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COGNITIVE NEUROSCIENCE AND INCLUSIVE PRACTICES IN MATHEMATICS TEACHING

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ABSTRACT

This study examines the role of cognitive neuroscience in promoting inclusive practices in mathematics teaching, offering an approach that considers the diverse needs of students. With advances in neuroscience, there is a deeper understanding of processes such as working memory, attention, and visuospatial skills, which are essential for learning mathematics. These processes are key to creating inclusive teaching environments, especially for students with specific educational needs, such as Autism Spectrum Disorder (ASD), *Attention Deficit* Hyperactivity Disorder (ADHD), and Dyslexia. Exploratory and descriptive documentary research aimed to explore the intersection between cognitive neuroscience and inclusive practices in mathematics teaching, showing how these approaches can promote more accessible, equitable, and effective learning for all students, especially those who need differentiated support. Although the implementation of these practices faces challenges, such as the need for continuous teacher training, the benefits found are substantial. The publications and examples of practical implementation demonstrate how integrating cognitive neuroscience into inclusive mathematics teaching can improve student performance and motivation. It is observed that this integration not

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only makes mathematics education more accessible, but also contributes to a more equitable and meaningful education for all students.

Keywords: Neuroscience. Inclusive Practices. Mathematics Teaching

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INTRODUCTION

Inclusive education has gained increasing prominence in recent decades, being recognized as essential for the development of pedagogical practices that meet the needs of all students, regardless of their abilities and challenges. In the context of mathematics teaching, this inclusion plays an even more crucial role, given the abstract character of the discipline and the diversity of cognitive difficulties that students may face in understanding it. Thus, to make mathematics education more accessible and effective, it is essential to adopt practices that consider individual differences and enable personalized learning.

It is relevant to highlight that educational inclusion is a right guaranteed by several international and national regulations, such as the Convention on the Rights of Persons with Disabilities, ratified in Brazil in 2008 (Brasil, 2016), and the Brazilian Inclusion Law (Brasil, 2015). Such legislation highlights the need to eliminate barriers that hinder equal access to education that promote pedagogical practices that ensure the effective participation of all students. In this scenario, the teaching of mathematics faces specific challenges due to the intrinsic characteristics of the discipline, such as the use of abstract representations, logical reasoning and complex problem solving. These aspects, which are central to mathematics, can become significant obstacles for students with specific educational needs, including those with Autism Spectrum Disorder (ASD), Attention Deficit Hyperactivity Disorder (ADHD), or Dyslexia.

In this scenario, cognitive neuroscience emerges as a valuable tool, offering *insights* into the mental processes underlying the learning of mathematics. By studying functions such as working memory, attention, and visuospatial processing, neuroscience allows educators to understand how these skills are activated and used to solve mathematical problems. This understanding is especially relevant for identifying and overcoming barriers that may impact the learning of students with specific needs. For example, students with ADHD may benefit from strategies that involve visual stimuli and task segmentation, while those with dyslexia may require support in developing phonological skills and using assistive technologies.

In addition, the application of neuroscience principles to education can help teachers develop more effective pedagogical practices, such as the use of multisensory resources, adaptations in the pace of teaching and formative assessment strategies. The integration of these practices in mathematics teaching favors the development of learning environments that respect cognitive diversity and promote the inclusion of all students. By considering the

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specifics of brain functioning, educators can adopt approaches based on scientific evidence, increasing students' chances of academic and personal success.

Thus, cognitive neuroscience not only contributes to the development of more inclusive pedagogical strategies, but also scientifically supports these practices, ensuring that they meet the real needs of students. In this sense, this study aims to explore the intersection between cognitive neuroscience and inclusive practices in mathematics teaching, highlighting how these approaches can promote more accessible, equitable, and effective learning for all students, especially those who need differentiated support.

Over the past few years, significant advances in cognitive neuroscience have allowed for a deeper understanding of the mechanisms that influence learning. Research on brain plasticity, for example, has demonstrated that the brain is able to reorganize itself in response to learning experiences, even in individuals with conditions such as ASD or dyslexia. These findings reinforce the importance of pedagogical practices that explore the potential of each student to the fullest, adapting teaching methods to their specific needs. Another key aspect refers to the role of emotions in learning. Studies in neuroscience show that fear of failure and mathematical anxiety can activate brain areas associated with stress, impairing working memory and problem solving. Therefore, creating a welcoming and emotionally safe educational environment is critical to academic success.

