Using Assistive Technology to Differentiate and Accommodate Students with Special Needs Facing Learning Difficulties in Mathematics

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Abstract

This paper will discuss how assistive technology forms the basis of differentiation and support for students with special needs when conquering specific math learning difficulties. The Department of Special Education utilized a quantitative research design to collect data from 240 teachers through a structured, self-developed questionnaire. The use of simple random sampling maximized representative samples and minimized biases. We established the effects of AT in terms of differentiated instruction, increased student engagement, and an inclusive learning environment. Teachers estimated complex mathematical concepts using AT tools, such as virtual manipulatives and educational apps, as easier to understand and improve student confidence and participation levels. Overall, the findings indicate a need for continuous teacher training and resource allocation to effectively integrate these into a holistic classroom experience. The conclusion is that integrating assistive technology into education is a gateway to ensuring that every special need student receives quality learning in mathematics, thus equalizing access to education. Recommendations call for investment in professional development of the teachers, adequate resources for AT tools, and inculcation of AT provision in curriculum design. Further research should investigate the long-term effects of AT on students' achievement in other subjects.

Keywords: Assistive Technology, Students with Special Needs, Learning Difficulties.

Introduction

Assistive technology (AT) seems effective as a transforming tool within education settings, especially when one deals with students that have special needs and face extreme difficulties in the learning of math. The low-tech tools, such as manipulatives and high-tech software applications, have proved quite useful in enhancing math-related understanding and engagement. The use of AT accommodates various learning styles and needs, thereby enhancing the outcomes of students with disabilities (Al-Dababneh & Al-Zboon, 2022). By offering tailored tools to interact with mathematical concepts, AT reduces the frustration that is often in the minds of the students who find it challenging to deal with mathematical understanding. Such a practice promotes the students' involvement and eventually boosts up their achievement levels (Wen et al., 2020). The use of AT for learning purposes provides an accessible classroom environment because

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it allows learners with learning disabilities to use mathematical content to access and make meaning with mathematical understanding through cognitive processes.

Students diagnosed with learning disabilities, autism spectrum disorders, or attention deficit hyperactivity disorder face specific challenges due to the abstract and complex nature of mathematics. This usually manifests in spatial reasoning, problem-solving ability, and abstract conception of ideas. Research studies, however have determined that such problems can be mitigated by assistive technologies, including dynamic geometry software, talking calculators, and math learning applications. For instance, the visual and audio aid breaks down complicated mathematical problems into palatable components making it accessible and easier to understand (Reshma, 2023). This will help students with special needs remember their math concepts and perform better in tasks that involve problem-solving activities.

In-class integration of AT supports the differentiated instruction methods, which are absolutely required because learning, happens in a heterogeneous group where students differ significantly in their ability levels. Differentiation enables teachers to modify experiences according to the needs of each student. It could be in adjusting topic speeds, the depth with which specific mathematics concepts need to be done, and the complexity the approaches to solution (Strogilos et al., 2023). In particular, this method works well for individuals who have disabilities since it eliminates some amount of stress and grants an avenue of learning that helps them understand at their preferred level. In such a case, virtual technologies like virtual manipulatives tend to assist students in learning mathematics, as they can better view mathematical expressions in an interactive, hands-on approach (Sandra & Kurniawati, 2020). Despite the numerous benefits of AT, issues such as teacher training and the expensive nature of these tools make them unaffordable for many individuals (Alnasser, 2021; Lynch et al., 2021). It is, therefore, essential to find out what may hinder its full use in special education mathematics.

Despite extensive research on the appropriateness of using AT in mathematics education, there is still a significant gap in understanding the long-term implications of this approach to student achievement. Most of these studies remain focused on short-term effects, that is, increased engagement and immediate improvements in understanding mathematics (Myers et al., 2021). However, longitudinal studies are missing on how they understand the long-term effects of AT in students' mathematical capabilities as they transfer from one level of schooling to another. This gap calls for conducting even more extensive research to explore the long-term AT impact on learning outcomes in particular. In addition, although many researchers have carried out studies into the merits of AT on general differentiation in class, only very few have explored its use in special education mathematics instruction. This study bridges those gaps through the exploration of the long-term effects of AT for students with a learning disability in mathematics, focusing particularly on how it supports differentiated instructional strategies. It is this knowledge that will build on best practices in the integration of AT in mathematics teaching to impact improvements in learning outcomes among special education students.

