importance of visual aids in helping students comprehend complex topics. Integrating visual-based learning tools into mathematics instruction significantly enhances comprehension, particularly for students with learning disabilities. Visual representations, such as diagrams and models, provide concrete ways to grasp abstract mathematical concepts which facilitate better understanding. Research indicates that employing visual strategies can support memory and processing in students with learning disabilities, enabling them to engage more effectively with challenging mathematical topics (Hord et al., 2021). Similarly, interactive learning tools such as Kahoot and Khan Academy provide engaging methods for students to practice mathematical skills. As Participant 3 mentioned:

"Interactive math software and learning websites such as Kahoot, Khan Academy," [P3]

These platforms offer a gamified learning experience that increases motivation and participation. Integrating interactive mathematics software and learning platforms like Kahoot and Khan Academy into educational settings has been shown to significantly enhance student engagement and academic performance. Kahoot, a game-based learning platform, employs gamification strategies that foster motivation and active participation among students. A comprehensive meta-analysis by Özdemir (2025) indicates that Kahoot has a substantial positive effect on student motivation. The study also suggests that Kahoot can reduce student anxiety by creating a more engaging and supportive learning environment. Accessibility features also play a crucial role in supporting students with visual impairments. Participant 7 explained:

"Providing activity sheets with large fonts,"[P7]

It emphasizes how text enlargement helps visually impaired students interact with mathematical content effectively. Integrating assistive technologies improves student engagement, enhances retention, and reduces math-related anxiety. These findings indicate that a combination of visual, digital, and accessibility-focused tools can significantly enhance the learning experience for students with disabilities in mathematics education.

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4. Support Needed to Effectively Integrate Assistive Technology

Table 4 shows the various forms of support needed to effectively integrate assistive technology in mathematics education for learners with disabilities.

The table presents the effectiveness of integration of assistive technology in mathematics instruction for learners with disabilities require various forms of support. Participants emphasized the need for institutional backing, financial assistance, teacher training, and collaboration among stakeholders. One of the main barriers identified was the lack of funding and institutional backing for assistive technology. Participant 1 stated:

"Financial support from the government to support these learners having disabilities." [P1]

This indicates that without sufficient financial resources, schools struggle to provide necessary tools and accommodations for students with disabilities. Government financial support plays a crucial role in providing necessary resources and accommodations for learners with disabilities.

Table 4 Support Needed to Effectively Integrate Assistive Technology

Theme	Sub-theme	Exemplar Texts
Resource Provision	Financial Support	"Financial support from the government to support these learners having disabilities." [P1]
	Assistive Technology Tools	"Schools should provide training, access to assistive tools, and a supportive environment." [P4]
	Learning Materials	"Providing learner's activity sheet with large fonts (LAS) is most applicable…" [P7]
	Visual Aids	"For those with poor eyesight, I can enlarge my visual aids." [P1]
	Equipment Access	"Lack of familiarity and availability of the equipment." [P2]
Teacher Training & Capacity Building	Lack of Training	"Lack of familiarity with available tools… do not know how to use." [P6]
	Need for Development Programs	"The school must provide programs and strengthen them…" [P6]
	Integration Challenges	"Limited resources and time constraints make it difficult…" [P4]
Institutional and Administrative Support	School Programs	"The school must have an effective program." [P2]
	Policy and Planning	"It requires strong support… training, resources and institutional commitment." [P3]
	Administrative Commitment	"The school must provide programs and strengthen it…" [P6]
Collaboration and Stakeholder Engagement	Teacher Collaboration	"Working together allows teachers to share strategies…" [P4]
	Parent and Expert Involvement	"Collaboration among teachers, administrators, parents, and technology experts…" [P6]
	Collective Decision-Making	"Conduct a meeting to talk about possible solutions..." [P1]

In the Philippines, the enactment of Republic Act No. 11650 in March 2022 underscores this commitment by mandating free public early and basic education services for learners with disabilities. This legislation also calls for the establishment of Inclusive Learning Resource

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Centers in every city and municipality, aiming to enhance educational accessibility and inclusivity (Department of Education, 2022).

Furthermore, Participant 4 emphasized, "Schools should provide training, access to assistive tools, and a supportive environment," highlighting the importance of school administrations prioritizing accessibility and inclusive education. Effective integration of assistive technology in educational settings necessitates comprehensive teacher training, access to appropriate tools, and the cultivation of a supportive environment. Educators proficient in assistive technologies can tailor learning experiences to accommodate diverse student needs, enhancing engagement and academic performance. Retiro et al. (2025) emphasized that while teachers generally hold positive attitudes toward assistive technology, its successful implementation depends on increased access to specific tools and improved teacher training to ensure effective integration into inclusive and special education classrooms in the Philippines.