Educational inclusion has become an essential pillar in discussions about equity and access to quality education, especially after the enactment of the legislation as mentioned above. In this context, cognitive neuroscience offers a robust scientific contribution to rethink pedagogical practices, especially in the teaching of mathematics, a discipline historically perceived as challenging. By better understanding how the brain processes mathematical information, educators can adapt their methodologies, promoting learning environments that value students' cognitive and emotional differences.

In this way, integrating cognitive neuroscience into inclusive mathematics teaching represents a significant step towards transforming educational practices and ensuring that all students, regardless of their abilities or challenges, can reach their full potential.

COGNITIVE NEUROSCIENCE APPLIED TO MATHEMATICS EDUCATION

Mathematical learning is a process that integrates specific knowledge, concepts and mathematical principles, along with the development of cognitive skills (Souza; Matias, 2020). In this scenario, cognitive neuroscience offers valuable theoretical subsidies to

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support pedagogical practices that respect the functional bases of the brain, suggesting that methods aligned with students' neurocognitive functioning may be more efficient (Cosenza; Guerra, 2011).

Mathematics didactics, in turn, is not limited to the use of techniques and materials, but involves a deeper understanding of the teaching and learning processes. As Laborde (2007) points out, didactics incorporates not only mathematical concepts and the relationship between teaching and learning, but also considers the influence of social interactions between teachers and students, in addition to adapting mathematical content with a view to pedagogical objectives.

Still, by mobilizing mathematical cognition, didactics requires the teacher to go beyond the application of pragmatic methods, since this alone is not enough for a full teaching of students. For Silva (2015), it is necessary for the teacher to have a basic understanding of how the learning process occurs, since "[...] it is not possible to efficiently mobilize any learning without knowing at least how to learn" (p. 212), thus being able to adapt their practices to their students, in order to enhance the effectiveness of learning.

Although mathematics has its own language, formalized in the school context, its learning involves several cognitive processes, such as memory, which activates emotional components and students' personal experiences. These factors need to be considered in teaching practice, since recognition and cognitive representation initially involve other forms of logic and structuring.

Therefore, it is essential that teachers adopt a holistic view of mathematics teaching, considering the cognitive, social, and emotional dimensions in the development of their practices, seeking to adapt them to meet the specific needs of their students. In this sense, the didactics of mathematics involves more than methods and techniques; it seeks to understand the teaching and learning processes, exploring the interactions between these aspects, the epistemological implications of the concepts and the social dynamics that influence educational practice (Laborde, 2007).

ESSENTIAL COGNITIVE PROCESSES FOR INCLUSIVE MATHEMATICS TEACHING

Cognitive neuroscience, by investigating the neural bases of mental processes, offers an essential contribution to the inclusive teaching of mathematics, promoting a broader understanding of how mathematical learning takes place. Although it does not establish a rigid protocol, it provides principles that guide pedagogical practices based on

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more effective learning and adapted to the needs of students. This knowledge allows mathematics teaching to value and stimulate specific cognitive skills, such as logical reasoning and problem-solving, by creating a teaching environment that respects cognitive diversity and facilitates inclusion. Thus, cognitive neuroscience supports practices that enhance the development of essential skills for mathematical thinking, favoring a more dynamic pedagogical approach aligned with the real capacities and challenges of students (Nampo; Caetano; Bezerra, 2022).

Fundamental abilities to perceive and compare quantities in a non-symbolic way are observed, and in us human beings, these abilities form the foundation for the development of symbolic numerical representations and require appropriate guidance throughout the development process. This brain system can be seen as a complex combination of specific numerical processing skills and broader executive functions, which include planning, inhibitory control, decision-making, cognitive flexibility, working memory, attention, categorization, fluency and creativity, essential competencies for learning and the construction of new knowledge (Luria, 1981; Lezak, 1982; Malloy-Diniz et al., 2010).