Research Objective

To examine the effectiveness of assistive technology to differentiate and accommodate students with special needs facing learning difficulties in mathematics.

Literature Review

Assistive technology, one of the most important tools that helps students with special needs overcome learning issues associated with mathematics, ranges from low-tech manipulatives to

high-tech software that enhances mathematical understanding. In the words of many different researchers, applying AT can dramatically enhance academic outcomes by making room for various types of learning needs (Al-Dababneh & Al-Zboon, 2022). For children with special needs, the ability to engage with math concepts through accessible instruments reduces frustration and enhances connection to the subject, thus attaining greater fruition levels (Wen et al., 2020).

Mathematics presents a unique challenge to students with specific disabilities, ranging from learning disabilities to autism spectrum disorder and attention deficit hyperactivity disorder. These conditions often manifest in areas such as abstract thinking, problem-solving, and spatial reasoning. According to Lien et al. (2023), studies indicate that assistive technology such as dynamic geometry software, talking calculators, and math-based educational apps assist the children in overcoming these challenges as they provide the students with visual and auditory support. The breaking of complex problems into manageable parts by AT matches the cognitive processes students with special needs have, thereby aiding the understanding and retention of mathematical concepts (Reshma, 2023).

The implementation of AT in the classroom also aids in differentiation. It is important to consider differentiation in order to meet the diverse needs of students, especially those with disabilities. Teachers who embrace AT can therefore employ differentiated instruction while focusing on the variation of pace, depth, and complexity in the mathematical content for the students (Strogilos et al., 2023). In differentiated instruction, students with special needs are able to focus on what they understand so as to reduce their anxiety and provide an inclusive learning atmosphere. For instance, virtual manipulatives enable students to represent math concepts at their own pace, thereby enhancing their understanding (Sandra & Kurniawati, 2020).

Moreover, math AT helps support children with an IEP. Federal laws like IDEA mandate the appropriate creation of supports for any student with a disability, including AT. Research has shown that inclusion of AT in students' IEPs greatly improves their performance in mathematics-based learning. The integration provides access to content that would have otherwise been inaccessible. For instance, the use of screen readers and voice recognition can enable students who are visually or physically impaired to access mathematical content more effectively, thereby ensuring equitable access to the curriculum (Greenstein & Zhang, 2022).

Another essential benefit of assistive technology is the higher self-efficacy of students. Students with special needs typically exhibit lower self-confidence in mathematical activities due to repeated failures in traditional instructional settings. Using AT effectively, however, will create an increase in the confidence of students through instant feedback and then positive reinforcement. For instance, in games that are math-based, students' practice helps them develop perseverance and builds self-confidence due to the low-stakes environment (Reddy et al., 2021).

Despite extensive publications on the effects of AT, the issue of its uptake in the classroom persists. According to one scholarly opinion, there is a lack of teacher preparedness for work in this collaborative environment. Numerous research studies have demonstrated that the majority of mathematics teachers do not receive sufficient training on the use of applicable supporting technology in mathematics teaching and learning, particularly when working with special needs students who require differentiation and accommodation. Undertraining usually translates into minimum usage of ATs and limits the benefits for students. There is a crucial need for professional development programs to help teachers responsibly integrate AT in mathematics curricula.

Another critical factor hindering the achievement of access to AT by students with special needs is cost. Most high-tech tools like complex software and equipment are too costly to meet the budgets of many school districts. Funding programs exist, but Lynch et al. (2021) state that they

may not often be enough to cover all emerging needs in a classroom for students with special needs. Therefore, teachers frequently must rely on a combination of low-tech and high-tech support, emphasizing cost and the needs of their students.

