



Mathematics Education and Its Contributions to Attention Deficit Hyperactivity Disorder

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Abstract: This research presents a systematic review of studies in mathematics education and problem-solving that address pedagogical work with children with a diagnosis of attention deficit and hyperactivity disorder. Through a historical-logical methodological analysis and a rigorous bibliographic search, significant contributions to the development of mathematical learning in this population were identified. The study highlights the main predictors of difficulties in mathematical performance, associated behavioral aspects, effective pedagogical models, and successful cases and didactic strategies that have shown significant progress, particularly in teaching through mathematical problem-solving. Additionally, a neutrosophic logic framework was applied to assess the degree of certainty, indeterminacy, and contradiction within each evidence category, providing a tripartite epistemic characterization of the reviewed literature.

Keywords: Mathematics education; ADHD; Mathematical problem solving; predictors of failure; Neutrosophic logic; Indeterminacy.

1. Introduction

Education constitutes a fundamental human right that underpins the integral development of individuals across cognitive, emotional, and social dimensions, providing freedom in various forms. This freedom fosters active societal participation and the autonomy to exercise leadership that influences scientific development and the well-being of communities and their environments. However, not everyone has access to this right. Various factors, such as geographic location, political conflicts, racial discrimination, and cultural differences, limit equitable access. In addition to these barriers, people with special educational needs (SEN) face an even deeper form of exclusion. They are often invisible in many contexts and face serious restrictions in accessing quality education and receiving adequate, dignified attention.

Learners diagnosed with attention deficit hyperactivity disorder (ADHD) tend to exhibit disruptive behaviors. These behaviors are characterized by an inability to sit still and can lead to tension in the school environment. They also have difficulty sustaining attention during academic activities, which negatively impacts their ability to comprehend key mathematical concepts and hinders their learning process.

We will address contributions to mathematics education focused on students with ADHD and mathematical problem-solving as a learning strategy. We will also state the predictors of failure and successful strategies identified in different educational contexts:

[1] investigated the performance of adolescents with learning disabilities (LD), attention deficit disorder (ADD), and attention deficit hyperactivity disorder (ADHD) in mathematical problem solving. The authors point out that cognitive functioning and reading skills are fundamental to understanding statements, identifying irrelevant information, performing operations, and reinterpreting verbal data. They also argue that slow calculation speeds can significantly hinder the process of solving mathematical problems and that the poor performance of young people with attentional disorders is primarily due to their difficulty sustaining concentration during monotonous tasks or repetitive stimuli.

[2] investigated the benefits of using game-based software to complement classroom instruction and improve the math performance of three students diagnosed with ADHD in grades four through six. The authors cite Lillie, Hannun and Stuck (1989) and Torgesen and Young (1983), who argue that computer-assisted instruction improves concentration and educational outcomes in such students. Similarly, studies such as those by Ford, Poe and Cox (1993) have found that students' attention levels increase with interactive formats containing animated elements.

[3] analyze the difficulties students with ADHD face when solving arithmetic-verbal problems. They describe the most common types of errors in this type of task and propose various teaching strategies for addressing them in the classroom. Their research involved a sample of 75 students, 37 of whom had been diagnosed with ADHD and 38 of whom did not have the disorder. The authors conclude that the learning difficulties experienced by students with ADHD are specific to the disorder and directly affect their academic performance. The results show that these students generally obtain lower grades than their peers without a diagnosis in both primary and secondary school. However, they also observe a progressive improvement in the number of correct answers as these students advance in school, except in the last cycle of primary school, when performance declines again.

On the other hand, [3] found that the formal aspects of problem-solving in students with ADHD are affected by difficulties in spatial organization, presentation, and writing. These students tend to clutter the workspace, fail to follow a logical sequence when developing solutions, and produce unclear or illegible lines and symbols. This makes their procedures difficult to understand.

[4] investigated academic difficulties in reading and mathematics in students with ADHD, as well as theoretical factors that could influence these deficits, and the impact of psychostimulant interventions. Their results showed that children diagnosed with combined ADHD (ADHD+) responded favorably to psychostimulant treatment, demonstrating improvements in word recognition and mathematical operations. The sensory stimulation used in the intervention led to significant advances in reading comprehension and calculation and problem-solving skills in mathematics. Among the main findings related to academic difficulties in students with ADHD, the authors highlight poor persistence in completing tasks, which is associated with low motivation. Additionally, patterns of limited production, greater variability in performance, and slowness in executing activities were identified. Conversely, it was evident that math performance improves with intense, constant, and immediate reinforcement stimuli, while the absence or withdrawal of these incentives generates frustration in students.

According to [4], incorporating playful elements, such as competition and animation, into math practice activities improves student behavior and academic performance. They also highlight that participating in interactive environments where students are guided by an avatar in computer-assisted instruction (CAI) programs contributes positively to engagement and performance in mathematics.

[5] conducted a study analyzing the neurocognitive and behavioral factors affecting the mathematical performance of children with and without an ADHD diagnosis. They evaluated how cognitive and behavioral variables predicted scores on standardized tests and productivity and accuracy in analog math tasks. Their findings suggest that deficits in neurocognitive functions play a larger role than behavioral aspects in explaining the low math performance of students with ADHD. In their theoretical review, [5] mention that Froehlich et al. (2007) found that approximately 8.7% of

school-age children meet the diagnostic criteria for ADHD. They also cite Langberg et al. (2010) who report that these students tend to complete fewer school tasks. Several studies have also documented that children with ADHD tend to receive lower grades, perform worse on standardized tests, solve fewer exercises, and make more mistakes than their peers without the disorder. Furthermore, students with ADHD tend to exhibit greater impulsivity and distracting behaviors during school activities than control groups, which maintain more task-focused behavior.