Educators require continuous training to effectively use assistive technology in their instruction. Participant 6 stated:

"The school must provide programs and strengthen them so that it will be beneficial to learners with special needs." [P6]

Without proper training, teachers may not fully utilize available resources or implement strategies that enhance learning for students with disabilities. A study by Jones & Smith (2019) found that professional development in assistive technology significantly improved the implementation of adaptive learning tools in classrooms. Equipping teachers with the necessary skills ensures that assistive technologies are integrated effectively into lesson planning and instruction, thereby improving student outcomes.

Collaboration between teachers, administrators, parents, and technology experts was also identified as essential for successful implementation. Participant 2 stated:

"Collaboration among teachers, administrators, and parents helps create a sustainable program for assistive technology." [P2]

This suggests that when all stakeholders work together, they can better assess student needs, secure necessary resources, and ensure the technology is used effectively. Schools that foster a collaborative environment where all stakeholders are involved in decision-making are more likely to create sustainable, long-term solutions for integrating assistive technology.

5. Proposed Structured Support System for Learners with Disabilities

To address the unique needs of learners with disabilities, the researchers propose the SMART Support Framework, a guiding model that outlines key strategies to enhance instruction, foster engagement, and ensure equitable learning opportunities for students with disabilities. Each component of SMART represents a critical element in building an effective and sustainable support system.

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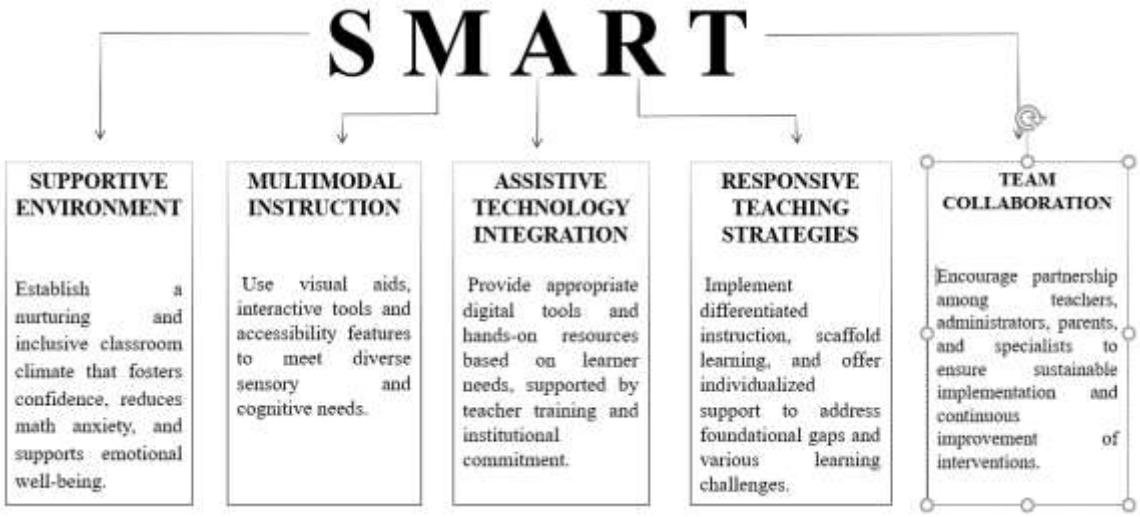


Figure 2 SMART Support Framework

The SMART Framework is a structured support system designed to help learners with disabilities succeed in mathematics by addressing their cognitive, emotional, and sensory needs. It promotes an inclusive classroom environment that reduces math anxiety, builds confidence, and encourages participation. The framework emphasizes multimodal instruction, assistive technology integration, and responsive teaching strategies such as differentiation and scaffolding. It also highlights the importance of collaboration among teachers, administrators, parents, and specialists to ensure continuous support. The SMART Framework serves as a practical guide for mathematics teachers in delivering inclusive and responsive instruction for learners with disabilities.

Discussions

After analyzing and interpreting the gathered data, the following key findings emerged:

1. Learners with disabilities face multiple challenges in mathematics education. These challenges include cognitive difficulties, where students struggle to understand abstract mathematical concepts, psychological challenges such as anxiety and lack of confidence, and sensory difficulties that hinder their ability to fully engage in lessons. Teachers reported that these challenges significantly affect student participation and learning outcomes making it essential to provide specialized instructional support.

2. Teachers integrate various forms of assistive technology to support learners with disabilities. This includes the use of visual aids such as enlarged text, graphical representations, and tactile materials to enhance comprehension. Digital tools like speech-to-text applications, screen readers, and interactive educational software are also utilized to accommodate different learning needs. These technologies help bridge learning gaps, promote inclusivity, and create a more engaging mathematics learning environment.