INCLUSIVE PRACTICES BASED ON NEUROSCIENCE FOR THE TEACHING OF MATHEMATICS

In the context of inclusive mathematics education, musicality[6] presents itself as a strategy to stimulate cognitive development. Understood not only as an aesthetic activity, musicality, in this case, is worked as a means of sensory involvement, offering experiences of listening, rhythm and body movement, aligned with mathematical foundations. This approach is inspired by music educators Willems (1968), Schafer (1991) and Gordon (2000) and aims to integrate sound activities with mathematical concepts in an accessible and practical way (Gomes; Manrique, 2014; 2016; 2017).

This integration of musicality into teaching may involve areas of the limbic system associated with emotions, and thus has the potential to create an inclusive and stimulating learning environment. Through careful and creative practices, the teacher can use musical elements to stimulate neurocognitive skills related to mathematical thinking, promoting the

[6] Musicality applied to education involves aspects such as attentive listening, which stimulates neurocognitive circuits; free expression, which promotes rhythm and motor coordination; and specific cognitive processes related to mathematics, such as transcoding. Integrated into the educational environment, these elements enhance fundamental skills, especially voluntary attention and working memory.

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development of all students, regardless of their specific characteristics, guaranteeing them equal access to learning (Fernandez, 2001).

In addition, sound elements favor mental representation, enabling the activation of essential skills, such as voluntary attention, inhibitory control, and self-regulation. By incorporating these sound activities into mathematics teaching, the teacher can promote a deeper understanding of the numeration system and mental calculation, encouraging the participation and progress of each student in a truly inclusive teaching environment (Gomes; Manrique, 2017).

CHALLENGES AND PERSPECTIVES FOR INCLUSIVE PRACTICES

The interaction between emotion and cognitive performance highlights fundamental challenges for the implementation of inclusive practices in the school context. Learning experiences that involve pleasure, stimulation, and accessible challenges favor cognitive development, while situations of anxiety and stress negatively impact learning, especially for students with disabilities, who are often subject to experiences of segregation and low self-esteem. The main challenge for inclusion is, therefore, to develop pedagogical practices that meet both academic content and the construction of an emotionally safe and stimulating environment, essential for all students to be able to explore their potential in an integral way (Amaral; Guerra, 2020).

In this context, Ferreira *et al.* (2015), reports that the contemporary student who grows up in a highly visual and virtual environment demands an in-depth reflection on the educator's profile. It is vital that educators incorporate the visual arts and neuroscience of learning in the creation of teaching materials and strategies that foster student motivation and well-being, regardless of their grade level. By adopting this approach, the teacher can develop the students' skills and competencies within a perspective of inclusive education that, for the authors, is based on psychopedagogy. Thus, the teacher also builds his own conceptions about a more just and egalitarian society, relying on the understanding of his social actions as a mediator of historical-social knowledge.

For inclusion to happen effectively, educational practices must be planned taking into account the emotional impact on the learning process. Practices that contemplate affection and motivation, as well as the use of appropriate challenges, which promote autonomy and reduce the impacts of negative feelings, enabling the full participation of students. Amaral and Guerra (2020) show that to create an inclusive environment, it is necessary to integrate

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strategies that consider the particularities of each student, seeking to promote emotional and cognitive development and ensure that everyone, without distinction, can enjoy an enriching and inclusive education.

METHODOLOGICAL TRAJECTORY

This research is of the exploratory and descriptive documentary type, aimed at the collection and review of available materials on the specific theme. According to Mattar and Ramos (2021, p.129), internet research is classified as documentary, as it involves documents that are now available *online* and can be retrieved for analysis. It can also be considered a field research, in a virtual environment, *online* or digital. In addition, it is exploratory of a descriptive nature, as researchers investigate a set of phenomena, looking for known or unknown anomalies, describing them, which can serve as a basis for more systematic research in the future (Wlazlawick, 2021).

Thus, a review of materials already published on the CAPES journal portal was carried out. To collect data more efficiently, an appropriate search engine was established, selecting keywords representative of the theme, using the Boolean operator (E/*And*), any field option and the contains option available on the platform to improve the search results.

To delimit the scope, we focused on the works produced from 2015 onwards, and the research was carried out in the first half of October 2024, following the corresponding steps in Chart 1.