[6] conducted a comprehensive review analyzing the primary challenges faced by students with ADHD and ADHD combined with learning difficulties in mathematics (ADHD+LDM). Based on a literature review, he highlights pedagogical strategies developed to improve teaching and learning processes, paying special attention to the cognitive deficits associated with these disorders. The review emphasizes the use of simple, structured teaching materials, as proposed by Miranda Casas et al. (2002) and Zentall (2005). These materials reduce verbal information and present a limited number of exercises per page to minimize distractions. Similarly, Martínez (2010) suggests incorporating visual aids, such as graphics or illustrations, to complement the verbal content of problems and facilitate comprehension. Using digital resources and computer games is also valued as an effective way to motivate students with ADHD and promote their autonomy. Zentall (2012) points out that these students tend to respond better to striking visual stimuli, such as bright colors or highlighted elements, which can be exploited through strategic underlining in math problems. Additionally, he recommends using auditory stimuli and audiovisual resources, such as recording students performing activities, to improve attention and self-control. Miranda Casas et al. (2002) advocate using problems contextualized in real situations to increase student interest. They also recommend training students to understand statements, subdivide information into simpler units, and generate mental images to facilitate problem representation. Conversely, Zentall (2007) emphasizes avoiding irrelevant information in statements and using visual aids, such as tables or diagrams, to reduce working memory overload.

[6] found that frequently changing classroom activities, allowing short breaks without affecting task tracking, and using elements such as mirrors to help students redirect their attention between the task and their own behavior promote self-regulation. Additionally, clear guidelines should be used, break times should be increased, achievement should be positively reinforced through incentives, and a structured and quiet environment should be maintained. Classroom organization, making eye contact when giving instructions, and allowing flexible time to complete tasks are also key factors in promoting the performance of students with ADHD and ADHD+DAM.

In their systematic review of the relationship between ADHD and mathematical performance, [7] analyzed research that explored the effects of inattention and hyperactivity-impulsivity symptoms on mathematical performance separately. Their review included quantitative studies extracted from five specialized databases (PsycINFO, Web of Science, PubMed, EMBASE, and Scopus), covering a total of 30 cross-sectional and 4 longitudinal studies. The authors concluded that there is an unfavorable relationship between attention deficit hyperactivity disorder and performance in mathematics. Seventy-six point forty-seven percent of the reviewed studies showed this relationship, even after controlling for variables such as IQ, age, socioeconomic status, and medication use. Overall, students with ADHD scored lower on math tests than their peers without the disorder.

When analyzing ADHD symptoms separately, they found that inattention was more closely related to math difficulties (~82%) than impulsivity symptoms (~38%). However, some studies with small sample sizes failed to establish a significant relationship, likely due to limited statistical power.

Furthermore, the findings suggest that math difficulties in children with ADHD may be associated with deficiencies in executive functions, including planning, organizing, retaining and processing information, and working memory, as well as the ability to infer data from problems with limited information.

The study also highlights variability in diagnosing and tracking ADHD subtypes. For instance, some children initially presenting with combined ADHD symptoms (ADHD-C) may progress to predominantly inattentive symptoms (ADHD-I) as they grow older because hyperactivity symptoms

tend to decrease with age while inattention symptoms persist. Finally, the researchers emphasize that the negative relationship between ADHD and math performance is more pronounced in cases of inattention. Therefore, they recommend subtype-specific diagnoses to more accurately identify students at higher risk for academic difficulties. Additionally, they suggest that pharmacological treatments can help children with ADHD cope with the demands of the school environment and take advantage of learning opportunities.

[8] investigated the difficulties children with ADHD experience when solving math problems requiring constant updating of information. They compared the performance of a group of 11- to 12-year-old children with ADHD to a control group of typically developing children, assessing their performance on problems that demanded different levels of cognitive updating.

The results revealed that students with ADHD solved fewer problems correctly than their peers without the disorder. They also made more mistakes, particularly in exercises requiring active updating of data during the problem-solving process. These children had difficulty selecting relevant information, planning an appropriate strategy, and executing the solution correctly. The researchers concluded that these limitations are closely related to alterations in executive functions, particularly the ability to update and manipulate information in real time. Therefore, the researchers point out that updating information is a particularly challenging process for children with ADHD and represents one of the main barriers to effectively solving complex mathematical problems.

[9] conducted a study focusing on the selection of arithmetic strategies in children with ADHD. Fourth- and fifth-grade students with and without ADHD symptoms participated and were asked to choose the best of two rounding strategies to solve two-digit addition problems in a computational estimation task. Both groups were matched for age, gender, general knowledge level, and calculation skills, as assessed by standardized tests (AC-MT). The results showed that although all participants could correctly apply a strategy, those with ADHD chose the most appropriate strategy less frequently than their peers in the control group. Additionally, they required more time to estimate sums, and their responses were less accurate.

The study revealed that the factors influencing strategy selection differed between the two groups despite their similar levels of mathematical competence. In conclusion, the authors emphasize that children with ADHD experience difficulties with strategic decision-making not due to a lack of knowledge, but rather due to differences in the cognitive processes involved in choosing and using efficient strategies.

