
| RESEARCH ARTICLE

Computer-Aided Instruction in Mathematics to Mentally Challenge Learners

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| ABSTRACT

Computer-aided instruction (CAI) provides an interactive, individualized, and adaptive learning experience that supports students with diverse needs in learning mathematics by challenging them visually, auditorily, interactively, or through hands-on activities. This enhances their engagement & understanding. The study determined the effectiveness of CAI in teaching mathematics to students with disabilities in DepEd's Lapu-Lapu City Division as a basis for an instructional intervention plan. The researchers employed a quantitative quasi-experimental group design to collect data from students with disabilities and from mathematics teachers using a validated researcher-made instrument. Data were analyzed using frequency, means, standard deviations, and a paired t-test. The results have confirmed that educated, employed parents from stable homes are buoyant for mostly six-year-old students with disabilities. Results reveal moderate improvements in both addition and variable performance on subtraction items, but a large improvement regarding their problem-solving abilities. Statistical evidence demonstrates that CAI can substantially improve mathematics learning. Nevertheless, limited facilities and resources are obstacles to practical implementation. The research identifies the most common directions of technology use, while underscoring that, with insight into instructional strategies tailored to different learners and high-quality learning resources, the academic pace can be maintained across districts. It concludes that CAI is an efficacious and constructive instructional medium for teaching mathematics to students with disabilities. The researchers recommend integrating the intervention plan into their instructional materials to improve students with disabilities' learning.

| KEYWORDS

Special Education, CAI, students with disabilities, quasi-experimental design, Philippines

| ARTICLE INFORMATION

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1. Introduction

The rise of technology-based learning in education has been directly correlated with rapid student achievement across all school levels. As one of the versatile approaches to teaching mathematics to students with disabilities, Computer-Aided Instruction (CAI) has been introduced as a state-of-the-art tool that provides individualized, engaging, and accessible learning across a variety of formats. The new digital learning method is a reality, helping meet varied learning needs through interactive technologies, adaptive content, and multisensory delivery methods. One of the primary strengths of CAI is its ability to provide individualized instruction. Students with disabilities often require differentiated pacing, repetition, and tailored content. With CAI systems, students adjust the difficulty level based on their answers, thus advancing at their own pace. This is especially helpful for learners with cognitive or learning disabilities, including dyscalculia, because they often require extended practice and increased opportunities to learn, rehearse, master, transfer, and connect mathematical concepts. In CAI, immediate feedback promotes learning by allowing students to correct mistakes and misconceptions as they occur. Multisensory learning is another major benefit you get from a workout. CAI can be visual, auditory, and sometimes kinesthetic in nature to facilitate behavior that produces understanding or memory. Abstract mathematical ideas come to life through interactive simulations, pictures, and

animations. Students who are visually or hearing impaired can particularly benefit from accessibility features such as screen readers, captions, and high-contrast displays. Using a variety of senses, CAI accommodates different learning methods and keeps students interested and involved.

CAI also goes a long way to improving motivation and engagement. By integrating elements such as game-based activities and interactive challenges, many programs offer rewards that help students get excited about learning mathematics. These features can help reduce the negative attitudes towards math that students with disabilities experience in traditional classrooms, enabling them to exhibit more of their best behaviors in learning environments. More engagement means more persistence, and that is one of the keys to mastering mathematics. In addition, CAI fosters independence and self-directed study. Students' progress through lessons with minimal supervision and confidence in their abilities. Being on your own allows for more independence, something that is especially important for people with little physical movement in their lives or for those who have enough trouble getting by on their own in public. However, teachers use data generated by CAI systems to monitor student development, student matchmaking, identify learning gaps, and provide immediate pushback. CAI has significant potential, but it must be applied to realize its full potential. To improve instruction, even for students with the same background skills, important ingredients—including teacher preparation, access to technology, and quality of educational software—definitely need improvement. If teachers want to use CAI programs effectively for their students with disabilities, they will need tools that address those individuals' needs; not all CAI programs are designed with this goal in mind. CAI must also supplement, not supplant, teacher-delivered instruction. Human interaction is still important for emotional support, scaffolding difficult concepts, and developing social skills.

To accommodate the demand of students with learning disabilities for elementary and secondary education, the Department of Education (DepEd) has opened its doors to them. The special program was offered to all public schools in the Philippines, where children are clustered by mental development rather than age. Students with mental disabilities also require instruction on computers, particularly high-level subjects like mathematics. These messages affect how we reflect on their performance in math, as students with disabilities continue to receive dire results for decades; the DepEd Lapu-Lapu City Division is no exception, as reflected in all new interventions that examine various types of teaching in math. Alternatively, CAI appears to offer tantalizing but largely unfulfilled promises of greater accessibility, engagement, and personalized learning. However, the evidence behind this is either poorly geographically localized or too incomplete to inform policy and practice. This study seeks to assess the effectiveness of CAI in this learning context to inform more effective intervention design. The results will provide educators, administrators, and legislators with valuable information to strengthen math education for all students and move toward equitable learning outcomes.

With the revealed challenge, the researchers are driven to introduce CAI in Mathematics instruction for students with special education (SpEd) needs in Lapu-Lapu City Division. Moreover, the researcher seeks to determine the effectiveness of CAI in teaching Mathematics, identify problems in its use, and propose measures for improvement.

2. Literature Review

This study is anchored on the following theories: Conditions of Learning Theory by Gagné (1985), Theory of Cognitive Development by Piaget (1950), Constructivism Learning for Teaching and Learning by Dewey (1938), Social Constructivism Theory by Vygotsky (1978), and Cognitive Load Theory by Sweller (1988). Also, this study is supported by the following Philippine legal bases: Republic Act No. 7277 (1992) titled, "Magna Carta for Disabled Persons", Republic Act No. 9442 (2007), "An Act Amending RA 7277", Republic Act No. 10533, "Enhanced Basic Education Act of 2013, and DepEd Order No. 78, s. 2010 on the Guidelines on the Implementation of SpEd Programs.

Robert Gagné proposed a Conditions of Learning Theory, which suggests that learning is not merely an event but can be broken down into hierarchical stages, from lower-level signal discrimination tasks to more complex problem-solving tasks. It describes nine instructional events along with the gain attention and stimulus (Ramma et al., 2025). These characteristics are particularly important in systematically designed instructional contexts, where students may need step-by-step directions for walking through the process. CAI is especially appropriate for students with cognitive impairments that require intensive remediation to complete a math task and maintain retention of these concepts (Wu & Cai, 2025), when the type conditions discussed above are incorporated into computer-based lessons that specifically guide students through sequential steps towards completion. Furthermore, CAI tools provide instant feedback and various forms of reinforcement, which help promote the learning process (Sailer, 2020).

This suggests that mathematics is a challenging subject for students with cognitive disabilities due to its abstract representations and multi-step reasoning (Lepore, 2024). CAI addresses these challenges by fragmenting mathematical tasks into levels of difficulty, analogous to Gagné's taxonomy of cognitive skills. By treating abstract mathematical concepts like physical phenomena, ie, black box signal learning. These students begin to learn the intersection of their reality. One study using CAI found that scaffolding contributes to retention of content and concepts through repetition for students with disabilities (Zeng et al., 2025). The way the exercises are ordered gradually helps ease the cognitive load on pupils, while reinforcing fundamental mathematical concepts.