Chart 1 - Description of the searches carried out in CAPES Journals

	DESCRIPTORS	WORK
1	Neuroscience (*and*) Inclusive practices (*and*) Mathematics Teaching	0
2	Neuroscience (*and*) Inclusion (*and*) Mathematics	3
3	Neuroscience (*and*) Inclusion (*and*) Mathematics Teaching	3
4	Neuroscience (*and*) Inclusion (*and*) Mathematics Education	0
5	Neuroscience (*and*) Inclusive Education (*and*) Mathematics	5
6	Neuroscience (*and*) Special Education (*and*) Mathematics	5
	Total	16

Source: The authors.

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Steps 2 and 3 contain the same articles, which indicates the absence of variation in the publications analyzed between these two steps. On the other hand, in stages 5 and 6, one of the articles is identical, suggesting that, although the analysis addressed new descriptors, there were no new results. In addition, in step 6, one of the articles was an editorial entitled "Neuroscience". This repetition can be significant to understand the evolution of discussions on the subject. Thus, of the total of 16 selected studies, only 11 remained for the continuation of the analysis.

During the reading of the abstracts, we sought to identify common topics and recurring characteristics. Each abstract was analyzed in detail, with emphasis on specific information related to the topics of interest, as presented and discussed in the results.

ANALYSIS AND DISCUSSION

Based on the data collected, an analytical reading of the abstracts of each article was carried out, seeking to identify those that specifically met the established criteria. In this process, one of the articles was excluded, because it was not about studies in the area of mathematics teaching, but about written oral language. Therefore, the items that were directly relevant to this research were prioritized, adopting as exclusion criteria those that were not aligned with the study. In this way, a selection focused on the most pertinent materials for the analysis and subsequent discussion of the work was guaranteed. It is important to emphasize that this stage was conducted in an impartial and transparent manner, with the objective of ensuring the quality and representativeness of the selected works.

Chart 2 - Articles analyzed

	TITLE	AUTHOR(S)	ANUS
1	Mediator teacher training: psychopedagogical inclusion and intervention	Ferreira, A. C. L. Vilas Boas, T. J. R Silva, A. B. S. M. Araújo, T. S. Santos, L. M. Souza, D. B.	2015
2	Musicality for the stimulation of voluntary attention of mental calculations (Inclusive Mathematics Education)	Gomes, H. C. Manrique, A. L.	2016
3	Inclusive mathematics education: musicality, cognitive neuroscience and teacher mediation	Gomes, H. C. Manrique, A. L.	2017
4	Neuroscience and the teaching of mathematics: a study on learning styles	Araújo, F. G. S.	2019

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	and multiple intelligences	Menezes, D. B. Bezerra, K. S.	
5	An ideological look at our studies on school mathematics and disability: from segregation to inclusion	Broitman, C. Cobenñas, P. Escobar, M. Grimaldi, V. Sancha, I.	2019
6	Factors based on Cognitive Neuroscience in the teaching and learning of mathematics: a systematic review of the literature	Nampo, D. S. O Caetano, R. S. Bezerra, R, C.	2022
7	Importance of considering cognitive processes in mathematics didactics	Costa, L. F. M. Ghedin, E.	2022
8	A look at the performance of a student who is the target audience of special education in the face of scenarios for mathematical learning, mediated by a musical environment	Morais, T. R.	2023
9	Analysis of the feasibility of using FNIRS in educational activities with children and young people with intellectual disabilities and autism	Benitez, B. Domeniconi, C. Oku, A. Y. A. Soares Junior, R. S. Mori, F. Y. R. Sassaki, L. Moura, T. L. D. Oliveira, T. Oliveira, L. C. C. Silva, G. Sato, J. R. Caetano, M. S.	2023
10	The production of knowledge in neuroscience and attentional theories in the area of Science Teaching and Mathematics Education	Pereira, A. S. Fonseca, L. S.	2024

Source: The authors (2024)

Article 1 (Ferreira *et al*., 2015) seeks to understand how fundamental factors of cognitive neuroscience can impact mathematics learning. The relevance of the theme is evident, since mathematics is a discipline often associated with learning difficulties, and the application of the principles of neuroscience can offer new approaches to improve student performance. The article also mentions several factors that influence learning, such as: organic factors, related to brain structure and the functioning of the Central Nervous System; Specific factors, such as specific disorders, in this case, dyslexia; Psychogenic factors, linked to trauma and internal conflicts; Environmental factors, such as opportunities for stimuli that favor learning. All these factors are decisive to understand the variables that can affect mathematics learning and, as interventions, can be adapted to meet the needs of students.