Further research is also needed in exploring the long-term impact of AT use on mathematics achievement of students with disabilities. Although studies show that some students respond fast to increase their engagement and achievements, only a few studies have investigated the effect of AT on the mathematical knowledge of these students over time. Long-term effects of AT are very crucial to the development of best practices in its use and ensuring that students continue to benefit from it as they go about further in school (Myers et al., 2021).

Involving parents is a requirement for the success of assistive technology interventions. It is only highly involved participation by parents in the choice and application of AT by their children that can significantly use the tool effectively on the part of students. The knowledge of parents about how AT can support their child's mathematical learning helps in reinforcement of use at home such that learning becomes homogenous. Parents also, through advocacy in the IEP meeting, can ensure that their children obtain the skills to master mathematics effectively (Golini, 2024).

Apart from the direct instructional advantages, assistive technology promotes collaboration and communication between students with and without special needs. For instance, students can engage with their peers on problem-solving exercises through interactive whiteboards, shared math apps, and online forums. In this manner, collaborative tools promote community and inclusiveness, allowing students with special needs to engage in collaborative work based on their learning style (Rao et al., 2021).

However, while this is a promising avenue to pursue, AT should not forget the call for building formative assessment literacy. Technology can assess learners' ongoing needs and thus design the subsequent instruction. There should be constant assessment in mathematics because, although students have the mental calculations to solve the given problems, their knowledge and understanding are still being assessed on the move (See et al., 2022).

Research also demonstrates that AT improves the delivery of executive functions skills, a group of skills that students with disabilities are most likely to struggle with. Task managers, digital organizers, and visual scheduling apps can aid in the development of a plan, organization, and management of learning tasks, thereby preparing students to solve mathematics problems in an orderly manner. Supporting these simple cognitive skills helped students make sense of mathematics besides translating to improvement in their general performance at the academic level (Anderson & Marino, 2023).

However, much evidence grows over the requirement to integrate AT in mathematics, technology in itself can never be the solution. The combination of teacher experience, thoughtful instructional design, and continuous support in student learning cannot happen without an integrated approach to AT. When all these things come together, the capacity of technology to greatly enhance mathematical learning for students with special needs is well described by Bereczki and Kárpáti, (2021).

It also helps instill independence in a child with special needs during class. With this kind of AT, the student is in a position to perform tasks that would otherwise be tedious and involve constant support from teachers to complete them independently. The student with dyscalculia will find it possible to use software that reads the math problem out loud, eliminating the need for constant teacher assistance (Kisanga & Kisanga, 2022).

Another very essential characteristic of AT in mathematics is that it contributes to equity in education. Through AT, each student is afforded equal access to the curriculum and other

opportunities to learn beyond their disability or ability. This way, the broader purpose of education-that is, inclusive education-is espoused, enabling students with disabilities to be well-equipped with requisite abilities and resources to achieve their goals along with their peers (Alam & Mohanty, 2023).

We must view assistive technology as part of a much larger support package within the educational ecosystem. We should not administer it alone, but rather integrate it into a holistic system that includes effective teaching techniques, collaborative learning, and monitoring. When used together with such factors, AT makes students overcome the challenges related to special needs and succeed in their mathematical learning experience (WHO, 2022).

Research Methodology

Research Design

This paper utilized a quantitative research design to explore the perspectives of teachers on the subject matter. We employed a quantitative method to ensure objectivity, reliability, and generalizability of the findings. We collected the data using a structured, self-developed questionnaire that measures the varied dimensions of the research focus.

Population

The population for this study was the special education department's teachers. These teachers held positions in diverse educational institutions, boasting extensive experience and expertise in their respective fields of interest. We selected the population based on their knowledge and experience, which provided valuable insights into the research questions.

Sample Size and Sampling Technique

We selected 240 teachers for this study using simple random sampling. This sampling mode guarantees an equal chance of selection for every member of the population. It lowers the likelihood of selection bias and increases the representativeness of the sample. Random sampling guarantees the inclusion of all diverse aspects and features from the larger population in the sample, thereby enhancing the generalizability of the results.