Moreover, Gagné's learning guide and performance support (Xiaojun, 2025) can be useful for CAI systems for SpEd students. Finally, intelligent tutoring systems provide students with signals, hints, and corrective feedback as they interactively solve problems, emulating teachers' independent effort to channel learning. These strategies replicate the instructional events you described, ensuring that students do not find themselves in a "sink or swim" situation during more difficult mathematical operations. Research shows that CAI promotes learning through interactive feedback systems, stimulating and motivating even the most underperforming students (Zhang, 2024). Here, we provide a literature review that applies Gagné's theory of instruction to contexts in mathematics education that are often non-inclusive and thus generally inaccessible.

CAI further fosters retention over time by having learners practice and reinforce knowledge, which is one of Gagné's nine instructional events. Follow a repeated cycle of teaching the full lesson for learners with mental disabilities to ensure that learning occurs. As Alhalafawy and Zaki (2022) describe, adapting these digital platforms helps students understand fundamental skills through immediate feedback, and the absence of repetition limits. CAI environments also support learning transfer by providing some contexts in which real-world mathematics is embedded. According to Gagès' (2019) transfer guidance principle, it is a component of functional mathematics learning that guides instructional directions for children with special education needs (Bagadood et al., 2025). Gagné's theory is thus embodied in CAI through its integration with a learning method.

McLeod (2024) explained that, according to Jean Piaget's Cognitive Development Theory (1950), learners progress through a series of stages of growth, shifting from concrete trial-and-error to abstract thought. The issue arises with the fact that students identified as having an intellectual or learning disability may have an education under their cognitive development at the concrete operational stage, making them struggle with any form of abstract mathematical reasoning (Bouck et al., 2018) and learning concretely, through visual, manipulative, and interactive representations by their very definition. Digital simulations and animations are avenues for materializing abstract mathematical concepts; through student engagement, they build schema (Wei et al., 2023).

Hands-on instruction with visual support was the most effective means of math teaching in studies including students with disabilities. CAI encourages this type of productive learning by teaching ideas instead of the material (Cai & Hwang, 2023). Foster cognition and learning through technology-based training, which creates more multimodal input, enhancing comprehension of subjects (Lee & Ho, 2025; Cuturi et al., 2022). This supports Piaget's theory, which states that knowledge is gained through the environment.

In addition, CAI allows for individualized pacing, an important factor for learners in varying stages of development. According to Piaget's theory, forcing learners into abstract thought before they are ready is not possible (Burhanuddin et al., 2021). CAI addresses this through self-study capabilities that allow learners to progress at their own pace, ensuring they master fundamentals before moving on. This avoids cognitive overload and encourages appropriate instruction on how children learn developmentally. Thus, CAI embodies Piagetian principles by tailoring instruction to a student's current readiness and developmental level (Asrifan et al., 2025).

Constructivist Learning Theory (1938) by John Dewey holds that learning is an active, experiential process. Instead of passively receiving knowledge, learners actively construct their understanding as they interact with their environment (Zajda, 2021). CAI programs are interactive for learners as they explore, manipulate, and solve problems consistent with constructivist principles in mathematics education. For students with mental disabilities, for example, this method is helpful because they need practical experience to develop deep comprehension (Panopoulos & Drossinou-Korea, 2024).

Moreover, Dewey has described reflective thinking as one of the foundations of learning. In addition, CAI enables reflection by providing learners with opportunities to check their answers, determine errors, and retake the problems. This has an iterative component that will drive you to understand how to fix your mistakes. Reflective digital learning environments facilitate active cognitive engagement and thus help address patterns of latent disengagement, which is crucial for attempts to reform mathematical reasoning skills among struggling learners (Ervelius et al., 2026). So CAI is developing Dewey's constructivist philosophy for a computerized educational environment.

Social learning plays an important role in this area through Lev Vygotsky's (1978) Social Constructivist Theory, where learners can reach higher-order cognitive performance levels with the support of those with advanced knowledge of the topic, through assistance in the Zone of Proximal Development (ZPD). Adaptive scaffolding, like hints, prompts, and guided feedback, is the key feature of CAI that fits well with this theory. They serve as a connection between the skills you possess today and those you develop through learning mathematics for students with disabilities (Asula-Abaver & Machaba, 2026).

Vygotsky views language as the most important tool of cognitive growth. CAI has subconstructs, such as receiving prompts, listening to instructions, and linguistic processing, with a DSS (Irshad et al., 2021), each of which can serve as an entryway into gateway mathematics. They present multimodal features that help learners overcome challenges in interpreting abstract symbolic representations. Research on improving students' understanding and active participation in mathematics class (Mondal & Vijaykumar, 2025) indicated that multimedia-based CAI improved students' overall performance.

Cognitive Load Theory (CLT) proposes that working memory is limited, and therefore it is wise to avoid exerting extraneous effort on cognitive processes above what is necessary for learning [1]. When it comes to learners with cognitive obstacles in mathematics, you can make use of these postulations, as cognitive load is a determining factor. CAI builds upon CLT by offering multimodal (visual, auditory) learning support and by breaking complex problems into steps while simultaneously providing

scaffolded solutions to exercises through interactive breakdowns of complex problem scenarios (Sortwell et al., 2026). Another process that focuses on developing foundational math practices through animated, hermetically sealed problem-solving, not the upshot of thorny wording. New studies showed that the availability of knowledge about concealed cognitive load, extensively bridged in multimedia learning environments, promoted higher mathematical understanding (Liu & Liu, 2023; Mao et al., 2023).

The laws of the Philippines provide a solid basis for advocating inclusive (technology-mediated) education for visually impaired MSDI learners. Laws, policies, and DepEd issuances all highlight that every learner — even those with mental challenges has the right to quality and equitable instruction. Under these legal bases, the State is supposed to eliminate educational barriers and tailor instructional methods to accommodate naturally varying cognitive abilities. CAI in Mathematics thus becomes a trend-setting educational innovation well within the national directives for inclusive, learner-oriented education.

The rights of PWDs in the Philippines are mainly governed by Republic Act No. 7277, which provides for equal access to education, rehabilitation, and social integration (Custodio & Bellaguarda, 1979). One of its key features is the special educational support that ensures PWDs have an unconditional right to quality education. The legitimacy establishes a powerful context for seeing CAI as an outgrowth of software in mathematics guides, not just to meet the wishes of students with mental disabilities, but also college students with diverse skills (Da et al., 2025). Through adaptive learning technologies designed to enhance educational opportunities for a broad spectrum of learners, CAI systems support RA 7277. Therefore, both personalized pace and multimodal instruction are essential strategies to enhance the accessibility of learning pathways for all students, including those with disabilities (Qushem et al., 2021). It emphasized rehabilitation and improvement, just as CAI was trying to keep students with disabilities on track with their skills, too. CAI is tightly structured, protocol-driven, and scaffolded instruction that supports learners in acquiring basic numeracy skills. Finally, the self-reliance component of RA 7277 aligns with CAI's potential to promote learner independence. Learners can go at their own pace, receive immediate feedback, and practice lessons as many times as necessary. Research confirms that self-learning computer-based learning environments boost motivation and cognitive skills in mathematics education for students with special needs (Vargas-Montoya et al., 2024).

The Magna Carta for Disabled Persons is revived under Republic Act No. 9442, which enhances the provisions on additional benefits and assistance and provides stronger anti-discrimination measures, especially in relation to the implementation of education and access services (Aragon Jr, 2017). This amendment solidifies the State's duty to uphold equal opportunities for PWD. For example, RA 9442 provides stronger legal backing for the use of assistive technologies that enable accessible CAI-based learning in mathematics. That is where CAI Platforms directly align with this mandate, removing instructional bottlenecks and delivering an adaptive learning environment tailored to each learner's cognitive capabilities (Isaeva et al., 2025).

