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THE CONTRIBUTION OF NEUROSCIENCE TO THE EDUCATION OF YOUNG PEOPLE AND ADULTS IN MATHEMATICAL DISCIPLINE

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Abstract: Historically, constructs developed at the heart of neuroscience have contributed to the education of thousands of students, especially in mathematics by providing relevant data for understanding the limitations and expansions delimited to teaching-learning. The present study has as its central objective the importance and benefits of transdisciplinarity in education, analyzing its practical application and its potential to promote more meaningful and contextualized learning. The methodology used consists of the analysis and synthesis of relevant studies and theories on the topic, in order to understand the importance of integrating these elements in the educational context, specifically using the bibliographic review that explored the relationship between neuroscience, transdisciplinarity and the teaching of mathematics. in Youth and Adult Education (EJA). The research seeks to provide theoretical and practical support for EJA educators, aiming to improve the teaching of mathematics, promote more meaningful learning and improve the quality of education in this modality.
Keywords: neuroscience, transdisciplinarity, mathematics teaching, EJA and pedagogical practices.

INTRODUCTION

The integration between different disciplines and the search for a more comprehensive understanding of reality have been recurring themes in the educational field. In this sense, the disciplinary approach emerges as a promising alternative, capable of providing a holistic and enriching look at knowledge. This article explores the importance and benefits of transdisciplinarity in education, analyzing its practical application and its potential to promote more meaningful and contextualized learning.

Mathematics at EJA has been enriched by the integration of neuroscience, which aims to understand how the brain processes the learning process, in which transdisciplinarity plays a fundamental role in this approach, as it allows the integration of diverse knowledge, expanding the complex understanding of reality.

By incorporating neuroscience into mathematics teaching, educators can achieve significant results. This way, understanding how the brain works makes it possible to use pedagogical strategies that respect the individual characteristics of students, favoring more effective learning. Furthermore, transdisciplinarity promotes the connection between mathematics and other areas of knowledge, producing more meaningful and contextualized learning.

The interdisciplinary approach has the potential to benefit EJA students, providing them with a deeper understanding of mathematical concepts and helping them to overcome possible difficulties, equally students can acquire solid skills in mathematics, increase their confidence in their abilities and be better prepared to resolve student and work obstacles.

The integration of neuroscience and transdisciplinarity in mathematics teaching at EJA is essential to promote inclusive and quality education, providing students with the necessary tools to understand and apply mathematics in their everyday lives.

The study of interdisciplinary neuroscience with the teaching of mathematics presents a positive point when using the contents discussed, the educator can obtain significant results in the training process and in pedagogical practices. He will have a deeper understanding of how the brain works and will be able to use pedagogical strategies that respect the way the brain system is maintained, improving the efficiency of teaching and learning mathematics in EJA.

By studying these subjects, EJA students will be able to develop solid mathematical skills, overcome learning difficulties and gain confidence in their abilities, which at the end of their studies will be better prepared to face academic and professional challenges.

Therefore, seek neuroscientific knowledge to support pedagogical practices in mathematics, with the aim of integrating transdisciplinarity in the teaching of mathematics, exploring different areas of knowledge, in addition to using pedagogical strategies that respect the functioning of the brain, promoting more effective learning, by stimulating the active participation of students, relating mathematics to everyday situations and awakening interest in the subject.

LUDICITY IN THE TEACHING AND LEARNING PROCESS OF EJA

The word playfulness comes from the word *Ludus*, which expresses activity, information that Huizinga (2014) asserts that ludus comprises children's and youth activities, leisure and sporting expressions. In other words, the function of playfulness can go beyond basic actions, it encompasses activities and tasks that can also be performed by adults of all ages.

As far as relevant, Massa (2015) argues that the playful aspect comprises a broad, volatile and dynamic aspect, which attributes meanings to the behavior of individuals, being more than their manifestations, which leads us to understand that it is the experience with play that allows for the individual to constitute himself as a person, forming his "self" and his personality, which is why we cannot talk about education without thinking about the perspective of play in the school curriculum in the initial grades.

There are several ways to bring play into the school environment, as Massa states when he says that experiencing play is to fully occupy the situation as a teacher and provide the same for the respective students. It is to carry out teaching that adds, instead of dividing cognitive from physical structure or emotion from centrality, analyzing the multiple aspects. Thus, playful expressions or actions are, in addition to a training tool, a capacity for progress (Massa, 2015).