[10] developed a techno-pedagogical model to improve mathematical problem-solving in children with ADHD. This model involved designing and evaluating a serious game called *A Journey Through Mathematics*. The authors point out that the use of serious games as support tools for mathematical learning in students with this disorder has been limitedly explored.

A group consisting of thirteen minors diagnosed with ADHD, six teachers specializing in special education, family members, and professionals with expertise in the subject actively participated in the design and validation of the game. Semi-structured interviews, classroom observations, the "Wizard of Oz" technique, and the CSUQ questionnaire were used to collect data to evaluate the usability, informational quality, interface, and overall satisfaction with the digital resource.

The results showed positive attitudes on the part of students and teachers, who were motivated to use this type of tool to facilitate learning. Within their theoretical framework, the authors cite Veltjen (2010), who emphasizes the significant potential of serious games to support various aspects of learning. Similarly, Prieto et al. (2015) state that these games improve visual perception, strengthen self-esteem, promote learning through challenges, and foster the development of social, linguistic, reading, rule comprehension, abstract thinking, and basic math skills.

[11] conducted an analysis of the relationship between ADHD symptoms, anxiety and maths performance among college students, emphasising the pivotal role of academic self-confidence. Using the ASRS self-report scale based on DSM-IV and DSM-V criteria, they found that individuals with more pronounced ADHD symptoms exhibited lower academic confidence, higher anxiety levels, and consequently, poorer math performance. However, anxiety levels remained stable throughout the

study, and mathematical confidence was the main mediator between ADHD symptoms and performance in mathematics. Additionally, they identified that low self-confidence affects performance not only in mathematics but also in other subject areas. The researchers concluded that improving the academic performance of students with ADHD symptoms requires strengthening their confidence and providing specific classroom support, including therapeutic interventions and training strategies that help them manage their symptoms.

[12] developed an educational intervention to improve verbal math problem-solving skills in students with ADHD. The intervention used first-person perspective video instruction (POVM) supported by a schema-based model and peer tutoring. The authors argue that conventional mathematics instruction is insufficient for these students and requires more intensive, comprehensive approaches. The video instruction allowed students to visualize the step-by-step procedures for solving addition and subtraction problems, strengthening their procedural knowledge. The results showed that participants maintained the skills they acquired and demonstrated independence and enthusiasm in applying them. Additionally, confidence and motivation increased through the symbolic representation of "heroes or helpers," which reduced behavioral manifestations associated with inattention. Overall, the POVM strategy combined with peer tutoring was effective in promoting student learning and socio-emotional development, thus validating its usefulness as an inclusive, motivating pedagogical intervention.

[13] present a case study of a nine-year-old Brazilian primary school student diagnosed with conduct disorder (CD) associated with attention deficit hyperactivity disorder (ADHD) who struggled significantly with mathematics. Through interviews with teachers and administrators, analysis of school documents, classroom observations, and direct interaction with the student, the researchers concluded that, while CD/ADHD was not the direct cause of the student's poor performance in math, it did intensify existing difficulties. Based on these findings, the authors propose strategies to improve educational outcomes for students with this profile. These strategies include strengthening school-family communication through regular meetings, establishing support networks with external professionals, defining and reinforcing clear classroom rules, and promoting structured, emotionally safe environments. They also recommend adapting assessment and teaching conditions by using oral tests, reducing homework, using drawings to represent problems, and using cooperative activities, role models, and audiovisual resources that encourage appropriate behavior.

[14] conducted a comparative study of cognitive inhibitory control during mathematical problem-solving among students with and without ADHD. They controlled for variables such as IQ, age, gender, and academic performance. The study was based on tests that included arithmetic problems with verbal statements and irrelevant numerical data. The results showed that children with ADHD made more mistakes, had greater difficulty selecting the appropriate graphical representation of the problem, and obtained a significantly lower average number of correct answers compared to their peers without the disorder. The authors concluded that these difficulties were primarily related to low inhibitory control, resulting in a tendency to respond impulsively with irrelevant information. This study underscores the importance of considering executive functions when designing teaching and assessment strategies in mathematics for students with ADHD and provides key references for the methodological structuring of pedagogical interventions focused on problem-solving.

[15] conducted a cohort study analyzing the risk of failure and poor academic performance in students with and without ADHD in two educational institutions in Ciudad Bolívar, Colombia. The sample consisted of 98 children, 47 of whom were diagnosed with ADHD according to the criteria of the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV), the Conners scale, and interviews and surveys of parents and teachers. The Goodenough test and other instruments were used, and grades from 2011 and 2012 were evaluated during a 12-month follow-up period. The results showed that 10% of children with ADHD failed school, compared to 0% in the control group. Additionally, 6.7% of children with ADHD underperformed. Students with the combined subtype obtained the lowest scores, particularly in mathematics, Spanish, and English. The

study concluded that ADHD is a significant risk factor for poor academic performance, as evidenced by the considerably lower grades of students with ADHD compared to their peers without the disorder.

[16] employed a qualitative approach to examine the mathematical abilities of first-grade elementary school students, taking into account their behaviors and personality traits according to Crozier's (2001) model. The researchers designed a training program adapted to different learning styles, types of intelligence, and special educational needs. This program was then transferred to a mobile application structured in three levels of complexity: basic, intermediate, and advanced. The program was based on using games as a central pedagogical tool to capture students' attention and motivate them, especially those with ADHD.