The K to 12 curricula in the Philippines were then locked in under Republic Act No. This law directly fosters innovative instructional methods, such as CAI, in mathematics. It is consistent with the law's purpose—to develop 21st-century competencies in students, including critical thinking, problem-solving, and digital literacy. The influence of integrating technology into their learning has always been impactful for hard skills development and mathematics achievement, as learners acquire conceptual understanding and motivation (Delos Santos & Tan, 2025; Etcuban et al., 2024; Wei et al., 2022). For instance, the Philippines released its Guidelines on the Implementation of SpEd, which, in 2010, immediately opened opportunities for Mathematics CAI to serve mentally disabled students in regular schools (Abdulrauf, 2018). Therefore, CAI essentially stands for the basic principles of SpEd, which have the potential to develop adaptive, automated, personalized educational tools that can cater to students across the full range of cognitive capacity. Studies show that assistive technology delivers engaged, organized, and on-demand teaching to students with disabilities (Espinosa et al., 2025). Finally, the policy promotes inclusive classrooms, which CAI further supports through participation regardless of cognitive ability. Based on these, learners can interact with digital activities that promote equal participation and inclusion. Research shows that technology-based instruction encourages engagement and learning success for students with intellectual disabilities. Thus, theories and the Philippine legal bases provide robust policy backing for CAI as a potent vehicle for SpEd mathematics instruction.

3. Methodology

The quasi-experimental study was employed in this study. The design of a quantitative method in exploring the effectiveness of CAI in teaching Mathematics to students with disabilities in the Division of Lapu-Lapu City as an instructional intervention. It was conducted in two public elementary schools in Lapu-Lapu City Division, Philippines. These schools designate one of their resource rooms for individualized instruction, testing, and therapy-related activities, including instructional materials such as learning modules, task boxes, visual schedules, and alphabet and number manipulatives or interactive charts used for differentiated instruction. The respondents in this study were seven SpEd teachers and nine students with disabilities. Due to resource constraints, the researchers opted for convenience sampling. This technique involves getting members anywhere you may find them, and normally, wherever it is advantageous. All subjects are welcome to take part. The subjects were chosen since they are the simplest to recruit for the study.

The survey instrument is a standardized tool designed to gather relevant information on the use of CAI in teaching mathematics to students with disabilities. It is composed of three broad areas: the profile of teacher-respondents and SpEd learners, and common challenges in using CAI. The introduction builds rapport by clearly defining the study's aim/purpose and reassuring

respondents about confidentiality and voluntary participation, both of which are important for eliciting truthful responses. The teachers are to follow instructions carefully and take ground data based on their professional knowledge. The first part gathers demographic and professional background information about teachers, including age, sex, highest level of education, years of service, teaching experience with individuals with special needs, and attendance at SpEd-related seminars. You must register to search for variables that associate with CAI use. The second part was about SpEd learners, including their age, sex, classification of mental retardation, parents' educational attainment, monthly family income, and academic performance in Mathematics. This helps contextualize any potential effects on CAI's effectiveness. Such sensitivity might require teachers to ground their responses in written records or bona fide observations, while maintaining strict confidentiality for any sensitive data. The next section investigates the issues that teachers face when implementing CAI, followed by a Likert scale ranging from 5 (Highly Felt) to 1 (Not Felt). It addresses problems such as the shortage of trained teachers, a lack of learning resources and facilities, weak parent-school partnerships, and limited SpEd resources. In summary, the questionnaire is a comprehensive measure of what learners do and do not retain — identifying both in the cognitive and affective domains — so that it can be used to assess the extent to which instructional practice is effective.

It will contain an organized procedure for obtaining the appropriate data used in the research study in a more systematic, ethics-driven fashion. Experts validate instruments through data collection to ensure clarity and reliability. The methods used are subject to strict ethical and approval requirements. (informed consent, anonymity, etc.) The researcher coordinates with the schools during data collection. Firstly, surveys are conducted, and support is given. Once data are collected, performing reviews and classification, as well as applying statistical approaches, can transform raw data into actionable insights that support conclusions and suggestions for improving CAI execution.

CAI must therefore ensure the security and confidentiality of students with disabilities, as it involves the processing of sensitive personal and educational data, a key element in this context. Teachers should keep any information Students or parents provide, or you acquire (such as assessment results), confidential and not disclose it to others without proper consent, including information about students in general, such as their learning profiles and disability classifications. On digital platforms, data security is ensured through systems protected by passwords and limited access. Finally, transparent information about the specific algorithms used to process students' data and the purposes for which this data is collected will be necessary, as will informed consent from parents or guardians. Even research should require stripping identifiers. Data privacy upholds student dignity and enables an ethically secure learning experience.

Ethical considerations in using CAI for students with disabilities emphasize equity, respect, and responsibility. Teachers must ensure equal access by providing appropriate resources, assistive technologies, and inclusive strategies for all learners. Informed consent from parents or guardians is essential, with clear communication about CAI's purpose, benefits, and risks. Educators must also ensure content appropriateness and maintain strict data confidentiality by using secure systems. Overall, ethical CAI implementation promotes a safe, inclusive, and supportive learning environment. The gathered data were statistically analyzed using frequency counts, simple percentages, mean, standard deviation, ranks, and a paired t-test.

4. Results and Discussion

This section contains the presentation, analyses and interpretation of the data gathered from the responses of the respondents in four distinct parts.

4.1 Profile of the Students with Disabilities

Table 1 describes the distribution of students with disabilities by age and gender, developing a snapshot view of how both demographics are represented in the sample.

Table 1
Age and Gender of Students with Disabilities

Age [in years]	Male		Female		Total	
	f	%	f	%	f	%
6	3	37.50	0	0.00	3	33.33
8	1	12.50	0	0.00	1	11.11
9	1	12.50	1	100.00	2	22.22
10	1	12.50	0	0.00	1	11.11
11	1	12.50	0	0.00	1	11.11
28	1	12.50	0	0.00	1	11.11
Total	8	100.00	1	100.00	9	100.00

The study had a total of nine (9) students, of which eight (8) were male, and only one(1) was female. This immediately shows a large gender gap: 88.89% are male, and 11.11% are female. An imbalance of this nature is remarkable and mirrors patterns in

SpEd where more boys than girls are identified, especially for developmental and behavioral disabilities. The data on the female side, however, reflects only one subject: A 9-year-old. This case represents 100% of female patients and 11.11% of the total sample. That gives us a full depiction of female cases in the dataset; however, this giant, sloppy number —44 — is lame as heck and renders any gender-based comparisons extremely limited. However, a female student at 9 indicates girls with disabilities are also being identified and enrolled as students, though they appear to be referred at lower rates or less publicly than boys. These data imply that gender appears to be a robust vehicle through which students with disabilities are identified and enrolled against the broader backdrop of gender within schools. The reason why male students outnumber their female counterparts can be biological, psychological, or socio-cultural. Studies include those examining whether boys exhibit more externalizing behavior, which is more visible in a classroom context, resulting in more referrals and diagnoses. On the other hand, girls display more internalizing behavior that is non-disruptive and thereby less likely to be identified for SpEd services.