This leads us to understand the importance of teachers experiencing playfulness in their pedagogical practices as an assertive methodology, because through this process, teachers can help their students develop the ability to think, create and interact. In addition, it contributes to the development of skills and abilities aimed at your personal and professional life, since, according to the PCNs, for an individual to develop, it is necessary for significant knowledge to occur, it is necessary to put energy into guidelines that maximize the student's openness to education, this can be observed, for example, in the desire to produce connections between their previous knowledge on a topic and what they are building on it (Brasil, 1998).

Therefore, the teacher plays the role of learning mediator, making the process pleasurable and meaningful, which can contribute to the student's good performance. For this learning to be successful, it is necessary to build meaning in the student's life, to establish a relationship between the student's previous knowledge and the new, thus valuing his "hidden curriculum" so that, from something already familiar to him, a space for something new is "accessible" in his mind. This way, the connection that is expressed between the previous formation of past or previously understood content and which reflects on the way in which recent subjects are received. These, in turn, begin to influence previous data, transforming cognitive learning, that

is, the joining of the absorbed subject into a balanced mental scheme. There is, in the course of, an interconnection whose product alters both the recent data, which then begins to have weight, as well as the delimited knowledge already acquired, relevant, in the cognitive structure of being the owner of knowledge (Moreira, 2001).

Therefore, learning at school is constructed through mediation between educator/student, but we must not fail to recognize the previous skills and abilities of this young person, as it is from this knowledge that we will create an association between the proposed contents and the pedagogically taught through the teaching-learning process involving the assertive methodology of playfulness, thus contributing to their removal from the situation of vulnerability by allowing this student to exercise their role as protagonist of the teaching-learning process.

As far as playfulness for young people and adults is concerned, we can say that it needs to have a real value, in relation to learning regarding development, as it is essential that there is the presence of a mediator, who can be anyone at home who has skills to assume the role of teacher responsible for the teaching-learning of the student who seeks his pedagogical assistance, as the greatest, in the personification of the teacher, therefore, who, in the child's construction, helps to build the core of the activities in the child's daily life. Therefore, it is what structures its basic axis, through the proposal of delimited utensils, dreams or activities, the cut and structure of spaces and time for recreation. Through the activities, teachers can analyze and elicit a spectrum of the progress paths of children as a whole and of each one specifically, recording their propensities for using language, as well as their social faculties and the affective and emotional instruments they have at their disposal (Brazil, 1998).

The essential element of this process is the teacher, because for playfulness to be successful it is necessary for the process to be significant for the development and learning of young people so that they can create relationships between their knowledge acquired through their experience and the knowledge acquired through the teaching-learning process presented by the educator/mediator of the situation presented without letting the young person lose their essence.

The relevance of including playfulness in the teaching of mathematics for students of Youth and Adult Education - EJA is justified due to the role it plays in the teaching-learning process, as playfulness can be inserted in different processes and disciplines, since the student, when learning in a playful way, starts to create relationships between their existing knowledge so that the simplest and most fun assimilation can provide pleasure in learning.

Therefore, this statement about playfulness can be applied in several ways, as it can function as an important assertive methodological tool for the development of this young person, by helping him through professionals who mediate the process in the classroom. Therefore, it must seek ways that this teaching process and assertive methodology does not remain just a pastime, but that playfulness is linked to knowledge, not just games followed by activities, but combining playful moments with curricular activities, aiming for meaningful learning.

The contributions of playfulness to the learning process include the promotion of socio-affective relationships, psychomotor development and cognitive aspects, in which the language of children, young people and adults can be built through playfulness, providing benefits that contribute to their development, designing your learning.

This way, Huizinga (2014), claims that playfulness as an element of culture, present in

all configurations of social organization, from the most primitive to the most sophisticated, a position also defended by Luckesi (2005) when noting playfulness as that which elicits the excellence of experientiality, in which the playful experience requires a total physical and psychological disposition from the being, fundamental constructions for the construction of the social being.

This way, playful learning as a means allows young people to develop in physical, mental, sensorimotor aspects, and can also make this learning something natural and inserted into their daily lives, a since learning is the process of acquiring knowledge and changing behavior based on experiences constructed by emotional, neurological, relational and environmental factors.

Vygotsky's theory (1991) reinforces the importance of play as an infant's social function, whose centrality and delimited base are fundamental objects for the formation of their persona and understanding of the environment in which they are inserted. Therefore, using play in the classroom can contribute for a positive affective memory that allows young people/adults to associate learning through play with an important moment of great emotional relevance in their life.