[17] proposes an inclusive pedagogical model designed to strengthen the teaching and learning of mathematical problem-solving skills among fifth-grade students diagnosed with ADHD in educational institutions in northern Bolívar. The model integrates the active participation of teachers, families, and administrators and is based on the principles of Universal Design for Learning (UDL) and the TRU model developed by Alan Schoenfeld. It also considers different learning styles (visual, auditory, and kinesthetic), enabling the creation of activities tailored to students' needs. Using a qualitative approach and action research, interventions were carried out in different school contexts, taking into account the subtypes of ADHD: inattentive, hyperactive-impulsive, and combined. The results demonstrate that students developed autonomy, strengthened their reasoning abilities, and mastered the phases of problem-solving by selecting modes of expression that align with their strengths and preferences, thereby enhancing their active and independent participation in the classroom.

[18] present a teaching experience based on three geometric concepts, analysed within the problem-solving phases of Schoenfeld's TRU model, in relation to Basic Learning Rights 5 and 7 for Year 5 in Colombia. The activity was carried out in person with neurotypical students and students diagnosed with ADHD in Year 5 at the Mauricio Nelson Visbal Educational Institution, and virtually with two ADHD students from the Turbaco Educational Institution via the Educational version of Minecraft. The two institutions are located in the northern part of the Bolívar department. Using a qualitative approach with a participatory action research design, it became clear that using gamified tools such as Minecraft Education Edition together with the strategies of the inclusive TDR model proposed by [19] improved the mathematical performance of students with ADHD and helped them to understand the problem-solving phases better, compared to those who did not use the technological resource.

2. Materials and Methods

According to [20], the qualitative approach is characterized by cyclical and repetitive development rather than a linear sequence. These stages are flexible actions that allow for progressive, in-depth exploration of the research problem in a continuous process of data collection and analysis. This study employs a qualitative approach, combining scientific research methods and techniques to gain a detailed and comprehensive overview of the phenomenon analyzed. The following theoretical methods were used:

Analysis of documentary sources, which allowed us to identify the state of the art and establish the theoretical references that underpin the research, especially in relation to mathematics education and attention deficit hyperactivity disorder (ADHD); and Historical-logical method, which was used to examine the evolution of pedagogical and didactic approaches applied in the teaching of mathematics to students with ADHD, considering their transformations and contributions over time.

The historical-logical method was used to examine the evolution of pedagogical and didactic approaches applied in teaching mathematics to students with ADHD, considering their transformations and contributions over time.

The analysis and synthesis method was applied in constructing the state of the art and identifying current trends in teaching and learning mathematics in populations with ADHD. This method allowed us to organize and abstract the collected information in a coherent and meaningful way.

For this study, we consulted academic databases that are recognized for their scientific rigor and relevance in mathematics education. The databases that offered the greatest theoretical and empirical contributions, as well as high relevance in terms of the research objectives, when linked to keywords related to the object of study, were selected.

2.1. Neutrosophic Assessment of Evidence Quality

As a complementary analytical framework, this study applies neutrosophic logic [29] to evaluate the epistemic state of each evidence category identified in the review. Neutrosophic logic extends classical logic by assigning each proposition a triple (T, I, F) , where T in $[0,1]$ represents the degree of truth or certainty of the supporting evidence, I in $[0,1]$ represents the degree of indeterminacy (methodological heterogeneity, gaps, or conflicting results), and F in $[0,1]$ represents the degree of falsity (contradictory findings), subject to $T + I + F \leq 1$ [29]. This framework has been applied in systematic analyses of scientific production and educational research to characterize epistemic uncertainty in heterogeneous evidence bases [30]. Each major evidence category identified in the present review was evaluated through a neutrosophic triple based on the convergence, sample size, and methodological quality of the supporting studies, as summarized in Table 5.

3. Results

The four tables below summarize the studies in chronological order. They identify the source, authors, title of the research, country, participatory sample, categories studied, and the main contribution of each study regarding mathematics education and ADHD.

3.1. Results

Several studies have examined the relationship between attention deficit hyperactivity disorder (ADHD) and mathematics learning. These studies have highlighted methodological approaches that promote inclusion and academic performance. Table 1 summarizes research conducted in the United States, Spain, and Australia. This research identifies predictors of difficulty and effective teaching strategies for students with ADHD.

In a U.S. study, [2] examined the effects of computerized instruction incorporating playful elements on fourth- to sixth-grade students with ADHD. Their results, published in *School Psychology Quarterly*, revealed that attention levels significantly increased when animated, video game-like environments complemented traditional teaching methods. [4] evaluated the effect of psychostimulant and sensory stimulation interventions on students with various subtypes of ADHD in the *Journal of Attention Disorders*. They concluded that performance in mathematics and problem

solving improves when reinforcers are powerful, consistent, and immediate. This highlights the need for highly stimulating environments to maintain the cognitive engagement of these students.

In the Spain case, [3] study, published in the Revista Iberoamericana de Educación Matemática, examined 75 students, 37 of whom had been diagnosed with ADHD. The researchers' main methodological contribution was segmenting the process of solving mathematical problems by explicitly dividing each component: identification of the unknown, explanation of the data, operation, and result. This visual organization promotes understanding and reduces cognitive overload in students with attention deficits.

[21] from Australia, conducted a community-based cross-sectional study comparing first-grade students with and without ADHD diagnoses. Their findings, published in the Early Childhood Research Quarterly, revealed that internalization issues, including anxiety and mood symptoms, predict negative student-teacher relationships. This impaired bond significantly affects learning, especially in areas demanding high levels of emotional regulation and sustained attention, such as mathematics.