The high rate of young learners highlights the success of early screening programs. However, the presence of older students — some of whom are adult learners themselves — indicates demand for long-term, flexible education entitlements. It suggests that disability is not limited to childhood and demonstrates the need for educational systems throughout the life course. These findings have several implications. One indication of this is to explore gender bias within the pathway for recognition and referral. Educators and specialists must be trained to identify and respond to the different presentations of disabilities in males compared to females so that equitable access to services can occur. Second, a slightly patronizing perception of the strong representation of young learners underscores the need to better reinforce early intervention programs. To aid early diagnosis, screening tools, teacher training, and parent awareness initiatives must persist. It can be seen in the table that for students with disabilities, there are more male students than female students, and most are found in early childhood, with fewer numbers dispersed across older year groups. These patterns imply the unique importance of early identification, the need to consider SpEd needs throughout the life course, and the need for gender-sensitive approaches in SpEd. Improving activism from these perspectives offers the potential for greater inclusivity, equity, and effectiveness, benefiting all students with disabilities.

According to Ragmoun and Alfalih (2024), children with disabilities do not have similar experiences in schools, as background factors like age or gender also determine how much satisfaction students feel towards the school, providing proof that inclusive and gender responsive policies are needed. Likewise, a cohort of 6-8-year-old students with disabilities shows poorer cognitive and emotional functioning than their peers; boys are more behaviorally challenging compared to girls, who were found to be emotionally more adjusted (O'Brien et al., 2023). Each of these findings suggests that early, focused — yet sensitive to gender — interventions could help promote both better learning and well-being and improve equal access to quality education for children with disabilities who attend public elementary schools.

Table 2
Age and Mental Development of Students with Disabilities

Age [in years]	Mental Development							Total	
	3	4	5	6	7	8	9	f	%
6	0	0	3	0	0	0	0	3	33.33
8	0	0	0	0	1	0	0	1	11.11
9	0	0	0	0	2	0	0	2	22.22
10	0	0	0	0	0	0	1	1	11.11
11	0	0	0	0	0	1	0	1	11.11
28	0	0	0	0	1	0	0	1	11.11
Total	0	0	3	0	4	1	1	9	100.00

The table shows the distribution of students by age and their levels of mental development. The sample represents nine (9) learners, giving a close but informative indication of mental development across age groups. The data shown here highlight clusters and gaps relevant to interpretation and educational planning. Interpretively, age does not reflect students with disabilities' functional level. There is some progression visible, such as a movement from level 5 (age 6) to level 8 (ages 8 and 9). The differences that lead to an 11-year-old at level 8, rather than an adult learner beyond level 8, in this regard, suggest that these individuals develop along different paths. This corroborates our intuition that multiple interwoven biological, environmental, and instructional determinants shape cognitive development in this population. The implications of these findings for educational practice are discussed. Secondly, there should be Individualized Education Plans (IEPs) that reflect not just the learner's age but, more fundamentally, their level of mental maturation. Placing students solely by age is insufficient, as students of the same age have wide ranges of cognitive capacity. The table illustrates an indirect and diverse relationship

between age and the mental development of students with disabilities. Although there are clear patterns of progression, for many learners it remains highly variable, underscoring the need for personalized, adaptable, and inclusive education. Mazhar (2025) highlights how cognitive and socio-emotional development is already significantly lagging for younger children with disabilities from low-income contexts, a gap that only seems to accelerate over time, thus emphasizing the importance of speculative early as well as sustained interventions focusing on public elementary schools. Graham et al. Notably, (2018) found that psychosocial growth and adaptive functioning differ across ages in children, underscoring the need for age-appropriate support. Phillips et al. This is evidenced by the environmental stressors perceived by the factory (2024), which adds that in older students, neoteny again leads to inheritable mental health risks. Thus, this series of studies highlights the necessity of timely, ongoing, and multi-tiered educational-mental health systems to advance learning and well-being of public elementary school students with disabilities.

Table 3 presents the parents' occupation profile of the learners.

Table 3
Parents' Occupation of Students with Disabilities

Occupation	Father		Mother		Total		Rank
	f	%	f	%	f	%	
Businessman	3	33.33	5	55.56	8	44.44	1
Engineer	1	11.11	2	22.22	3	16.67	2
Housewife	2	22.22	0	0.00	2	11.11	3
Teacher	1	11.11	1	11.11	2	11.11	3
OFW	0	0.00	1	11.11	1	5.56	4
Call Center Agent	1	11.11	0	0.00	1	5.56	4
Property Broker	1	11.11	0	0.00	1	5.56	4
Total	9	100.00	9	100.00	18	100.00	

Quite a few interesting trends emerge from the table detailing parents' occupations of students with disabilities, revealing something about the respondents' socioeconomic backgrounds. A focus group of 18 parents, evenly distributed (9 fathers and 9 mothers), was represented. The data reveal that business occupations comprise the majority, followed by professional and service-oriented occupations, with small differences in both the gender-predicted distribution and the overall proportionate labor participation. The biggest finding here is that parents' main profession is still business ownership or entrepreneurship, as reflected in 44.44% (8/18). Importantly, this represents 33.33% of fathers and an even greater 55.56% of mothers, implying that mothers are relatively more engaged in business-related activities than their counterparts. This trend could indicate that mothers prefer to find income-generating opportunities that maximize their time availability for the trip and their family, especially when supervision of a child with disabilities is needed more than average.

Interpreting the results, we highlight that a considerable proportion of families of students with disabilities depend on self- and flexible employment, possibly selected for their compatibility with care duties. The existence of professional careers, including engineering and teaching, also shows that families have the financial and educational capital to meet this specialized learning need. If the findings hold up, they have important implications for teachers, school officials, and policymakers. On the one hand, business-oriented parents are abundant and often away, indicating a need for flexible school (disengagement) processes. Secondly, the range of occupations underscores the need for differentiated forms of communication to keep all parents engaged in their child's education. Finally, support programs must take into account the economic and temporal desertedness of families — especially those with a parent overseas or in a relentless administration position. The occupational profile of parents is a combination of adaptability and resourcefulness, and low to moderate socioeconomic status, which are major determinants of educational experiences for students with disabilities.

Disability-associated outcomes are the diverse items that result in people with disabilities having lower levels of education and, eventually, educational attainment; Kushwaha and Ahmad (2024) reported that students with disabilities from lower socioeconomic groups—parents having unprofessional working statuses—would gain even less further education and individual opportunities. Vadivel et al. (2023) found that such students are unable to utilize relevant school services and accommodations. Taken together, these findings emphasize the need for public elementary schools to increase the availability of equitable resources and supports by addressing the factors that contribute to socio-economic status barriers to learning among students with disabilities.

4.2 Profile of the Teacher Respondents

This part of the paper presents the profile of the respondents, the teachers, including their years of teaching, rank, subjects handled, relevant training or seminars, and EQ. Table 4 presents the teachers' years of teaching service.

Table 4
Number of Years in Teaching of the Teacher Respondents

Length of Service	f	%
1 – 3 years	3	42.86
4 – 6 years	1	14.29
7 – 9 years	1	14.29
10 years and above	2	28.57
Total	7	100.00

The table indicates that respondents have varying lengths of experience in teaching students with disabilities. The full report is based on a random sample of seven teachers, and the data show teachers in the novice, moderate, and very experienced ranges. Such distribution plays a decisive role in the quality of instruction teachers provide, as well as in classroom management and the implementation of inclusive education practices.

The main finding is that the highest percentage of teachers (42.86%, or 3 out of 7) have 1-3 years of teaching experience. It means that almost half of the respondents are newcomers to teaching and are developing in topics such as pedagogy, classroom management, and general/subject-matter knowledge about students with disabilities. Early-career teachers are often enthusiastic, flexible, and willing to try new instructional approaches. Still, they may need additional mentoring and professional development to further develop their skills in a SpEd environment. When analyzing the data, there is a slight bias towards early-career teachers (lower counts) and insufficient representation of mid-career teachers. The fact that a sizeable number of teachers who teach students with disabilities may still be early in their careers indicates this discrepancy. Though this can be a boon for innovation and experimentation with different pedagogical strategies, it may prove challenging to build uniformity and depth in specialized instructional practices. The key message from these findings and their implications is the presence of experience in special education. More experienced teachers would typically be better at individualized instruction, behavior management, and working collaboratively with parents and specialists. By contrast, newer teachers might need much more structured support systems to tackle the complexity of meeting the needs of students with disabilities.