NEUROSCIENCE AND THE EDUCATIONAL PROCESS

Neuroscience is the understanding of the nervous system and its communications with the entire functioning of the human body, encompassing the relationship between the brain and behavior. Thus, from this statement we realize that neuroscience plays the role of neural control of vegetative functions and digestion, circulation, breathing, homeostasis, temperature, sensory and motor functions, as well as movement, conception, supply and absorption of water, the which justifies the relevance of the study of neuroscience, which also plays roles in the mechanism of attentional focus and memorization, learning, feelings, language and verbalization (Ventura, 2010).

Neuroscience, according to Souza and Gomes (2015), is the field of study that seeks to understand the functioning of the nervous system and its relationships with cognitive and behavioral processes, in which scientific reflection on the nervous system, whose goal is to address its development, its structuring, its progress and its modifications, integrating its multiple roles. They also complement each other in their delimitation, the biological sciences that reflect on bases that scrutinize neural structuring and processes, aiming to understand the mechanisms analyzed.

This way, we can infer that neuroscience has as its object of study the pathologies of the nervous system and their repercussions on all activities of the being, with the purpose of proposing studies of diagnostic, prevention and treatment methods, since it is concerned with the discoveries of the causes and mechanisms generating the problems researched.

BRIEF HISTORY OF THE EMERGENCE OF NEUROSCIENCE

The first occurrence of the term neuroscience occurred in 1960, designating an area broader than neuroanatomy and neurophysiology, with Vygotsky and Luria as its main precursors, who defend the progression of learning through dynamic flows of exchanges, analyzes and increasingly complex self-regulating syntheses. It is considered that the learning process goes beyond the accumulation of information, as it consists of restructuring, via transformation, through structural changes arising from actions and interactions caused by disturbances to be overcome.

The first occurrence of the term neuroscience occurred in 1960, designating an area broader than neuroanatomy and neurophysiology, with Vygotsky and Luria as its main precursors, and research indicates that Neuroscience is divided into three main subdisciplines: Molecular Neuroscience, Cellular Neuroscience and Systems Neuroscience.

Each of these areas focuses on different levels of study of the nervous system, from molecular and cellular aspects to the organization and functioning of neural circuits at the systems level, and we will study the field of neuroscience focused on the study of cognitive neuroscience in which focuses on cognitive processes, such as memory and attention, and their complex relationship with language, learning and influences from the external environment. These aspects play a crucial role in the sociocultural development of the subject throughout its history. (Bastos and Alves, 2013).

The word "neuroscience" has its etymological roots in the Greek term "neuron" meaning (nerve) and in the Latin "scientia" meaning (science). This term emerged in the 20th century, when the field of study that investigates the nervous system and its functions began to gain academic and scientific recognition.

According to Gazzaniga, Ivey and Mangun (2019), the use of the term "neuroscience" to describe this interdisciplinary field of study was universalized in the 1960s. Since then, neuroscience has developed rapidly, encompassing diverse disciplines such as anatomy, biology, physiology, genetics, pharmacology and neurology, with the aim of understanding the structure and functioning of the nervous system and its impact on cognition, behavior and health Souza and Gomes (2015) support the thesis that the teaching and learning approach is the responsibility of the educator. Mentioning that: knowledge in Neuroscience can be useful to understand how students' brains process knowledge, learn and suggest appropriate pedagogical interventions, which can enable all students to have guaranteed learning opportunities in an equal manner, guaranteeing the reduction of their condition socially vulnerable.

It is important that, by knowing how the brain works, the teacher can make pedagogical actions appropriate and, therefore, enable all students to have access to teaching and learning in a democratic and meaningful way so that the student can exercise their educational role.

When it comes to Youth and Adult Education (EJA), it is important to consider several aspects in which students in this type of education generally have life experiences, play professional roles during the day and may have missed the opportunity to study at the appropriate age, Furthermore, there are currently EJA students who face learning difficulties and are not ready to advance to subsequent grades, a reality present in many state schools.

Cognitive stimulation consists of a series of adapted activities that aim to improve the individual's cognitive and functional capabilities, repeating interventions that favor neuroplasticity. These interventions cover aspects such as memory, language, praxis, reasoning, perception, orientation and attention, with the aim of increasing cognitive and functional performance (Tobar; Alvarez; Garrido, 2017).

NEUROSCIENCE AND MATHEMATICS TEACHING

The inclusion of neuroscience in the teaching of mathematics at EJA is widely debated, as transdisciplinarity plays a fundamental role in the integration of

knowledge and the complex understanding of reality (Relvas, 2012).

Furthermore, there is a broad debate about the incorporation of neuroscience in EJA teaching, and the reason for this debate is the recognition that transdisciplinarity is crucial for the integration of knowledge and a more complex understanding of reality.