Several relevant categories were identified based on the analysis of these studies: the use of games and digital resources to increase motivation and focus, the importance of interpersonal relationships (especially the quality of the bond with the teacher), the usefulness of sensory stimuli to support cognitive processing, and the need for clear, visual teaching structures to facilitate the organization of mathematical information. Together, these findings reaffirm that teaching mathematics to students with ADHD successfully depends on methodological adaptation, personalization of the learning environment, and emotional support.

Table 1. The relationship between attention deficit hyperactivity disorder (ADHD) and mathematical performance

No	Source	Authors, Country, Year	Original Title	Sample	Category	Contribution
1	School Psychology Quarterly, 17(3):242-257	Kenji R. Ota & George J. DuPaul, USA, 2002	Task Engagement and Mathematics Performance in Children with Attention-Deficit Hyperactivity Disorder: Effects of Supplemental Computer Instruction	3 students (grades 4 to 6)	ADHD, Math, Game	Students were significantly more attentive when the CAI included a game-like format with animation.
2	Revista Iberoamericana de Educación Matemática	Nuria Rosich Sala & Ángel	El alumnado con déficit de atención e hiperactividad (TDAH) en el	75 students (37 with ADHD,	ADHD, Math	Recommends segmenting the problem-solving process into steps:

No	Source	Authors, Country, Year	Original Title	Sample	Category	Contribution
		Casajús, Spain, 2008	aprendizaje de las matemáticas en los niveles obligatorios	38 without)		identifying the unknown, explaining the data, performing calculations, and presenting the result.
3	Journal of Attention Disorders – SAGE	Sydney S. Zentall, Kinsey Tom- Wright & Jiyeon Lee, USA, 2012	Psychostimulant and Sensory Stimulation Interventions That Target the Reading and Math Deficits of Students With ADHD	Students with ADHD+, ADHD–, and mixed types	ADHD+, ADHD–, ADHD, Math, Reading	Sensory stimulation produced differential gains in calculations and problem-solving. Performance improves with powerful, frequent, and immediate reinforcement; performance drops with the removal of rewards.
4	Early Childhood Research Quarterly, 51 (2020), 275–284	Nardia Zendarski et al., Australia, 2019	Student–Teacher Relationship Quality in Children with and without ADHD: A Cross- Sectional Community-Based Study	1st-grade students (177 with ADHD, 208 without)	ADHD, Student– Teacher Relationship, Behavior	Internalizing problems (e.g., anxiety, mood symptoms) predict negative student– teacher relationship quality (STRQ).

Table 2 lists international studies exploring the links between ADHD and mathematics learning. These studies emphasize neurocognitive factors, genetic relationships, problem-solving difficulties, and technological proposals. This evidence supplements the pedagogical analysis by offering an interdisciplinary perspective from the fields of neuropsychology, genetics, and educational technology.

In the United States, [22] examined the relationship between learning disorders and ADHD via neuroimaging studies. They noted that children with math learning disabilities (MLD) exhibit impairments in working memory, visual-spatial processing, and attention. Conversely, children with developmental dyscalculia (DD) struggle with fundamental numerical abilities due to structural differences in the brain, independent of factors like dyslexia or low IQ.

In the United Kingdom, [7] conducted a systematic review of 34 studies (30 cross-sectional and four longitudinal) showing a negative correlation between ADHD and mathematical ability. One of the most relevant findings was the identification of a common genetic basis for both conditions. The inattention component was found to be more decisive than hyperactivity in low mathematical performance.

[8], from Italy, investigated the impact of information updating on the mathematical problem-solving abilities of 11- to 12-year-old children with ADHD symptoms. Their results showed that this group experienced greater difficulty than their typically developing peers, confirming the limiting role of working memory and cognitive flexibility in mathematical performance.

In Iran, [23] developed a computer-assisted instruction (CAI) environment integrating a pedagogical agent named Koosha. This digital tutor used text, images, narration, sounds, and animations to facilitate math learning for students with ADHD, improving their concentration and comprehension by engaging multiple sensory modalities.

These studies reinforce the understanding of ADHD as a multidimensional condition affecting math performance from neurological and instructional perspectives. They also underscore the importance of educational approaches based on universal design and adaptive technology that consider emotional and cognitive factors affecting learning.

Table 2. International Studies on ADHD and Learning Mathematics

N	Source	Authors, Country, Year	Original Title	Sample	Category	Contribution
5	Springer Science+Business Media, LLC 2011	Semrud-Clikeman & Bledsoe, USA, 2011	Updates on Attention-Deficit/Hyperactivity Disorder and Learning Disorders	Brain imaging on cortical structure	ADHD, Math Learning Disability (MLD), Learning Disorders, Developmental Dyscalculia (DD)	Children with MLD struggle with working memory, visual-spatial processing, and attention. Children with DD have difficulties with basic numerical skills not caused by dyslexia or low IQ, but by

No	Source	Authors, Country, Year	Original Title	Sample	Category	Contribution
6	BMC Medicine (2015) 13:204	Tosto et al., UK, 2015	A systematic review of ADHD and mathematical ability: current findings and future implications	Review of 30 cross-sectional and 4 longitudinal studies	ADHD, Math Ability	structural brain differences. Found a negative relationship between ADHD and math ability due to inattention; twin studies showed a genetic link between math ability and ADHD.
7	Research in Developmental Disabilities 59:186–193	Re et al., Italy, 2016	Difficulties of children with ADHD symptoms in solving math problems when information must be updated	Children aged 11–12 with ADHD and control group	ADHD – Problem Solving	Children with ADHD showed impaired problem-solving performance when required to update information compared to typically developing peers.
8	Springer: Education and Information Technologies 23(2)	Mohammadhasani et al., Iran, 2018	The pedagogical agent enhances mathematics learning in ADHD students	30 primary school boys with ADHD	ADHD – Math Learning – Pedagogical Agent	A CAI environment with a pedagogical agent ("Koosha") was designed using text, images, audio, and animation to support math learning in

No	Source	Authors, Country, Year	Original Title	Sample	Category	Contribution
						ADHD students.