Research Instrument

We constructed a self-designed questionnaire using relevant literature. We designed the questionnaire to gauge the teachers' perceptions, attitudes, and practices concerning the research topic. It is a questionnaire utilizing closed-ended questions and a Likert scale for straightforward scaling of responses. We thoroughly reviewed existing tools and literature during the questionnaire development process to ensure the questions were comprehensive and relevant to the study.

Data Collection Procedure

We collected the data using a combination of physical and online channels, facilitating easy access to a large population. We distributed physical questionnaires, emailed their online counterparts to the teachers, or sent them through any other relevant online facility. This ensured a higher response rate with flexibility according to the choices of those wishing to take it.

Validity and Reliability

A panel of education experts reviewed the questionnaire contents. The reviewers' criticisms and suggestions were used to revise the questionnaire to ensure it measured what it was supposed to,

ensuring its validity. Conducted during the review process were face validity and content validity checks. We conducted a pilot study with a small group of teachers not included in the main sample to ensure reliability. This study tested the internal consistency of the questionnaire. We used Cronbach's alpha in SPSS to measure the tool's reliability, considering 0.70 or above as acceptable to ensure consistent measurement of constructs across different respondents.

Ethical Considerations

We took ethical considerations very seriously throughout the research process. The participation in this study was purely voluntary. We informed participants of their right to withdraw from the study at any stage, without any negative consequences. We acquired informed consent from all participants prior to data collection. The participants' responses were anonymous and confidential, making it impossible to trace the data back to specific individuals. Furthermore, the final report would only use the data for research purposes, excluding any identifying information.

Data Analysis

After the data collection process, we coded the responses and entered them into SPSS (Statistical Package for the Social Sciences) for easier analysis. We computed descriptive statistics for frequencies, means, and standard deviations to provide a general overview of the data. We computed inferential statistics like t-tests and ANOVA to ascertain any differences between the groups. We also performed a correlation analysis to determine the existence of a relationship between the variables. We interpreted the findings based on how they reflected the research objectives.

Table 1: Frequency Distribution at the Basis of Demographics

Title	Description	Frequency	Percentage (%)
Gender	Male	73	30.4%
	Female	167	69.6%
Age of Respondents	21-30 Y	58	24.2%
	31-40 Y	72	30.0%
	41-50 Y	76	31.7%
	51-60 Y	34	14.2%
Designation	SSET	129	53.8%
	JSET	111	46.3%
Qualification	Master	193	80.4%
	M.Phil.	33	13.8%
	PHD	14	5.8%
Place of Posting	School	129	53.8%
	Center	111	46.3%
Area of Posting	Rural	129	53.8%
	Urban	111	46.3%
Experience	1-5 Y	122	50.8%
	6-10 Y	94	39.2%
	11-15 Y	24	10.0%
	>15 Y	0	0.0%
		240	**100%**

A higher proportion of the respondents were female (69.6%) compared to male (30.4%), and the majority of respondents were aged 41-50 years (31.7%).