The author Relvas (2012) highlights the importance of approaching mathematics in this teaching modality, taking into consideration, the interaction between different disciplines and the comprehensive understanding of knowledge. Furthermore, the relationship between neuroscience and education is close, since the brain plays a crucial role in the learning process (Oliveira; Brim; Pinheiro, 2019).

This leads us to realize the importance of studying the brain for understanding the learning process and developing effective pedagogical practices, as through appropriate stimuli, it is possible to promote the reorganization of brain structures and stimulate the development and learning of students (Guerra, 2010).

When adopting theories and pedagogical practices based on biological bases and neurofunctional mechanisms, the teacher, aiming to optimize students' capabilities, is directly using neuroscientific knowledge.

This way we can understand that the teacher in this teaching-learning process plays an excellent role, which is that of protagonist of the teaching-learning action, since it is through his stimulation that students reorganize their brain structures for the development of student learning, making the connection between theory and practice of content taught in the classroom.

The use of neuroscience in teaching mathematics at EJA aims to understand mathematical thinking and make learning more meaningful and contextualized, which we can confirm through the approaches of (Consenza and Guerra 2011) who defend the transdisciplinary approach and the use of playfulness as a form of contribution to more attractive teaching that can arouse student interest and participation, making them play a leading role in the teaching-learning process, but it is worth highlighting that neurosciences do not aim for contemporary pedagogy, but rather interventions in existing pedagogical practices and aiming for a more efficient, effective teaching-learning process that respects the functioning of the brain of the students involved in the process.

The partnership between neuroscience and education brings significant advances to the educational field, allowing us to understand the central nervous system and its influence on individuals' behaviors, thoughts, emotions and movements (Dos Santos and Souza, 2016), since neuroscience is dedicated to study of mental skills, such as thinking, learning, memory and language, contributing to the training of educators (Gazzaniga and Heathrton, 2005).

Mathematics teaching must encourage students to seek explanations and purposes, relating it to everyday problems and scientific investigation, this way they begin to perceive mathematics as an instrument for understanding the world and making it the protagonist of their educational process. (Brazil, 1996).

MATHEMATICS AND TRANSDISCIPLINARITY

Transdisciplinarity is an approach that seeks integration and interaction between disciplines and areas of knowledge, overcoming the traditional boundaries of isolated disciplines. This perspective promotes a broader and more holistic view, allowing the understanding of phenomena in a complex and integrated way.

The study of transdisciplinarity began in the 20th century, especially with the reflections of the French philosopher Jean Piaget and the complexity theorist Edgar Morin, a time when Piaget highlighted the importance of an interdisciplinary vision to understand the nature of knowledge developed over time, while Morin proposed a transdisciplinary approach to dealing with the problems of contemporary society.

By inserting transdisciplinarity into the teaching-learning of EJA students, it was possible to perceive significant benefits, especially in the context of mathematics teaching, in which playfulness is one of the pedagogical guidelines that must be integrated into this process.

The incorporation of the transdisciplinary approach into Bahia's curricular framework is evident both in the teaching of history and culture and in the arts, promoting anti-racist and respectful education. Transdisciplinarity is presented as an orientation for the relationship between disciplines, allowing communication and the transfer of knowledge without gnosiological barriers, providing an integrated activity in secondary education, but the plural set of knowledge itself does not have gnosiological barriers. The articulation of curricular components is a specific condition of knowledge, as, in their genesis, they are interconnected, and can be understood as a union of knowledge, genuine and transversal. From a transdisciplinary perspective, the understanding of social and natural reality and its phenomena is holistic, contextualized and conceives the interrelationships between areas of knowledge, as knowledge is originally interconnected (Mendes, 2019).

As we can see, complexities and resistance arise when seeking a transdisciplinary approach, requiring constant behavior in overcoming limits and searching for new perspectives. However, this challenging journey is fundamental to expanding our understanding of the world and promoting more comprehensive and innovative solutions to current and future problems.

LUDICITY IN EJA TEACHING

The use of playfulness in EJA makes the teaching of mathematics more attractive and meaningful for adult students, since many of them may have a negative and insecure view of the subject they are studying. Therefore, games, games and recreational activities provide a relaxed learning environment, promoting the active participation of students, in addition to arousing interest, motivating engagement and facilitating the understanding of mathematical concepts.

Furthermore, the transdisciplinary approach at EJA, combined with playfulness, allows the connection of mathematics with other areas of knowledge, such as history, art and culture, making teaching more contextualized and related to the students' reality.