Table 3 presents a set of studies focusing on pedagogical models, public policies, and digital resources to strengthen mathematical learning in children diagnosed with attention deficit hyperactivity disorder (ADHD). The studies come from Colombia, Mexico, and the United Kingdom and are mainly grouped into three categories: inclusive assessment proposals, problem-solving strategy selection, and digital game use for teaching mathematics.

[24] from Colombia proposed a qualitative assessment model and an individualized adaptation format for students with special educational needs (SEN), including those with ADHD. Their proposal addresses the need to address functional diversity in first- to third-grade classrooms in a contextualized manner. The Ministry of National Education [25] complemented this approach by designing Guide 12, which supports the conceptual foundations for a public policy aimed at educational inclusion. The guide promotes protective environments, equal physical access, family participation, and opportunities in recreation, culture, and employment. It reaffirms a broad framework for serving students with SEN and ADHD in Colombia.

In the field of mathematical cognition, [9] found that children with ADHD in the United Kingdom are less likely than their peers without a diagnosis to select the most efficient strategies for solving arithmetic problems. These findings reaffirm that executive functions affected by ADHD, such as planning, inhibition, and working memory, negatively impact mathematical performance, even when arithmetic knowledge is adequate.

Conversely, two recent studies from Latin America highlight the pedagogical potential of digital games. In Mexico, [10] designed a serious game called "A Journey Through Mathematics," which focuses on problem solving.

The evaluation of the resource revealed high levels of motivation and enthusiasm among students and special education teachers alike. In Colombia, [26] conducted a case study on digital, game-based learning in statistics with fourth-grade students. The results were compelling: Students with ADHD matched or slightly outperformed the control group, suggesting that gamified environments can effectively promote mathematical understanding and performance.

Together, these studies demonstrate the effectiveness of inclusive, technological, and adaptive strategies in teaching mathematics to students with ADHD. Combining a diversity-sensitive pedagogical approach with structured public policies and motivational tools, such as educational video games, is a promising path toward equitable, transformative mathematics education.

Table 3. This study examines pedagogical models, public policies, and digital resources for strengthening mathematical learning in children diagnosed with attention deficit hyperactivity disorder (ADHD)

No	Source	Authors, Country, Year	Original Title	Sample	Category	Contribution
9	Centro de Servicios Pedagógicos, Universidad de Antioquia	Alba Lucia Cano Gómez & Alejandra Montoya Giraldo, Colombia, 1998	Modelo de integración escolar para niños con déficit de atención con o sin hiperactividad	1st to 3rd grade students	ADHD	Propose a qualitative evaluation model for children with SEN and a format for individual adaptation.
10	Colombian Ministry of Education (MEN), 2006	MEN, Colombia	Guía No 12: Fundamentación conceptual para la atención en el servicio educativo a estudiantes con necesidades educativas especiales -nee.	–	ADHD – SEN – Educational Inclusion	Public policy for SEN that includes protective environments, family and social participation, equal access to physical environments, transportation, communication, leisure, culture, and inclusive education and employment.
11	Journal of Attention Disorders	Sella, Re, Lucangeli, Cornoldi & Lemaire, UK, 2018	Strategy Selection in ADHD Characteristics Children: A Study in Arithmetic	4th–5th grade students	ADHD, Arithmetic Study	Students with ADHD selected the best arithmetic problem-solving strategy less frequently than control group students.
12	Campus Virtuales, 8(2), 2019	González Calleros, Guerrero García, Navarro Rangel, Mexico, 2019	A serious game for math problem solving for children with ADHD	13 children, 6 special ed. teachers, parents and specialists	ADHD – Games – Problem Solving	Designed and evaluated a serious game titled A Journey Through Mathematics; students and teachers reported high motivation and enthusiasm for using this resource.
13	Revista Brasileira de Educação Especial	Moreno & Valderrama, Colombia, 2015	Game-Based Learning in Children with ADHD: A Case	4th grade students (17 experimental – 40 control)	ADHD – Digital Games – Statistics	Students with ADHD not only equaled the performance of the

No	Source	Authors, Country, Year	Original Title	Sample	Category	Contribution
			Study in Teaching Statistics to Fourth Graders in Colombia			control group, but slightly surpassed them.

Table 4 presents research analyzing academic performance and teaching strategy development for students with Attention Deficit Hyperactivity Disorder (ADHD). The studies were mainly conducted in Colombia and Spain. The research addresses topics such as school performance, teaching practices, educational technology use, and the social construction of diagnosis.

Regarding academic performance, [15] study showed that students with ADHD are at a higher risk of failing school, particularly in subjects like mathematics, Spanish, and English. This finding underscores the importance of providing differentiated support in vulnerable school contexts, such as those in Ciudad Bolívar in Bogotá.