Table 2: Frequency Distribution at the Basis of Objectives of Research

Sr.	Statements of Questions	SA	A	UD	DA	SDA	M	SD
1	Assistive technology helps to differentiate instruction for students with learning difficulties in mathematics.	33 14%	189 79%	18 8%	0 0%	0 0%	4.06	0.46
2	The use of assistive technology improves the engagement of students with special needs in mathematics lessons.	69 29%	170 71%	1 0%	0 0%	0 0%	4.28	0.46
3	Assistive technology allows me to accommodate individual learning needs in my mathematics classroom.	85 35%	153 64%	1 0%	0 0%	1 0%	4.34	0.53
4	Students with special needs show improved problem-solving skills when using assistive technology.	65 27%	170 71%	2 1%	3 1%	0 0%	4.24	0.52
5	Assistive technology makes it easier to provide personalized learning experiences in mathematics for students with learning difficulties.	39 16%	193 80%	4 2%	4 2%	0 0%	4.11	0.48
6	Using assistive technology helps students with special needs better understand abstract mathematical concepts.	101 42%	134 56%	5 2%	0 0%	0 0%	4.40	0.46
7	Assistive technology reduces frustration for students with special needs when learning mathematics.	39 16%	199 83%	2 1%	0 0%	0 0%	4.15	0.46
8	Students with learning difficulties are more likely to participate in class activities when assistive technology is used.	64 27%	171 71%	3 1%	2 1%	0 0%	4.24	0.53
9	Assistive technology improves the confidence of students with special needs in their mathematical abilities.	34 14%	205 85%	1 0%	0 0%	0 0%	4.14	0.52
10	I have seen a positive impact on the academic performance of students with special needs through the use of assistive technology in mathematics.	68 28%	166 69%	5 2%	1 0%	0 0%	4.25	0.48
11	Assistive technology helps students with special needs break down complex mathematical problems into manageable parts.	101 42%	134 56%	5 2%	0 0%	0 0%	4.40	0.53
12	The use of assistive technology supports a more inclusive learning environment for students with special needs in mathematics.	101 42%	134 56%	5 2%	0 0%	0 0%	4.40	0.38
13	Assistive technology enables me to modify the pace of lessons for students with learning difficulties in mathematics.	39 16%	199 83%	2 1%	0 0%	0 0%	4.15	0.38
14	Students with special needs benefit from visual and auditory support provided by assistive technology in mathematics.	64 27%	171 71%	3 1%	2 1%	0 0%	4.24	0.51
15	Assistive technology tools like virtual manipulatives or math apps enhance the conceptual understanding of students with special needs.	34 14%	205 85%	1 0%	0 0%	0 0%	4.14	0.36
16	Using assistive technology allows me to meet the diverse educational needs of all students in my mathematics class effectively.	68 28%	166 69%	5 2%	1 0%	0 0%	4.25	0.16

Most respondents strongly agreed or agreed that assistive technology effectively differentiates and accommodates students with learning difficulties in mathematics, with the highest mean score (M=4.40) seen in statements regarding understanding abstract concepts and promoting an inclusive learning environment.

Table 3: T-test Analysis at the Basis of Gender

Gender	N	Mean	Std. Deviation	df	t	Sig. (2-tailed)
Male	73	67.86	2.85	238	0.24	0.808
Female	167	67.77	2.56			

There is no significant difference in perceptions of assistive technology's effectiveness between male and female respondents (p=0.808).

Table 4: T-test Analysis at the Basis of Designation

Designation	N	Mean	Std. Deviation	df	t	Sig. (2-tailed)
SSET	129	68.33	2.18	238	3.39	0.001
JSET	111	67.19	3.00			

SSET teachers reported significantly higher perceptions of the effectiveness of assistive technology compared to JSET teachers (p=0.001).

Table 5: T-test Analysis at the Basis of Place of Posting

Place of Posting	N	Mean	Std. Deviation	df	t	Sig. (2-tailed)
School	129	68.33	2.18	238	3.39	0.001
Center	111	67.19	3.00			

Teachers posted in schools rated the effectiveness of assistive technology significantly higher than those in centers (p=0.001).

Table 6: T-test Analysis at the Basis of Area of Posting

Area of Posting	N	Mean	Std. Deviation	df	t	Sig. (2-tailed)
Rural	129	68.33	2.18	238	3.39	0.001
Urban	111	67.19	3.00			

Rural-posted teachers rated the effectiveness of assistive technology higher than urban-posted teachers, with a significant difference (p=0.001).

Table 7: One-Way ANOVA Analysis at the Basis of Age

Age	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	49.77	3	16.59	2.41	0.07
Within Groups	1622.64	236	6.88		
Total	1672.40	239			

There was no significant difference in perceptions of assistive technology's effectiveness based on age (p=0.07).

Table 8: One-Way ANOVA Analysis at the Basis of Qualification

Qualification	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	14.91	2	7.46	1.07	0.35
Within Groups	1657.49	237	6.99		
Total	1672.40	239			

There was no significant difference in perceptions of assistive technology's effectiveness based on qualification (p=0.35).