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The results indicated that the application of pedagogical interventions based on cognitive neuroscience factors can improve performance in mathematics, and the use of sensory stimuli, such as vision and touch, is highlighted as an effective strategy to activate different areas of the brain and favor the formation of long-term memory. In addition, the research suggests that skills such as mindfulness and memory are fundamental for learning, highlighting that educators should consider such factors when planning their lessons. Personalization of teaching, taking into account the individual needs of students, can be an effective strategy.

In summary, the study offers a comprehensive overview of how cognitive neuroscience can be applied to improve the teaching of mathematics. The analysis of the factors that influence learning and the methodology of the systematic review contribute to a deeper understanding of effective pedagogical practices, also highlighting the relevance of an integrated approach that considers the various dimensions of learning, promoting a more inclusive and effective educational environment.

The intersection between musicality, neuroscience and mathematics education is what article 2 addresses (Gomes; Manrique, 2016). The proposal to use musicality as a tool to stimulate voluntary attention in children, especially those with attention difficulties, is innovative and pertinent, since music, as a form of cultural and emotional expression, can be a powerful resource in education, promoting not only cognitive learning, but also the social and emotional development of students.

The research was conducted with students between 6 and 8 years old, including those with ADHD, allowing for a richer and more diverse analysis of responses to music interventions. However, the relatively small sample size and the limited duration of the interventions (12 one-hour meetings) limited the generalization of the results.

However, the results indicated that musicality can have a positive impact on voluntary attention and performance in mental calculations. The transformation observed in the class, as reported by the class teacher, suggests that music not only improves concentration, but also promotes a more collaborative and respectful learning environment. The implications of the study are significant for educational practice, especially in contexts of inclusion, since musicality can be an effective strategy to engage students with attention difficulties, promoting a more inclusive and dynamic learning environment. However, educators need to receive adequate training to integrate musicality into their pedagogical practices effectively.

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Although the article presents an interesting and innovative proposal, it also raises questions about the need for more research in the area, that is, it could benefit from a more detailed analysis of the data collected, perhaps including quantitative metrics that support the qualitative claims. In addition, the inclusion of a broader perspective on the different forms of musicality and their applications in education could further enrich the discussion.

Article 3 (Gomes; Manrique, 2017) addresses Reuven Feuerstein's Theory of Structural Cognitive Modifiability as a theoretical basis, emphasizing that all individuals have the ability to learn and modify themselves through mediated experiences, regardless of their disabilities. The four essential criteria of the theory are: Intentionality, Reciprocity, Meaning and Transcendence, fundamental for teacher mediation and the promotion of an inclusive learning environment.

The study focuses on executive functions, such as voluntary attention and working memory, and on the Triple Code model of numerical processing, suggesting that musicality can be an effective tool to stimulate these functions, promoting a more dynamic and engaging learning environment for all students, especially those with ADHD.

It uses a qualitative approach with classroom observations, which allows a deeper analysis of the interactions and the impact of the proposed activities. The observed teacher implemented activities that integrated musicality and mathematics, resulting in a learning environment where all students actively participated, demonstrating enthusiasm and creativity. The results indicated that the use of musical elements in mathematical activities not only facilitated the understanding of mathematical concepts, but also promoted the inclusion and participation of students with learning difficulties, highlighting the importance of didactic strategies that consider the neurocognitive abilities of students, suggesting that inclusion should be an intentional and well-planned practice.

The challenges faced in inclusive education are also mentioned in the article, such as the need for adequate teacher training and curricular adaptation to meet the diverse needs of students. The proposal for teacher training is seen as an opportunity to enhance the teaching of inclusive mathematics, promoting autonomy and cognitive modification of students. And finally, the research points out the relevance of teacher mediation and Executive Functions, suggesting that innovative and interdisciplinary approaches are essential to meet the needs of all students, since inclusion in mathematics education is not only a matter of adaptation, but an opportunity to enrich the learning process for all involved.