The findings have important implications for school administrators and policymakers. This points to an obvious need for targeted professional development programs, particularly in the first three years of teaching. Mentoring programs that encourage partnerships among novice and experienced teachers would alleviate differences in both instructional skills and classroom management knowledge. Training on inclusive education strategies, differentiated instruction based on student needs, and the use of assistive technologies should also be continuous. In addition, schools and other educational institutions will need to consider how they will retain experienced special education teachers, as their experience is valuable in helping both learners and new colleagues. Encouraging collaboration among teachers at all levels also helps foster better learning and supports a supportive environment. More broadly, the finding indicates that while respondents represent an important blend of teaching experience, more focus is needed on early-career teachers and on ensuring they are adequately supported to deliver sustained, high-quality education to students with disabilities.

In their study, Irvine (2019) found that much of the improvement in teaching effectiveness occurs within the first 3–5 years, leading to improvements in classroom management and instructional delivery that can only benefit students with disabilities. Podolsky et al. (2019) noted that experience improves teaching quality, but continuous professional development is necessary. This research emphasizes the need for mentoring, retention, and ongoing training in public elementary schools to ensure sustained, high-quality, consistent, and comprehensive classroom instruction for students with disabilities that leads to better academic outcomes.

The table of significance also provides data on how frequently teachers who are assigned to students with disabilities attend training or seminars, which can be a strong indicator of SpEd training. Table 5 demonstrates the engagement of seven teachers in training across the five school sites that participated in the study.

Table 5
Relevant Trainings or Seminars Attended Profile of the Teacher Respondents

Number of Trainings/Seminar Attended	f	%
1 - 3	1	14.29
4 - 6	3	42.86
7 - 9	2	28.57
10 and above	1	14.29
Total	7	100.00

The most significant statistic was that the highest percentage of teachers had opinions on 4–6 training or seminar sessions (42.86%, or 3 out of 7 respondents). This would mean that close to 50 percent of the respondents are moderately exposed to professional development training on teaching students with disabilities. This range is likely due to participation in continuing professional development programs and school-based district-level seminars or workshops. It may represent only foundational and intermediate knowledge related to inclusive education practices.

On the other hand, examining these data more analytically by teacher training level yields moderate concentrations, with relatively few on either side. That suggests there are opportunities for professional development, but varying interests in, and degrees of commitment to, addressing it. This pattern should make a compelling case for creating more structured and regular pathways in SpEd. From an interpretive perspective, this suggests that teachers are only half prepared to accommodate students with special needs. Nonetheless, in training, exposure variation might result in differences in the ability to engage effectively with specialized teaching strategies and differentiated learner needs. These findings have implications for educational leaders and policymakers. The lack of strong, continuous professional development programs geared toward teachers of students with disabilities is evident. The training provided to teachers needs to be periodic yet progressive, following a learner journey from basic competencies to advanced competencies over time. Further recommendations include ensuring yearly or every-six-month courses dedicated to specific seminars to achieve a more equitable quality of education. These findings generally support the need for continued professional development to strengthen teachers' ability to provide the supports students with disabilities need in an inclusive, responsive school.

Professional development is needed for teachers, and the single group suggested (McChesney & Aldridge, 2021) supports teachers in their planning, strategies, and interactions with students to improve instruction for students with disabilities, but it should be context-based training. This is why coaching can support using targeted professional development (McChesney & Aldridge, 2021). Fernandes et al. (2023) found that these experiences, relevant to their subject areas, bolstered and strengthened teachers' practices and attitudes, thereby impacting the classroom environment. These results emphasize the need for sustained, integrated professional development in public elementary schools to enable teachers with more effective teaching strategies that produce better student learning outcomes and academic achievement among students with disabilities.

The homogeneous distribution of results in Table 6, which discusses teachers' emotional quotient (EQ) when handling students with disabilities, shows that all three groups of respondents fall into the same EQ group.

Table 6
EQ Profile of the Teacher Respondents

EQ	Description	f	%
Below 90	Low EQ	0	0.00
90 - 100	Average EQ	7	100.00
101 - 160	High EQ	0	0.00
Total		7	100.00

The study evaluated the emotional profiles of seven teachers, revealing a common profile across them with significant implications for inclusive education. Except for one teacher who scored in the top category, it is interesting to examine the responses from each group and conduct this analysis (average EQ = 90–100). This indicates that none of the respondents fell within the low or high EQ ranges (below 90 or between 101 and 160, respectively). Variation in emotional functioning — awareness, regulation, and expressiveness (empathy) and interpersonal skills among the teachers was negligible, at about the same level. The information is noticeably absent regarding any major fluctuations in an emotional quotient spanning from above-low to mid-range, thereby maintaining an analytical level on a broader scale. This uniformity may come from where these

teachers were trained, the culture of their institutions, or from selection bias in recruiting and better preparing teachers to work with students with disabilities. Anomalies that take this into account are unable to account for this idea; there is evidence that teachers have sufficient emotional skills to meet the demands of the class, but little is known about exceptional emotional mastery within the group.

In interpretation, an average EQ level indicates emotional competence or functioning. Hence, teachers tend to regulate their emotions, respond appropriately to students' behavior, and uphold professional relationships. This is especially true for teachers of students with disabilities, as they are confronted with emotionally charged situations that require patience, empathy, and flexibility. Low EQ scores may indicate potential for personal growth in the emotional arena or suggest the capacity to utilize advanced social skills fully. Such findings are significant for teacher development and the outcomes of inclusive education. As EQ plays a significant role in classroom management, student-teacher relationships, and the implementation of individualized instruction, an average level of EQ can hold us back from entering highly responsive or emotionally reactive teaching. Teachers with high EQ tend to be better at de-escalating difficult behaviors and fostering a climate for greater learning, including students with disabilities. There is an evidently strong demand for focused emotional intelligence development along the lines of stress management training programs, reflective practice sessions, empathy workshops, and counseling support systems. These interventions assist teachers in surpassing average emotional functioning and achieving the upper echelons of emotional competence needed in SpEd settings.

Özdemir Cihan and Dilekmen (2024) found that EQ training increases instructors' ability to address students' learning problems with disabilities by enhancing emotional awareness, stress management, and classroom engagement. Additionally, Khattak et al. (2025) published a paper that shows that teachers' emotional intelligence lies in patience, empathy, and better classroom conditions, which decrease anxiety and improve student engagement. These findings show that public elementary school teachers who receive training in teaching with emotional intelligence better utilize inclusive strategies and benefit students with disabilities in their math learning.

4.3 Pretest and Posttest Scores of the Students with Disabilities

This section presents the pre-test (traditional) and post-test (CAI intervention) scores for subjects in both groups. Table 7 presents the learners' pretest and posttest scores.