Table 9: One-Way ANOVA Analysis at the Basis of Experience

Experience	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	65.39	2	32.69	4.82	0.01
Within Groups	1607.01	237	6.78		
Total	1672.40	239			

Experience significantly influenced perceptions, with those having more years of experience perceiving assistive technology as more effective (p=0.01).

Findings

The research findings highlight educators' general perception of the role assistive technology can play in differentiating and accommodating the needs of students with special needs who struggle with math. The idea that assistive technology generates options for instruction for such students, particularly through differentiation, received strong acceptance from The teachers emphasized that virtual manipulatives, math apps, and other assistive technologies offer flexibility by adapting to the diverse cognitive abilities of students, thereby simplifying the process of adjusting the pace and complexity of the lesson. This would reduce frustrations and increase student engagement in learning mathematics.

The findings from the data also showed that, to a significant extent, assistive technology enhances the confidence and participation of the students in mathematics class. Most teachers experienced that when special needs pupils make use of assistive devices, the students tend to be more interactive in the class. They also develop problem-solving abilities. Assistive technology does not only offer a student visual and auditory support but also quick feedback. This makes a student feel accomplished, thus enhancing a sense of self-efficacy. This gamified learning application also tends to create a low-pressure environment wherein students feel more comfortable practicing mathematical skills, thereby increasing their participation and enjoyment of the subject. Assisting technology educators report assisting students with learning difficulties while making complex problems into more manageable parts that provide better understanding and retention.

The findings suggest that assistive technology not only improves student engagement and understanding but is also supportive of a more inclusive learning environment. Teachers agreed in the majority that the use of assistive tools helps them be better equipped to serve individual educational needs, especially for those students with significant learning challenges. Thus, we can argue that assistive technology fosters a safe sense of belonging in the classroom, promoting equity

and inclusion. According to the teachers, integrating these assistive technologies into the classroom enhances the individual learning plans for each student, thereby preventing students with learning disorders from falling behind. Overall, the findings of this study reflect the significance that assistive technology offers in terms not only of improved academic results for such students but also by offering a support and inclusive learning environment for students with special needs in mathematics.

Discussion

The findings demonstrate that assistive technology has a distinct impact on the differentiation and accommodation of students with special needs who encounter specific learning difficulties in mathematics. Thus, these research results are in line with those of earlier studies because they show that teachers can adapt their lessons to meet the different learning needs of their students by using AT. This makes math tasks less frustrating and more interesting for students. Indiani (2022) also shows how AT can transform an environment into inclusive learning by providing flexibility in the method of presenting content and controlling its pace. Respondents of this study agreed that variations in tool use, such as virtual manipulatives, math-based apps, and other technologies, enable them to differentiate instruction to meet the students' cognitive abilities. Attard & Holmes (2022) assert that technology-based differentiation aims to enhance learner outcomes, particularly in abstract mathematics concepts, for learners who may struggle to comprehend these topics.

Additionally, the results highlighted the critical role that assistive technology plays in the lives of students with special needs; not only does it boost their confidence but also makes them more dynamic in class. A study by Schunk and DiBenedetto (2021) supported this view, demonstrating that "AT builds self-efficacy through immediate feedback and positive reinforcement." Educators in this study pointed out that the implementation of AT in instruction enhances engagement in learning activities and problem-solving among the learners experiencing learning difficulties. For instance, gamified learning applications embody AT, which reportedly offers a suitable, low-risk environment for students to hone their mathematical skills without the fear of failure. This resonates with the views of Schoenfeld (2022), arguing that AT can break down difficult mathematical problems into relatively easier component parts, which then facilitate improvement of understanding and remembering by the students.

The study's findings demonstrate that assistive technology (AT) significantly reduces barriers in less inclusive classrooms by exposing students with special needs to the same content as their peers. Therefore, the observation by Xu and Kuti (2024) that "assistive technology ensures that disabled students get equitable access to the curriculum" gains weight. By meeting individual needs, assistive technology enables students to access the curriculum according to their best interests. The research participants confirmed that the application of assistive technology (AT) enhances their ability to meet the needs of diverse students, fostering a sense of integration and inclusion within the class. It means that in this process, effective integration of AT can be an integration of technology along with pedagogical design and support of the teachers. The data from this study highlights the crucial role of assistive technology in supporting the diverse needs of students with learning difficulties in mathematics, as part of a larger educational strategy.