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Article 4 "Neuroscience and the teaching of mathematics" (Araújo; Mark; Bezerra, 2019) presents an analysis of the intersection between neuroscience and pedagogical practices in mathematics teaching, highlighting the importance of understanding how students learn to improve teaching effectiveness. The main objective of the study was to investigate the relationship between learning styles and the Theory of Multiple Intelligences in the context of mathematics teaching, in which the authors seek to understand how knowledge about the functioning of the brain can be used to increase learning rates in mathematics and, thus, transform the educational experience of students.

The authors argued that neuroscience offers valuable *insights* into how students process information and learn. In this sense, understanding these processes can help teachers adapt their teaching methodologies, promoting a more effective and engaging learning environment. The survey points out that many teachers still maintain traditional conceptions of teaching, which can be limiting, requiring a *shift* towards more modern approaches based on scientific evidence. They also discuss the relevance of learning styles (visual, auditory and kinesthetic) and the Theory of Multiple Intelligences, proposed by Howard Gardner, arguing that the integration of these theories in the teaching of mathematics can help personalize learning, making it more interesting and accessible and, consequently, increase students' interest in mathematics, in addition to improving their performance.

The research was based on a bibliographic review, a methodology that enabled the authors to substantiate their arguments and propose new directions for teaching practice. The authors consider that understanding the functioning of the brain and applying teaching strategies that consider learning styles and multiple intelligences can lead to more effective mathematics teaching, benefiting student learning, but also empowers teachers to become more effective in their pedagogical practices.

According to the authors, educators should update themselves on neuroscience findings and consider implementing methodologies that integrate this knowledge into their classes, in addition to reflecting on their own practices, promoting changes that can benefit student learning.

The authors conclude that neuroscience can be a powerful ally in mathematics teaching, offering tools and knowledge that can transform teaching practice, shifting the focus from traditional methods to more student-centered approaches based on scientific evidence.

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Article 5 (Broitman *et al.*, 2019) presents a critical analysis of mathematics education, especially with regard to the inclusion of students with disabilities, discussing the need to rethink pedagogical practices and discourses surrounding school mathematics, in addition to emphasizing the importance of an inclusive approach based on human rights.

The authors made observations in classrooms and identified a widespread concern among educators about how to teach mathematics to students with intellectual disabilities. Teachers expressed a sense of powerlessness, using phrases such as "we do what we can" and "with these students, much cannot be done", which reveals a lack of training and adequate didactic strategies to deal with diversity.

The authors criticize the medical model, often applied in education, in which disability is portrayed as an obstacle to be overcome, rather than a characteristic that should be considered in the construction of inclusive pedagogical practices, a view that perpetuates segregatory practices and limits learning opportunities for these students. There is an explicit demand for continuous training for educators, who seek guidance on how to teach mathematics in an inclusive way. The authors highlight that the existing curricula do not offer adequate support for the organization of teaching that contemplates the diversity of students, and defend the creation of a learning environment that promotes the construction of a "mathematical community" where all students, regardless of their abilities, can actively participate. This implies developing practices that value cooperation and the exchange of knowledge between students with and without disabilities.

In summary, the investigations carried out by the authors not only question the current pedagogical practices, but also invite a deeper reflection on the ideological aspects that permeate the teaching of mathematics. They emphasize the importance of recognizing and challenging the inequalities that exist in the education system, promoting education that is truly inclusive and equitable. The entire study is a call to action for educators, policymakers, and researchers, highlighting the urgency of rethinking mathematics education in an inclusive context. Education should be a space of opportunity for all, where diversity should be recognized and celebrated, moving towards an educational practice that respects and values all students.

Article 6 (Nampo; Caetano; Bezerra, 2022) refers to a systematic review of the literature on the intersection between neuroscience and mathematics teaching, highlighting how the principles of neuroscience can be applied to improve mathematical learning, whose

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objective was to identify and analyze pedagogical interventions based on neuroscience that impact and optimize the teaching and learning of mathematical content.