This interaction between different disciplines broadens the understanding of content, stimulates critical thinking and favors the construction of knowledge in an integrated way.

Transdisciplinarity also influences the progress of socio-emotional skills, such as teamwork, creativity and problem solving, in addition to providing students with challenges aimed at stimulating collaborative thinking, exploring different perspectives and finding creative solutions to the challenges proposed. through different games and recreational activities.

Furthermore, the insertion of transdisciplinarity and the use of playfulness in teaching mathematics at EJA provides a more dynamic, meaningful and contextualized learning experience.

IMPORTANCE OF NEUROSCIENCE AND THE TOWER OF HANOI IN THE CONTEXT OF EJA

Recreational activities provide a path to the formation of an extensive range of knowledge and developments in different skills, as they absorb guidelines that have a fundamental didactic value, helping students to engage in thought progress, interconnecting with the content shown in the games.

However, it is correct to analyze the way these games are being used. According to Lorenzato (2006), this evaluation can provide insights into the effectiveness of teacher training in universities, since these courses have the potential to function as a means for education professionals to understand and give importance to the integration of manipulative materials.

According to the same author, various games must be used as means to expand students' understanding of mathematical content, through the use of a methodological approach based on activities that enhance young people's cognitive progress. Furthermore, manipulable teaching tools, including games, can be added to mathematics classes, considering that it will be healthier for the students' training because, in possession of the teaching material, their thoughts will be more expanded, as they can have the power, in your rhythm, to form your trails and, with greater skill, fix the results. arising from its activities.

There is an evident openness that points to games as central characters in the educational core, offering students access to a world of openings and formation of mathematical knowledge.

According to the above, Machado and Oliveira's (2012) vision of the Tower of Hanoi is coherent, because, although it is a game seen as simple, it brings together varied elements of difficulty that can be managed in the daily lives of the students involved. and contextualized in Youth and Adult Education (EJA), for example, including using computational resources. The game in question can be experienced thinking about the breadth of absorption of its contents, which encompass collective experiences and individual cognitive progress such as mathematical thinking, basic operations and more.

In everyday life, Youth and Adult Education (EJA) students find themselves involved with realities that operate mathematics, even if they are not inserted at a high level of complexity. The practical application linked to theory provides an original methodology of knowledge for these students, allowing them a differentiated understanding of the application of these subjects in their work activities. There are broad motivations that support the integration of games into student daily life, with their role in the learning of contemporary students becoming increasingly clear, including those from EJA and others in the same contextualized situation, demanding non-regular adaptations that distance themselves from regular education. and traditional.

At the heart of the Tower of Hanoi game, a well-defined field of skills can be progressed towards mathematics teaching objectives, fundamentally when placed in the day-to-day life of EJA. Among these skills, the attentional focus must be on the schematization of future movements, the ability to generalize and the formation of mathematical models that link the basic number of movements with the number of disks.

It is pertinent to highlight that the occurrence of these expanded skills will depend on the teacher's pedagogical interventions. Based on games in mathematics classes, these interventions must occur in seven distinct phases: proximity to the core of the activity, understanding the rules, playing according

to the guidelines, educational intervention, written mediation and skillful play (Grando, 1995).

Such interventions occur in the study context of different students, but must gain special attention when experienced by special, contextualized and non-regular students, according to neuroscience precepts, as the being-environment interconnections experienced by a being centrally guide the topography and function of your answers. The connections between environmental events and the organism's responses can enact contingencies, that is, conditioned communications between elements of behavior and the variability of stimuli that precede or follow them. Students' responses to a given subject must be contingent according to their non-homogeneous capabilities and individualities (Ferrari, et al. 2001).

CONCLUSION

Playfulness, transdisciplinarity, neuroscience and mathematics teaching are fundamental elements in EJA. By exploring these concepts in an integrated way, it is possible to promote more effective and meaningful teaching, which meets the specific needs of this audience. Therefore, going beyond the traditionality commonly related to the teaching of mathematics, plastering content in boxes that are sometimes not appreciated by students who already have some level of difficulty with the subject itself and its required skills.

Playfulness plays a crucial role in EJA, as it allows students to engage in pleasurable and stimulating activities, contributing to the development of cognitive and social skills, as through games, games and challenges, students can learn concepts in a playful way. and motivating, overcoming their condition of social vulnerability and entering the world of work.

Therefore, the present study achieved its central objective previously stated, identifying the importance and benefits of transdisciplinarity in education, analyzing its practical application and its potential to promote more meaningful and contextualized learning, according to the studies reviewed and reflected throughout the process. discussion of the results found.

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