[6], from Spain, proposed specific methodological strategies for students with ADHD and learning difficulties in mathematics (DAM). These strategies include using simplified teaching materials with few activities per page, meaningful visual stimuli, graphic and oral support, and breaking down tasks to facilitate retention and comprehension.

Regarding teacher training, [27] identified significant gaps in the management of ADHD. He proposed strategies involving families, specialists, and the school environment and emphasized the importance of establishing clear rules and providing close support to promote student focus and self-regulation.

The technological component gained momentum with the contributions of [16], who developed a game-based mobile application for first-grade students. The application supports both mathematical learning and behavioral self-regulation. Consistent with this approach, [17] designed an inclusive pedagogical model integrating problem-solving with the frameworks of Universal Design for Learning (UDL), the TRU Model, VAK, and the Zone of Proximal Development (ZPD), adapted for different ADHD subtypes. The model produced positive outcomes regarding students' autonomy and mastery of mathematical problem-solving.

[28] also analyzed the social dimension of the diagnosis and concluded that ADHD is a social construct mediated by the family and educational environment. They found that the diagnosis profoundly impacts children's identity.

Finally, [18] study highlights the benefits of using gamified environments, such as Minecraft Education Edition, to teach geometry. Students with ADHD who participated in this experience performed better in problem-solving tasks and demonstrated a deeper understanding of the phases of the mathematical process.

Taken together, the studies listed in Table 4 provide valuable evidence on the effectiveness of inclusive models, technological support, and diversity-centered strategies. This research invites us to rethink traditional school practices and implement transformative pedagogical approaches that recognize the uniqueness of each student with ADHD.

Table 4. Academic Performance and Development of Teaching Strategies for Students with Attention Deficit Hyperactivity Disorder (ADHD)

No	Source	Authors, Country, Year	Original Title	Sample	Category	Contribution
14	Universidad Nacional de Colombia - https://repositorio.unal.edu.co/handle/unal/21550	Zúñiga Zambrano, Y.C., Colombia, 2013	Academic Performance in Students with ADHD in Bogotá Schools	47 ADHD students (grades 1–3) and 51 non-ADHD (grades 1–4)	ADHD – Academic Performance	Shows greater risk of low performance and school failure among students with ADHD, particularly in mathematics, Spanish, and English.
15	UNIR Spain- https://reunir.unir.net/bitstream/handle/123456789/2988/Creu_Obrer_Marco.pdf?sequence=1&isAllowed=y	Creu Obrer Marco, Spain, 2014	ADHD and Mathematics : Proposals to Improve the Teaching-Learning Process in Secondary Students	Literature review	ADHD and ADHD+MLD	Proposes workbooks with clear and concise instructions, simplified layouts, few exercises per page, significant visual stimuli, oral support, and task decomposition.
16	https://repository.usta.edu.co/handle/11634/2758	Bohórquez Sáenz, J.E., Colombia, 2016	Teaching Strategies for Managing ADHD in 5th Grade Teachers	52 public school teachers	ADHD – 5th Grade	Identifies gaps in teacher training and proposes multimodal strategies involving families and professionals. Emphasizes individualized support and calm communication.
17	https://recursos.portaleducoas.org/sites/default/files/5187.pdf	Román & Zabaleta, Colombia, 2017	Design of a Game-Based Mobile App for Math Learning in	1st grade students	ADHD – Games – Math	Designed a mobile app to support math learning and behavioral

No	Source	Authors, Country, Year	Original Title	Sample	Category	Contribution
18	http://www.scielo.org.co/pdf/rcps/v26n2/0121-5469-rcps-26-02-00245.pdf	Vargas & Parales, Colombia, 2017	The Social Construction of Hyperactivity	31 participants : children, parents, and teachers	ADHD	regulation in students with ADHD. ADHD is constructed socially as a hereditary problem and parenting failure. The diagnosis influences the child's identity construction.
19	http://repositorio.uan.edu.co/handle/123456789/8299	Zabaleta Mesino, R., Colombia, 2023	Inclusive Pedagogical Model for Teaching Mathematics through Problem Solving in 5th Grade Children with ADHD	5th grade students (8 ADHD, 6 neurotypical)	ADHD (all subtypes) – Math – Gamification	Inclusive model based on TRU, UDL, VAK, and ZPD, adapted to ADHD subtypes. Promotes autonomy and learning through diversified activities.
20	Mundo FESC, 14(28), 30-47	Zabaleta, R., Rojas, O. & Villarraga, B., Colombia, 2024	Geometric Problem Solving Using Minecraft Education Edition with 5th Grade Students with ADHD	5th grade students	ADHD – Game – Geometry	Students using Minecraft and the inclusive TDR model performed better in math and problem-solving than those without this technology.

Table 5. Neutrosophic Assessment of Evidence Categories (ADHD and Mathematics Education)

Evidence Category	Key Studies	T	I	F
Predictors of academic failure (executive function deficits)	[1,5,7,14,15]	0.85	0.10	0.05

Positive outcomes from inclusive and gamified interventions	[2,4,10,12,18,28]	0.72	0.20	0.08
Pedagogical models and structured strategies (UDL, TRU, VAK)	[3,6,13,17,19]	0.70	0.25	0.05
Digital tools and CAI environments	[2,8,10,16,24]	0.68	0.22	0.10

Note: T = degree of truth/certainty; I = degree of indeterminacy; F = degree of falsity; $T+I+F \leq 1$.