Ultimately, the results reveal that AT not only enhances the academic performance of the students but also transforms the students with special needs to be more independent. When AT is applied, it allows students to engage in activities that would otherwise be exhausting and require teacher support, enabling them to perform autonomously in their learning processes. This tends to support the claim that Ghalia et al. (2023) raised, whereby they argue that empowerment is achieved by

reducing the dependency on direct teacher support. All in all, this study confirms that assistive technology facilitates the differentiation and inclusive education of special needs students in mathematics because it supports enhancing engagement, fostering confidence, enhancing inclusive practice, and building independence during the teaching-learning process. However, its effectiveness always depends on teacher training and availability of resources, as continued professional support for teachers is required.

Conclusion

Findings of the study point out the overall impact that assistive technology has on providing learning opportunities for students with special needs as they struggle through math. The use of assistive technology facilitates instructional differentiation, increases engagement, and further fosters the establishment of an inclusive learning environment. It empowers both students and teachers through assistive technology, which involves simple tools such as making complex concepts easier to understand and tailoring learning. Researchers have found that virtual manipulatives, educational applications, and other technological tools effectively instill confidence, participation, and academic performance in students. This will further elucidate that assistive technology is essential for improving teaching and learning in an inclusive school environment.

Another important aspect is continuous training and support for teachers to ensure the appropriate implementation of AT for students. Teachers who possess knowledge on how to use AT approach teaching differently, given that their students have varying learning styles. It is also necessary to equip schools with sufficient resources to effectively support these technologies. In this regard, assistive technology will prove to be the most precious asset in providing equitable access to education to students with special needs, where learning difficulties are at a high level in mathematics. Therefore, the effectiveness of assistive technology in this particular area could potentially indicate its long-term sustainability in fostering more effective inclusive education.

Recommendations

1. Professional development involves providing educators with professional development programs to prepare them to effectively use assistive technology in the classroom.
2. Provide schools with sufficient funding to purchase and maintain assistive technology tools that support differentiated instruction in the classroom.
3. The policymaker should address the question of aiding in the integration of assistive technology into curriculum development to facilitate inclusive learning for students like them.
4. Future researchers should investigate the long-term impact of assistive technology in relation to student achievement and study different subjects with different types of learning difficulties.

References

- Alam, A., & Mohanty, A. (2023). Cultural beliefs and equity in educational institutions: exploring the social and philosophical notions of ability groupings in teaching and learning of mathematics. *International Journal of Adolescence and Youth*, *28*(1), 2270662.
- Al-Dababneh, K. A., & Al-Zboon, E. K. (2022). Using assistive technologies in the curriculum of children with specific learning disabilities served in inclusion settings: teachers' beliefs and professionalism. *Disability and Rehabilitation: Assistive Technology*, *17*(1), 23-33.