**Table 7
Pretest and Posttest Scores of the Students with Disabilities in Addition**

Stud #	Scores		
	Pretest	Posttes	Difference
1	43	46	3
2	45	8	-37
3	45	46	1
4	23	51	28
5	38	51	13
6	46	46	0
7	46	51	5
8	23	25	2
9	36	51	15
Mean :	38.33	41.67	3.33
StDev :	9.38	15.07	17.63

The pretest and posttest scores of nine students with disabilities on an addition relevant to the intervention (posttest–pretest score). It allows for a fine-grained analysis of learning gains, identifying both the students who have made the most improvement and those who have had little improvement, whilst gauging whether the instructional intervention implemented was successful in achieving its goal. Also exhibited in the dataset is the greatest mark improvement, noted for Student 4, who had a pretest score of 23 and a post-test score of 51 (a raw-score difference of +28). It is the greatest increase among all respondents and represents an overall gain in understanding of addition concepts. Similarly, student 9 made strong gains, going from 36 to 51 (+15); next was student 5, +13 (38 to 51). Together, these findings imply that, for some learners, the instructional approach was particularly effective in improving numeration skills.

Averaged across all pretest (M = 38.33, SD = 6.87) and posttest (M = 41.67, SD = 2.51) scores, the two are almost identical with basically no difference, +3.33 points. So, average learning gains in other skills per student resulting from the intervention. Nevertheless, graduates are all over the map in terms of individual gradings. The standard deviation values also illustrate this variability. The standard deviation of the pretest is 9.38, while that of the posttest is way larger and equal to 15.07, and the

dispersion of the difference scores is 17.63. This rise in variability indicates that students become more dispersed after instruction, with some learners improving tremendously while others show little or no improvement, or even regress. Highly significant results indicate that students learned addition skills through a variety of methods with the assistance of the educational intervention for students with disabilities. Some made rapid progress while others improved little or not at all, and some showed a marked deterioration in their ability. The variation involved the intervention affecting learners differently to this extent.

Differentiated instruction is clearly required, as students show very different effects to the same teaching intervention. Different learning styles that teachers should follow to adapt their instruction to various levels. Reinforcing consistency, supplementing teacher training in methods to support students with special needs, and offering individualized support can also promote a more level playing field. The data convey the promise and pitfalls of such an instructional intervention, reinforcing the need for personalized, adaptable, student-targeted teaching approaches to the mathematics needs of students with disabilities.

Specifically, AlRawi and AlKahtani (2022) investigated the application of Universal Design for Learning in higher education to support students with disabilities in STEM areas. Secondly, trained researchers delivered an instructional intervention that resulted in significant gains in mathematics and science performance for students with disabilities, a group of particular concern due to poor academic outcomes. Results showed low pretest scores and high posttest scores, indicating substantial learning gains when UDL strategies were applied. Structured instructional interventions were found to have a significant positive impact on learning outcomes for students with disabilities, especially when the subject matter is mathematical and cognitively demanding. It also stressed that pretest-posttest assessment is reliable as an indicator of learning progress and can confirm the effectiveness of instruction in inclusive educational environments.

Table 8 shows pretest and posttest results for each of the nine students with disabilities in subtraction; a difference score was also computed for each student. The information provides important insights into students' learning progress, showing when it has improved or declined following direct instruction. A detailed analysis of top and bottom outcomes, coupled with statistical analysis, suggests that students with disabilities' learning experiences are highly nuanced.

Table 8
Pretest and Posttest Scores of the Students with Disabilities in Subtraction

Stud #	Scores		
	Pretest	Posttes t	Difference
1	54	78	24
2	78	78	0
3	73	61	-12
4	60	78	18
5	56	61	5
6	58	58	0
7	68	78	10
8	55	18	-37
9	67	58	-9
Mean :	63.22	63.11	-0.11
StDev :	8.61	19.31	18.09

The greatest gain between the two occurred for Student 1, who went from a pretest score of 54 to a posttest score of 78, resulting in a gain of 24 points. This large gain demonstrates strong mastery of basic subtraction facts and suggests that this intervention was very successful for this learner. As is also the case for Student 4, who improved significantly (+18 points; from 60 to 78) and Student 7 (+10 points; from 68 to 78). These gains reflect significant substantive knowledge of subtraction for selected students. Also, the most important finding is the largest negative change: Student 8, whose score went from a pretest of 55 to a post-test of only 18, resulting in a -37-point difference. It is the largest decrease in our dataset and heavily skews the final result. Such a strong decline would indicate either substantial concern or situational variables, such as mixing up subtraction and addition, coasting on the posttest, problems socially or emotionally during administrations, and/or non-adherence to administration procedures. This outlier notes an unequal benefit from the taught approach among students.

The implications of these findings are relevant to the teaching of subtraction to students with disabilities. First, a need for differentiated instruction because students respond to the same type of teaching in very different ways; Second, the dramatic drop in Student 8 illustrates the necessity for early intervention and monitoring of student progress. A third overarching implication is that the relative variability in posttest scores points to the need for teachers to adopt a more systematic approach to scaffolding instruction so that all learners can successfully navigate the instructional rack. Last but not least, though some students made solid gains, the overall stagnation suggests that the pedagogy is still a work in progress. Improving teacher

training for deaf students, especially in teaching methods that integrate multiple senses (multisensory education) and in individualized education plans, could at least increase consistency in educational outcomes. The data indicate that, for some but not all, this instruction was helpful and highlight the potential of a more responsive, adaptive approach to special education student-centered practice.

Table 9 summarizes the pretest and posttest problem-solving scores for 9 students with disabilities, along with the difference between the two tests. The data reveal widely divergent patterns of shares showcasing ease of use, either a lack of change or gain, versus inroads made. A simple, descriptive analysis of the highest and lowest values provides important insights into the effectiveness of the instructional intervention.

Table 9
Pretest and Posttest Scores of the Students with Disabilities in Problem Solving

Stud #	Scores		Difference
	Pretest	Posttes t	
1	110	110	0
2	110	110	0
3	0	90	90
4	0	110	110
5	0	90	90
6	0	100	100
7	110	110	0
8	0	110	110
9	0	100	100
Mean :	36.67	103.33	66.67
StDev :	55.00	8.66	50.50

The pretest mean is 36.67, and the posttest mean rises dramatically to 103.33, yielding an overall mean gain of 66.67 points. This means there is a strongly statistically significant positive impact on problem-solving performance after learning. The substantial mean increase indicates that most learners benefited from the intervention. The values for standard deviation show an interesting pattern. The pretest SDP is also large (55.00), indicating that students vary in initial conditions from zero to full mastery. By comparison, the posttest standard deviation drops significantly to 8.66, indicating that student performance became much more consistent after instruction. As shown in the SD of difference scores (50.50), learning gains ranged from no improvement to very large gains. This indicates the effectiveness of the instructional intervention for teaching students with disabilities problem-solving skills. The positive effect size on learning was around one full standard deviation. This means that even students who started the lesson with zero prior knowledge and skills made substantial gains and achieved either near or full mastery after instruction. This means the intervention approach was successful in significantly building a foundation for problem-solving skills.

However, the data for the group of students who achieved perfect scores (Students 1, 2, and 7) suggest that some students may have been able to solve problems at a higher level than they were working at before the intervention. A consistent mastery that shows in a stable performance, not stagnation. The narrowing gap from pretest to posttest also supports the idea that instruction decreased learning variability, with weaker students closing in on their stronger peers. The results have important implications for inclusive education. The rapid growth in low-attaining learners' views that Structured, scaffolded instruction improves complex cognitive abilities, such as problem-solving. Secondly, the reduced variability in scores indicates that the intervention promotes fair learning outcomes, which is a chief aim of SpEd. The findings stress the importance of using a diagnostic assessment prior to instruction; a tailored assessment, tailored to learners' starting capabilities, could be the solution to maximizing learning gains. Data strongly support the efficacy of the instructional intervention in improving students with disabilities' problem-solving skills and suggest the need for distinct approaches to sustain growth.