The results indicated that several factors, such as sensory stimuli, teaching strategies and emotional aspects, influence mathematical learning, such as the use of different sensory stimuli (touch and vision), highlighted as a way to activate different areas of the brain, favoring the formation of long-term memory. The article mentions specific interventions, such as the use of *Cuisenaire* Scales, which have been shown to be effective in maintaining students' attention and solving mathematical problems, and in addition, they point out that approaches that include mindfulness and memory skills can also improve math performance.

The authors suggest that the findings have significant implications for pedagogical practice in mathematics teaching, but recommend that further research be conducted, especially from randomized controlled trials, to validate neuroscience-based interventions, developing more effective teaching methods tailored to students' needs.

Article 7 (Costa; Ghedin, 2022) reveals several layers of understanding about how cognition influences mathematical learning and pedagogical practice, since these are not limited to the memorization of formulas or techniques, but involve the activation and expansion of the student's cognitive structure. The authors argue that the understanding of mathematical concepts is closely linked to the mobilization of cognitive processes, such as attention, memory, and reasoning, suggesting that pedagogical practices that consider these processes are more effective for the development of mathematical thinking.

The authors discuss the importance of semantic memory and its relationship with mathematical language, since it is essential for the understanding of new concepts and words, especially in a field such as mathematics, which has its own complex language. The lack of understanding of meanings can lead to learning difficulties, indicating that didactics must be sensitive to these nuances.

The article mentions the "crisis" in mathematics teaching in Brazil, evidenced by unsatisfactory results in large-scale assessments, pointing out that this crisis can be attributed to several factors, including the lack of meaning in conceptual definitions and the disconnection of mathematical content with the social and cultural context of students, which suggests the need for a didactic approach that integrates mathematics into the daily lives of students, making learning more relevant and meaningful.

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In this vein, teacher training should include a deeper understanding of cognitive processes and how they relate to mathematical learning, that is, educators should be able to develop pedagogical practices that respect and use the way the brain learns, promoting more effective teaching adapted to the needs of students.

Based on theories of mathematics didactics, educational psychology and cognitive neuroscience, the authors emphasize that such a multidisciplinary approach is indispensable to create a more holistic understanding of mathematical learning, allowing educators to develop strategies that consider the complexities of human learning.

The analysis of the article reveals that the consideration of cognitive processes in mathematics didactics is fundamental to improve student learning, since the integration of neuroscience theories and a student-centered approach can transform pedagogical practice, making it more effective and meaningful. Thus, the continuous training of teachers and the adaptation of teaching practices to the cognitive needs of students are substantial steps to face the current challenges in mathematics teaching.

Article 8 (Morais, 2023) reveals several important dimensions about the intersection between music, learning, and educational inclusion. The study focuses on a student identified with a learning disability, specifically with an intellectual disability, and explores how a musical environment can serve as an effective pedagogical tool. The choice of the musical environment is justified by its ability to stimulate memory and attention, central aspects for learning, especially with students with specific needs.

Data collection was carried out directly at the school, with observations at three different moments: at the beginning of the study, after four and seven months of intervention. The results indicated a significant evolution in the performance of the student who, initially, had difficulties in recognizing numbers and writing, using only capital letters; and, with the musical intervention, there was an improvement in his writing ability, starting to use cursive and recognizing numerical sequences up to thirty. This evolution suggests that the musical environment not only facilitated mathematical learning, but also contributed to the development of motor and cognitive skills.

The musical environment is configured as a semiotic tool that promotes inclusion and learning, and music presents itself as a multisensory resource that can engage students with difficulties, making learning more accessible and enjoyable. Exposure to the musical environment can improve memory and attention, corroborating studies that associate music with cognitive development. These findings have significant implications for educational

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practice in special education contexts, as they suggest that the integration of musical environments into pedagogical activities can be an effective strategy to meet the needs of students with learning difficulties.

The article offers valuable insight into how music can be used as a powerful tool in special education, promoting not only mathematical learning, but also the integral development of the student, which reinforces the relevance of inclusive and adaptive environments that consider the particularities of each student, contributing to a more equitable and effective education.