3. The integration of assistive technology in mathematics instruction faces multiple barriers. Teachers identified several challenges, including the lack of institutional support, insufficient financial resources, and limited access to training on assistive technology. Many educators expressed difficulties in acquiring the necessary skills to effectively implement these technologies, leading to inconsistencies in their application. Additionally, outdated school facilities and a shortage of technological resources further hinder the seamless integration of assistive technology into the curriculum.

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4. There is a need for structured support systems to ensure the sustainable integration of assistive technology. Providing ongoing professional development programs for teachers, securing adequate funding for assistive tools, and fostering strong collaboration among educators, parents, and policymakers are crucial steps toward addressing the current challenges. By strengthening these support mechanisms, schools can create a more inclusive educational environment that promotes equitable learning opportunities for all students.

5. The SMART Framework offers a structured support system that addresses the cognitive, emotional, and sensory needs of learners with disabilities, helping reduce fear and anxiety in math and building a foundation for confidence and engagement. By creating a supportive environment and using inclusive strategies, it empowers learners to overcome emotional barriers and participate more actively in mathematics learning.

Conclusion and suggestions

Conclusions

Based on the above-mentioned findings, the following conclusions were drawn:

1. Learners with disabilities require targeted interventions in mathematics education. The study revealed that without specialized instructional strategies, these students struggle with comprehension and engagement.

2. Assistive technology plays a crucial role in enhancing the learning experience of students with disabilities. The use of visual, digital, and interactive tools significantly contributes to improved comprehension, motivation, and participation among students.

3. Institutional and financial constraints limit the successful adoption of assistive technology. The lack of funding, outdated infrastructure, and insufficient teacher training are major obstacles in promoting an inclusive learning environment.

4. Sustainable implementation of assistive technology requires collaboration and continuous professional development.

5. The proposed SMART structured support by the researchers maybe used by the mathematics teachers.

Limitations

1. The study focused primarily on the perspectives of teachers regarding the difficulties encountered by learners with disabilities and the assistive technologies used in mathematics instruction. The perspectives and experiences of the learners with disabilities themselves were not directly included.

2. The study involved a limited number of participants from specific educational settings, which may limit the generalizability of the findings to other schools, regions, or educational contexts with different resources and support systems.

3. The data collected were based mainly on teachers' self-reported experiences and perceptions, which may be influenced by personal biases, interpretations, or recall limitations.

4. The study specifically examined the integration of assistive technologies in mathematics instruction, and therefore the findings may not fully reflect the use and challenges of assistive technologies in other subject areas.

5. The study did not extensively examine the long-term effectiveness or impact of assistive technologies on learners' mathematical achievement and independence, as it was limited to observations and experiences within a specific time frame.

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Recommendations

Considering the significant findings revealed and conclusions drawn in this study, the researchers suggested the following recommendations.

1. Develop and implement a structured support system for learners with disabilities. Schools should establish dedicated intervention programs that cater to the specific needs of students with disabilities.

2. Promote the consistent and effective use of structured support system for learners with disabilities through clear implementation guidelines, ongoing monitoring of student progress, and strong collaboration among teachers, administrators, and support staff to maintain inclusive educational practices.

3. Strengthen the integration of assistive technology by improving access to resources and training and increase institutional and financial support for assistive technology implementation.

4. Provide regular teacher training and capacity-building programs and conduct further research on the long-term impact of assistive technology on student performance.

5. Promote strong collaboration between teachers, school administrators, parents, and support staff to enhance inclusive practices and ensure the holistic development of learners with disabilities.

New knowledge and the effects on society and communities

This research provides new understanding about the integration of assistive technology in mathematics instruction for learners with disabilities. It shows how tools such as screen readers, tactile graphics, interactive software, and digital manipulatives improve accessibility and engagement. These technologies help students with diverse needs participate more actively in learning and promote equal opportunities in education.

The study also highlights the importance of teacher training and preparedness in using assistive technology. When teachers are equipped with the right knowledge and skills, they can adjust their teaching methods to support individual learning needs. This approach helps students become more confident, independent, and motivated to learn mathematics while reducing fear and anxiety.

In a broader sense, the study contributes to building an inclusive society that values diversity and equality. Providing access to assistive technology allows learners with disabilities to become more involved in school and community activities. It encourages cooperation, empathy, and respect among students, teachers, and families.

The findings can guide schools and policymakers in improving educational programs and creating inclusive environments. By supporting the use of assistive technology, communities can ensure that every learner has the opportunity to succeed academically and socially. This leads to stronger, more inclusive communities where education becomes a shared path toward progress and empowerment.

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