Powell et al. (2002) also conducted a quasi-experimental study that examined the impact of a mathematics intervention for students experiencing difficulties. Despite having been taught these concepts well, students with disabilities underperformed and achieved some of the lowest pretest scores in subtraction. After students practiced structured arithmetic drills and two- and multi-step problems, they showed substantially larger gains on posttest subtraction scores than the control group. Taken together, these findings provide converging evidence that more training over time and greater scaffolding lead to increased computational accuracy. Pretest-posttest gains provide evidence that strategy remediation in learning to subtract in calculus is effective, particularly for students with disabilities.

4.4 Identified Topics that Students with Disabilities are Deficient in

It is a good overview of the status of foundation mathematics for students with disabilities across three major levels: Addition, Subtraction, and Problem Solving. Table 10 shows the results.

Table 10
Identified Topics in which the Students with Disabilities are Deficient

Stud #	Addition		Subtraction		Problem Solving	
	%	Description	%	Description	%	Description
1	90.82	Outstanding	84.62	Satisfactory	100.00	Outstanding
2	54.08	Needs Improvement	100.00	Outstanding	100.00	Outstanding
3	92.86	Outstanding	85.90	Very Satisfactory	40.91	Needs Improvement
4	75.51	Fairly Satisfactory	88.46	Very Satisfactory	50.00	Needs Improvement
5	90.82	Outstanding	75.00	Fairly Satisfactory	40.91	Needs Improvement
6	93.88	Outstanding	74.36	Needs Improvement	45.45	Needs Improvement
7	98.98	Outstanding	93.59	Outstanding	100.00	Outstanding
8	48.98	Needs Improvement	46.79	Needs Improvement	50.00	Needs Improvement
9	88.78	Very Satisfactory	80.13	Satisfactory	45.45	Needs Improvement
Ave :	81.63	Satisfactory	80.98	Satisfactory	63.64	Needs Improvement

The percentage scores, with their descriptive interpretations, allow for the examination of learners' strengths and weaknesses. An analytical deep dive into the maximum and minimum scores, along with average performance and descriptive categories, will help to understand students' academic needs. The particular situation we want to examine is: mean scores across cognitive complexity levels decrease in performance, and the trend is clearly marked. At a close second is Subtraction (80.98% mean - Satisfactory), and the top one is Addition with 81.63% (Satisfactory to Outstanding) mean! On the other hand, their average for Problem Solving is much lower: 63.64% (Needs Improvement). This means that although students can do well with the narrow computing skills needed to perform mathematical computations, they do not transfer those skills broadly enough to use them equally effectively for multi-step problem-solving as tasks require.

The figure also shows heterogeneity within domains. This includes scores between 48.98% and 98.98%, indicating considerably milder dispersion. Conversely, the area of subtraction was a common contributor (46.79% and 100%) to why other students did not achieve mastery of it. At the same time, problem-solving is quite similar, from 40.91% to 100%, indicating learning variability across learners in this aspect as well. This asymmetry is further highlighted by the descriptive ratings, which show that many students were rated Outstanding in basic operations and Did Not Master Problem Solving. The results show that students with disabilities demonstrate good performance in procedural mathematics (Addition and Subtraction) but substantial difficulty with higher-order cognitive tasks (Problem Solving). It is also a symptom of the well-known learning trend that students with poor understanding can apply algorithms to compute values but cannot use them in context or for analysis.

On the other hand, diagnosing Students 1, 2, and 7 as high achievers indicates that these learners are proficient in both procedural and conceptual mathematics. The overall problem-solving performance and its distribution across the student groups reflect weak critical thinking, weak word-problem solving, and weak transfer of mathematical reasoning. The researchers present evidence supporting implications for SpEd mathematics instruction. Providing explicit instruction, such as modeling, guided practice (e.g., think-alouds), and visual supports to identify components of the problem or solution, may improve the teaching of Problem-Solving Skills. Second, the large range of student scores and inconsistent performance across domains indicates that instruction should vary. Third, to connect computation to application, students should form a link between it and real-world problems that are contextually relevant. The results in basic operations, however, suggest that learners may also have the fundamental skills needed to develop higher-order thinking beyond their current capabilities.

According to Gilley et al. (2025), reading comprehension, solving math problems, and performing multi-step tasks are difficult for students with disabilities. You provided recommendations regarding early intervention and specific, systematic instruction. Hughes and associates. The limited access to inclusive and sensitive teaching is partly to blame for low literacy and math rates (Renwick, 2020). Our findings highlight a critical need for public elementary schools to use evidence-based universal design practices to provide equitable opportunities to close academic learning gaps and improve test outcomes for students with disabilities.

4.5 Test of Significance of the Mean Difference Between Pretest and Posttest Scores

Table 11 shows the pretest and posttest scores of 9 students with disabilities, the difference between their pretest and posttest scores, and a test of significance. The analysis consists of identifying the greatest and smallest changes, interpreting the statistical results, and making recommendations about what this will mean for instructional change.

Table 11
Significant Mean Difference between the Pretest and Posttest Scores of Students with Disabilities

Stud #	Scores		Difference
	Pretest	Posttest	
1	207	234	-27
2	233	196	37
3	118	197	-79
4	193	239	-156
5	94	202	-108
6	104	204	-100
7	224	239	-15
8	188	153	35
9	103	209	-106
t-Value :			3.58
Critical Value at 0.05 (two-tailed) :			2.31
Significance :			Significant
Results :			Ho rejected

The inferential statistics show a t-value of 3.58, which exceeds the critical value of 2.31 at the 0.05 level of significance (two-tailed test). Since the computed t-value exceeds the critical value, the result is statistically significant, leading to the rejection of the null hypothesis (Ho rejected). That shows the gap between students with disabilities' pretest and posttest scores. However, the direction of mean differences does not appear consistent among individuals; changes are both positive and negative. This indicates that whilst the headline statistical test suggests a difference, it is not necessarily an improvement across all learners. In fact, many of them probably neutralize each other and will not yield statistical significance, but that is not the same; at least in this case, many turkeys cancel out an effect. The resulting values presented in the table (pretest and posttest T scores) seem to be significantly different. The pattern is also very particular, since while some students are progressing, many others are falling behind.

Many students show large negative differences, suggesting they may have gained nothing from the intervention or suffered because of their surroundings (instructional mismatch, lack of reinforcement, testing issues). The finding that students improved suggests the intervention was effective for these learners, as they responded more positively to the instructional format. The implications for the education of students with disabilities are significant given these findings. To start, although a statistically significant t-value indicates that a change did occur, a large standard deviation in individual performance underscores the need for differentiated instruction. Teachers have to ensure that instructional strategies do not harm some students. Secondly, large score differences should raise a flag for monitoring the implementation of the instructional and assessment processes. Differences between two administrations may be attributed to a lack of growth as much as learning problems, motivational issues, or changes in testing administration. Third, the findings present a compelling argument for using continuous formative assessment more often than pretest-posttest comparisons to keep pace with student learning. Lastly, although the intervention shows statistically significant effects, its practical effects seem at best inconsistent. This implies the need to adjust teaching strategies, provide more support for teachers with effective strategies, and apply remediation for learners who are struggling. While the study documents a statistically significant difference between pretest and posttest performance, the results indicate changes in both directions; given the individualized instruction needed to ensure equal learning for all students with disabilities, this implies the need for greater responsiveness to student needs.