4. Discussion

The findings of this study are consistent with previous evidence addressing the relationship between attention deficit hyperactivity disorder (ADHD) and academic performance in mathematics. The studies reviewed can be grouped into three categories that enrich our understanding of the challenges and opportunities of teaching this subject to students with ADHD: predictors of academic failure, positive outcomes under specific conditions, and methodological proposals that address their needs.

First, [1, 5, 7, 15] agree that students with ADHD are at a higher risk for academic failure due to deficits in executive functions, such as sustained attention, planning, working memory, and inhibitory control. These deficits affect performance in solving mathematical problems by making it difficult to select relevant information and follow appropriate strategies. Evidence from [8, 14] reinforces this idea by showing that ADHD-specific difficulties negatively affect the processing of verbal and numerical information during problem-solving, which impacts overall academic performance.

However, other studies have shown favorable results when interventions tailored to these students' characteristics were used. For instance, [4], as well as [12], demonstrate improvements in mathematical performance through constant stimuli, audiovisual materials, educational video games, and peer tutoring. Similarly, recent research, such as that by [10], as well as [18], highlights the potential of gamified environments, such as Minecraft Education, to strengthen motivation, commitment, and ownership of the problem-solving process. This has a positive impact on student autonomy and confidence. These results align with [11] findings that self-confidence mediates the relationship between ADHD and mathematical performance.

Third, multiple pedagogical models and strategies aimed at improving mathematics teaching in inclusive contexts have been identified. Authors such as [3,6], and Miranda Casas et al. (2002) recommend using structured materials, visual aids, multisensory strategies, and contextualized problems. They emphasize reducing cognitive overload and facilitating understanding of statements. Proposals such as [19] are based on Universal Design for Learning (UDL) and Schoenfeld's TRU

model. These proposals offer a methodological framework that aligns with the needs of students with ADHD and allows for the design of diverse, accessible activities.

Overall, the findings underscore the necessity of inclusive mathematics education. Such an approach recognizes the cognitive and emotional barriers that students with ADHD face and harnesses their potential by utilizing interactive resources, digital games, and flexible methodologies. This discussion underscores the importance of designing teaching practices that address diversity and transform traditional methods of teaching mathematics in the classroom.

The neutrosophic assessment of evidence (Table 5) reveals that the category of predictors of academic failure exhibits the highest epistemic robustness ($T = 0.85$, $I = 0.10$, $F = 0.05$), reflecting strong convergence across multiple international studies and methodological traditions. In contrast, findings on digital tools and CAI environments present the greatest combined indeterminacy and falsity ($I = 0.22$, $F = 0.10$), consistent with the variability in sample sizes, short follow-up periods, and contextual differences across studies. Inclusive pedagogical models and structured strategies occupy an intermediate epistemic position ($T = 0.70$, $I = 0.25$), indicating that while their components are well founded, uncertainty persists regarding long-term effectiveness and scalability in diverse school systems. This tripartite representation of certainty, indeterminacy, and contradiction complements traditional systematic review approaches by making explicit the epistemic gaps that should inform future research design [31, 32].

5. Conclusions

Attention deficit hyperactivity disorder (ADHD) significantly impacts poor mathematical performance, particularly in processes requiring complex cognitive skills, such as problem-solving. These difficulties are not just behavioral issues; they are closely linked to limitations in executive functions, such as inhibitory control, sustained attention, working memory, and planning.

However, reviewed findings suggest that these difficulties can be overcome with inclusive and differentiated teaching strategies. Using digital resources, gamified environments, and multimedia tools increases motivation, improves concentration, and facilitates students with ADHD's understanding of mathematical procedures. Interventions that integrate visual, auditory, and kinesthetic components, as well as those that promote active participation through play, collaborative work, and educational technology, stand out in this regard.

Models such as Universal Design for Learning (UDL), Schoenfeld's TRU framework, and the inclusive TDR model by [19] offer viable, well-founded approaches to designing teaching practices that address classroom diversity. These approaches enhance mathematics learning and promote the development of autonomy, self-regulation, and strategic thinking in students.

Similarly, the importance of ongoing collaboration between teachers, families, and professionals in clinical and educational fields is emphasized. Coordinating these collaborations is essential for providing consistent, tailored responses to students' individual needs, fostering more equitable and emotionally safe learning environments.

In conclusion, achieving a truly inclusive mathematics education necessitates transforming traditional school practices, recognizing diversity as a pedagogical opportunity, and implementing flexible, creative, and technically sound models that address the unique needs of students with ADHD and ensure their right to a quality education. Future research should incorporate neutrosophic multi-criteria frameworks to systematically evaluate the quality and transferability of pedagogical interventions for students with ADHD, thereby reducing the indeterminacy levels documented in Table 5 and strengthening the evidence base for inclusive mathematics education.

Future research should explore the application of neutrosophic-based uncertainty models to characterize the heterogeneity of ADHD subtypes in mathematical performance, enabling more nuanced diagnostic and pedagogical assessments. Longitudinal and experimental studies are needed to evaluate the sustained impact of gamified, inclusive, and technology-mediated interventions across diverse cultural contexts, particularly in Latin American educational systems where ADHD is frequently underdiagnosed. Cross-cultural comparative analyses would strengthen the generalizability of current evidence. Additionally, the integration of neutrosophic cognitive maps could serve as a methodological bridge between clinical assessment and pedagogical design, providing educators with tools to navigate the indeterminacy inherent in ADHD-related learning profiles [29].

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