In article 9 (Benitez *et al*., 2023), the authors reveal several expressive dimensions on the application of Functional Near-Infrared Spectroscopy (FNIRS) technology in educational contexts, especially for children and young people with autism and intellectual disabilities. Investigating the hemodynamic response of the prefrontal cortex to support educational interventions, the authors sought to identify biomarkers that would help in decision-making about learning criteria and in the teaching of skills such as reading, mathematics, and emotional expressiveness, highlighting the importance of an assessment that considers cognitive, behavioral, and environmental aspects, in line with the biopsychosocial model of disability.

The use of FNIRS is considered promising for the analysis of brain activation during educational tasks, enabling a personalized assessment of student performance, in order to allow educators to adjust their teaching approaches according to the specific needs of each student. Research indicates that neurophysiological analysis can help predict and monitor pedagogical performance, contributing to effective and individualized educational planning. The analyses included comparisons between specific tasks and rest, which allowed for a deeper understanding of how students interacted with educational content.

It is observed that the results of the research have significant implications for educational practice, since the ability to monitor cognitive effort and brain response can lead to more effective interventions adapted to the needs of students. This is essentially relevant in a context where many students face educational inequities, allowing educators to develop strategies that promote inclusion and academic success.

By integrating neuroscientific approaches with educational practices, it is possible to revolutionize the way education is planned and implemented for populations with special needs, contributing not only to the field of inclusive education, but also paving the way for future investigations into the intersection between neuroscience and pedagogy.

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And, finally, article 10 (Pereira; Fonseca, 2024) reveals important dimensions about the intersection between neuroscience and education by investigating how the knowledge produced in Science and Mathematics Teaching, present in dissertations and theses, addresses cognitive neuroscience and attentional theories, providing *insights* into how students learn and how teaching strategies can be adapted to improve learning.

The results indicated that, although there is a significant production of knowledge in the area, only a fraction of the dissertations and theses directly address the relationship between neuroscience and science teaching and mathematics, which indicates a gap in knowledge that can be explored in future research. In addition, the authors highlight the importance of considering attentional mechanisms in the learning process, especially in inclusive contexts, such as teaching deaf students.

Attentional theories have direct implications in pedagogical practice, which justifies the use of teaching strategies that consider such mechanisms, aiming to promote more effective learning, such as the adaptation of teaching materials and the use of different methodological approaches can help meet the needs of diverse students, including those with learning difficulties.

The study contributes to the discussion on the magnitude of neuroscience in education, emphasizing that understanding cognitive processes can lead to more informed and effective teaching practices. For this, teacher training must include knowledge about neuroscience and attentional theories so that they can apply these concepts in the classroom.

The analysis of the work reveals that, although there is a growing interest in the intersection between neuroscience and education, there is still much to be explored, requiring more studies that integrate these fields, aiming to improve pedagogical practice and, consequently, student learning.

FINAL CONSIDERATIONS

The application of cognitive neuroscience to mathematics teaching has proven to be essential for the development of inclusive and accessible pedagogical practices, promoting respect for the particularities of brain functioning during the teaching and learning process. Understanding how the brain processes concepts and emotions makes it possible to create strategies adapted to the needs of each student, reinforcing functions such as memory,

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attention, and emotional control, in addition to providing richer and more meaningful learning experiences.

To make teaching inclusive, practices that integrate sensory and emotional stimuli are needed, such as activities that use musicality, as they facilitate the assimilation of content, engaging the limbic system and promoting a welcoming and equitable learning environment. These approaches are especially beneficial for students with specific needs, reducing stress and increasing motivation.

In addition to improving mathematical learning, pedagogical practices based on neuroscience contribute to a true inclusion, where each student is valued and can develop their potential in an adapted environment. For this, the continuous training of teachers in neuroscience is indispensable, as it enables the implementation of inclusive methodologies that respect multiple intelligences and learning styles, personalizing education to make it accessible to all.

In a way, transforming mathematics education through neuroscience requires collective commitment and constant updating from educators, who play a central role in creating inclusive and welcoming practices. The continuity of this research and the application of these practices represent fundamental steps so that each student has the opportunity to learn and prosper, making inclusion a fundamental principle in education.

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