- Alnasser, Y. A. (2021). The perspectives of Colorado general and special education teachers on the barriers to co-teaching in the inclusive elementary school classroom. *Education*, *49*(6), 716-729.
- Anderson, K., & Marino, M. T. (2023). Using technology as a compensatory technique for executive function skill deficits during the coaching process. *Journal of Special Education Technology*, *38*(4), 539-546.
- Attard, C., & Holmes, K. (2022). An exploration of teacher and student perceptions of blended learning in four secondary mathematics classrooms. *Mathematics Education Research Journal*, *34*(4), 719-740.
- Bereczki, E. O., & Kárpáti, A. (2021). Technology-enhanced creativity: A multiple case study of digital technology-integration expert teachers' beliefs and practices. *Thinking Skills and Creativity*, *39*, 100791.
- Ghalia, N., Ahlam, D., & Isami, E. (2023). Empowering Education for Students with Learning Difficulties and Disabilities: A Faculty and Student Perspective on the Utilization of Assistive Technology at the Academic Arab College of Education in Haifa.
- Golini, E. J. (2024). *Understanding Family Experiences of IEP Meetings and Building Skills to Empower Families at the IEP Meeting* (Doctoral dissertation, City University of New York Hunter College).
- Greenstein, S., & Zhang, D. (2022). Understanding, honoring, and enabling the mathematical participation of students with learning disabilities through research at the intersection of special education and mathematics education. *The Journal of Mathematical Behavior*, *65*, 100919.
- Indiani, N. M. (2022). Unleashing the Power of Data: Exploring the Transformative Effects of Data-Driven Strategies on Personalized Learning Experiences and Student Mastery. *Eurasian Journal of Educational Research*, *102*(102), 301-322.
- Kisanga, S. E., & Kisanga, D. H. (2022). The role of assistive technology devices in fostering the participation and learning of students with visual impairment in higher education institutions in Tanzania. *Disability and Rehabilitation: Assistive Technology*, *17*(7), 791-800.
- Lien, K. M., Kuo, C. C., & Pan, H. L. (2023). Improving Concentration and Academic Performance of a Mathematically Talented Student with ASD/ADHD: An Enrichment Program. *Education Sciences*, *13*(6), 588.
- Lynch, P., Singhal, N., & Francis, G. A. (2021). *EdTech for learners with disabilities in primary school settings in LMICs: A systematic literature review*.
- Myers, J. A., Brownell, M. T., Griffin, C. C., Hughes, E. M., Witzel, B. S., Gage, N. A., & Wang, J. (2021). Mathematics Interventions for Adolescents with Mathematics Difficulties: A Meta–Analysis. *Learning Disabilities Research & Practice*, *36*(2), 145-166.
- Rao, K., Torres, C., & Smith, S. J. (2021). Digital tools and UDL-based instructional strategies to support students with disabilities online. *Journal of Special Education Technology*, *36*(2), 105-112.
- Reddy, P., Reddy, E., Chand, V., Paea, S., & Prasad, A. (2021). Assistive technologies: Saviour of mathematics in higher education. *Frontiers in Applied Mathematics and Statistics*, *6*, 619725.
- Reshma, P. T. (2023). *Effectiveness of certain instructional strategies based on graphic organizers on achievement, retention and problem solving ability in geography among secondary school students* (Doctoral dissertation, Research Centre in Education, Govt. College of Teacher Education, Kozhikode).

- Sandra, L. A., & Kurniawati, L. A. (2020). Differentiated instructions in teaching English for students with autism spectrum disorder. *JET (Journal of English Teaching) Adi Buana*, *5*(01), 41-53.
- Schoenfeld, A. H. (2022). Why are learning and teaching mathematics so difficult?. In *Handbook of cognitive mathematics* (pp. 1-35). Cham: Springer International Publishing.
- Schunk, D. H., & DiBenedetto, M. K. (2021). Self-Regulation, self-efficacy, and learning disabilities. *Learning disabilities-neurobiology, assessment, clinical features and treatments*.
- See, B. H., Gorard, S., Lu, B., Dong, L., & Siddiqui, N. (2022). Is technology always helpful?: A critical review of the impact on learning outcomes of education technology in supporting formative assessment in schools. *Research Papers in Education*, *37*(6), 1064-1096.
- Strogilos, V., Lim, L., & Binte Mohamed Buhari, N. (2023). Differentiated instruction for students with SEN in mainstream classrooms: contextual features and types of curriculum modifications. *Asia Pacific Journal of Education*, *43*(3), 850-866.
- Wen, Z. A., Silverstein, E., Zhao, Y., Amog, A. L., Garnett, K., & Azenkot, S. (2020, October). Teacher views of math e-learning tools for students with specific learning disabilities. *In Proceedings of the 22nd International ACM SIGACCESS Conference on Computers and Accessibility* (pp. 1-13).
- World Health Organization, & United Nations Children's Fund. (2022). *Global report on assistive technology*. World Health Organization.
- Xu, Y., & Kuti, L. (2024). Accommodating students with exceptional needs by aligning classroom assessment with IEP goals. *International Journal of Inclusive Education*, *28*(8), 1474-1487.