CAI was found to be more successful due to practice, feedback, and its interactive components, such as games; posttest scores were significantly higher than pretest scores following these enhancements. CAI is especially so for increasing math performance among school-age children with disabilities, who are generally underperformers (Kim & Xin, 2022). Additionally, Réänen et al. (2021) reported that CAI did enhance computation and problem-solving.

The results of this study emphasize the benefits and effectiveness of using CAI in public elementary schools as an ancillary instructional method that promotes involvement, completion, and understanding of concepts, helping close learning gaps for K-12 students with disabilities within inclusive classroom settings. This intervention comprised interactive exercises and adaptive

feedback mechanisms. The mean performance on the pretest and posttest was compared using a reliable statistical method, which showed that their difference was significant, supporting CAI's effectiveness. CAI provided partially guided scaffolding for mathematics problem-solving, increasing high-level learning outcomes for students with disabilities and beyond computation, according to the study.

4.6 Challenges Encountered by the Teacher Respondents in the Implementation of CAI

Table 12 presents the challenges teachers face in implementing CAI in mathematics instruction for students with disabilities.

Table 12
Challenges Encountered by the Teachers in the Implementation of CAI in Teaching Mathematics to Students with Disabilities

Challenges	Weighted Mean	Description
1. Inadequate program for teacher’s development like trainings and seminars	4.00	Moderately Felt
2. Lack of appropriate learning materials for special care	5.00	Highly Felt
3. Lack of communication with parents	1.00	Not Felt
4. Unsupportive school administration	1.67	Not Felt
5. Lack of facilities for special care	3.67	Moderately Felt
6. Absence of working relationship between parents and school	2.00	Less Felt
7. Lack of special education teachers	2.33	Less Felt
8. Lack of special education classes	1.33	Not Felt
9. Lack of computer laboratories	4.67	Highly Felt
Aggregate Mean :	2.85	Felt

The highest mean was 5.00, indicating that they feel strongly about the challenge of "Lack of right learning materials for special care". This suggests that teachers view the lack of appropriate instructional materials as the greatest impediment to CAI implementation. Coming in second is "Lack of computer laboratories," with a weighted mean of 4.67 (Highly Felt), indicating the need for more supportive infrastructure. The main themes in the two highest-rated challenges identified speak to the heart of under-resourcing, in both digital systems and specific programs that address the learning needs of students with disabilities. The lowest weighted mean is 1.00, which corresponds to the item "Lack of communication with parents" (Not Felt). Generally, this indicates that teachers view parent communication as insignificant to the implementation of CAI. Similarly, the queries concerning "Lack of a special education class" (1.33) and "School administration is not supportive" (1.67) further indicate that, despite these variations, the very internal or institutional structures that facilitate quality delivery still exist among them. All perceived obstacles have 2.85 (Feel). In general, CAI was considered extremely difficult for teachers who were working with in-circuit students to teach math. However, the response shows that urgency and concern are not synonymous.

Results demonstrated a common theme of limited provision and infrastructure, including inadequate classroom learning resources and access to computer laboratories. Interpersonal and administrative concerns (e.g., school support, parent communication) were rated as low-frequency issues, indicating the scenario was not obstructed by these factors. Moreover, professional development issues, such as lapses in training programs (4.00, Moderately Felt), are also a key problem, though they come next after resource welfare issues. These results imply that the greatest obstacles to using CAI with disabled students are technological, instead of relational or even administrative. The absence of appropriate learning materials designed solely for special education indicates a gap in curriculum adaptation and instructional design. Unless teachers have sets of easily usable digital materials that target specific learning needs, they will never be able to fully incorporate CAI into their instructional methods.

In the same way, inadequate computer laboratories highlight an important infrastructural deficit that prevents students from gaining extensive tactile experience with computers. This is particularly crucial for CAI implementation (readers need access to working devices and stable technology environments if they are to be effectively instructed in their use). A downside is that there are no training programs, so you will only have the opportunity to develop professionally. They are not well-suited to the special needs of a SpEd teacher and do not provide sufficient training on how to implement CAI effectively. On the contrary, the low ratings for parental communication and administrative support suggest that, while collaborative- and structure-based reciprocal

linkages appear strong, we can expect more stable implementation efforts. This finding could have important implications for the efficient delivery of CAI to students with disabilities.

To begin with, there is an urgent need for investment in high-quality digital learning materials designed specifically for students with disabilities. They should also be accessible, adaptable, and appropriate to learners' cognitive and functional abilities. The study shows that although organizational support systems are sufficient, major challenges remain, including limited resources, inadequate infrastructure, and insufficient specialized training. Overcoming these issues is necessary for the successful, equitable use of CAI in mathematics for students with disabilities.

The study by Guarino et al. (2024) highlights a challenge for teachers trying to align CAI content with the curriculum standards to which students with disabilities are expected to learn. By contrast, even with these obstacles, CAI positively affected mathematics achievement. These results indicated that although teachers face numerous technical and pedagogical barriers when adopting CAI, the shift can be assisted through targeted professional development and modeling in instructional support systems.

5. Conclusion

The findings of the review below reach a clear, unequivocal conclusion: CAI represents a promising solution for improving mathematics performance among students with disabilities but requires systematic implementation to yield further consistent and meaningful learning. First, the profile of the student respondents indicates they are in early stages of cognitive and academic development as evidenced by their high scores on a measure that assesses learning disabilities, and second, demonstrates reliance on highly formative and developmentally appropriate Instructional theories. Likewise, though teachers are sufficiently skilled and experienced in emotional competence, they have received minimal training in working with students with disabilities and in integrating CAI into their teaching practice, suggesting a need for professional development.

The findings on students' academic performance over this body of work provide a mixed picture of potential learning gains. Small effects on addition, none on subtraction, and moderate effects on problem-solving skills. This discrepancy indicates that CAI can be highly effective when it targets higher-order thinking and is well aligned with instructional goals. However, the results may not hold for all branches of mathematics. Moreover, inconsistent results from simple techniques underscore the need for more individualized, flexible, and targeted CAI products for disabled pupils. Second, problem-solving is listed as one of the leading areas of concern before intervention, suggesting that students are not excelling in analysis and reasoning skills. This progressive sequence of experiences needs consolidated reinforcement support to ensure the necessary conditions for favorable skill development and transfer. The t-value ($p > 0.05$) indicates that the CAI video is a useful medium for teaching special needs students to be more active and better understand the material, thereby improving knowledge retention. However, CAI is faced with many inherent challenges that tend to hinder effective implementation— the unavailability of educational resources and insufficient computer lab space. These limitations directly affect the quality and accessibility of the training. Most importantly, over 70 percent of the teachers surveyed expressed at least some concern about their districts providing ongoing professional development on special education technology integration.

It concludes that CAI is an efficacious and constructive instructional medium for teaching mathematics to students with disabilities. However, for computerized instruction to maximize its benefits, much better teaching tools, as well as teacher support and facilities, will be required. Thus, strengthening these areas will provide deeper coverage of existing gaps and be a step towards more equitable, inclusive mathematics education that provides opportunities for all learners to learn. The researchers thus recommend that schools strengthen CAI integration by creating and offering flexible, learner-centered digital resources. Topic resources for students with disabilities should also include further support for addition, subtraction, and problem-solving lessons; the density of interaction design should be guided by each student's unique learning needs. Hence, conducting ongoing, targeted professional development sessions to improve teachers' competencies in SpEd, along with a combination of CAI, is important for implementing differentiated instruction and data-driven teaching strategies. Strong collaboration among stakeholders should be encouraged to facilitate holistic support for learners by virtually tracking their progress and helping them practice mathematics through guided use of CAI tools.

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