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CHAPTER 2

# EDUCATION AND NEUROSCIENCES IN DEBATE: VIEWS AND REFLECTIONS ON THE CONSTRUCTION OF HUMAN KNOWLEDGE

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## ABSTRACT

Introduction: The central theme of the research was to highlight contributions to theoretical and scientific knowledge regarding the relationship between education and neuroscience. The objective was to analyze how the brain changes throughout life in response to experiences and environmental stimuli and how these processes impact learning and human development. Methods: A descriptive qualitative study was conducted through a literature review emphasizing the current context of scientific research related to the application of neuroscience to education and learning. To this end, the theoretical framework of Lent, Vayer, Guerra, and Relvas, among other scholars on the subject, was examined. Results: The study investigated aspects relevant to the proposed theme, raised points about learning theories, and showed how phenomena occurring in the school environment can be researched methodologically. Conclusion: The results highlight the importance of relating cognitive learning mechanisms to neurodevelopmental factors and their social applications.

**Keywords:** Education; Neuroscience; Knowledge.

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## INTRODUCTION

The central theme of this research is the characterization of contemporary theories about the relationship between neuroscience and education. It is imperative to understand the function of the brain during the teaching and learning process. It is evident that learning is a pivotal factor in the development of individuals. The knowledge acquired during training constitutes a fundamental aspect of an individual's growth and evolution. Therefore, the objective of this study is to analyze the learning process of the subjects from psychogenetic theories that privilege cognitivism.[2] According to Lefrançois (2008), the main interest of these theories "is in the most complex mental capacities, whose functions have to do with perception, formation of concepts, memory, language, thinking, problem solving and decision making" (P.222).

In light of this, Oliveira's (1999, p. 64) contribution is relevant. He states that learning is essential for the integral development of individuals and occurs primarily through social interaction. Thus, the learning process should start with what students already know and expand their knowledge through interaction with others. Since these interactions are with heterogeneous subjects, an individual who is more advanced in a certain aspect can contribute to the development of others. This study examines theorists' thoughts on human cognitive development[3] to conceptualize these lines of thought according to related research. It is interesting to note that psychological theories about the functioning of the mind are based on the analysis of human behavior (Amaral & Guerra, 2022, p. 40). In this case, a theory is

> a human attempt to systematize a field of study, offering a specific perspective to explain and predict observations and solve problems. A learning theory is a human construct that systematically interprets the field of learning. It represents an author's or researcher's point of view on how to interpret the learning theme and the independent, dependent, and intervening variables. Learning theories attempt to explain what learning is and why it works the way it does (Moreira, 2021, p. 12).

## METHODOLOGY

Interestingly, this study is descriptive research with a qualitative approach based on a literature review. In other words, it revisits and revises existing research and discussions on the application of neuroscience to education and learning. Thus, the intention was to begin with the contributions of scientific theories related to this field of study. This approach involved seeking classic works and observing the current state of research on the subject in an interdisciplinary dialogue approach.In this

[2] Cognitive theory, first developed by John Dewey and subsequently by Jerome Bruner, views learning as a process of problem-solving. According to Piletti (2009, p. 55), it is through solving everyday problems that individuals adjust to their environment.
[3] Based on systematic observations, Piaget, Ausubel, Vygotsky, and Wallon proposed theories that anticipated ideas about human behavior. These ideas have been supported by evidence about brain functioning and are now being rescued by neuroscience (Amaral Guerra, 2022, p. 43).

context, the decision was made to seek methodological rigor by using theoretical support through a literature review related to the presented theme. This was achieved by reading books, articles, and theses.

It is also noteworthy that the primary authors cited in this research are Lent, Ausubel, Relvas, Luria, Piaget, Vygotsky, Taille, Vayer, Guerra, and Cosenza, among other theorists in this field, whose theoretical foundations will be examined. In this perspective, it should be noted that notes were raised to characterize this research methodology in the field of neuroscience and education. In this bias, the research sought to expand the repertoire of consulted sources with the aim of reaching an understanding that the current advances in neuroscientific studies allow for dialogue between scientists and educators about the mechanisms of development of the learning process.

## THEORETICAL REFERENTIAL

In light of the analytical perspective of this theoretical investigation, it is important to consider the significance of having a broad and comprehensive understanding of how the human brain learns and how this knowledge can be applied to the learning process. Regarding theories about the role of school in forming individuals, it is important to bear in mind that teaching should not only address the intellectual stages students have already reached, but also the stages they have not yet incorporated, encouraging new achievements and acquisitions, and adding new capacities and skills[4].

In this respect, the teaching and learning process should be designed based on the student's specific level of maturation and the educational objectives established by the school (Oliveira, 1999, pp. 61-62). Based on this theoretical framework, learning generally refers to changes in the connections between neurons; it is the process by which the brain reacts to external stimuli by strengthening some synapses and weakening others. It is interesting to note that

> the five senses—sight, touch, smell, taste, and hearing—pick up signals from the environment and tend to emit a response, whether consciously or not. These signals are perceived by sensory neurons, which generate an excitatory synaptic action potential. This potential then travels along the corresponding nerves toward the central nervous system and reaches central synapses. The information received may be modified by information from regions linked to perception, cognition, emotion, and attention (Lent, 2008).

As demonstrated, this understanding is relevant to education in that it leads individuals to fully develop their capacities. According to Lefrançois (2008), "The most important common characteristic of topics in cognitive psychology is that they presuppose mental representation and information processing" (p. 224). In light of this analytical basis, which encompasses sensory system modalities, specific stimuli,

[4] There seems to be a set of systems in the human brain that are consistently dedicated to the processes of reasoning and decision-making, with a special emphasis on the personal and social domains. These systems are also involved in emotions and feelings, and they are partly dedicated to processing signals from the body (Damasio, 1996, p. 45).

and their respective receptors, the potential contributions of different scientific disciplines to education are gradually becoming clearer[5], especially given the understanding that education involves multiple intersections and cannot be dissociated from a process affected by the senses. Ausubel's theory of meaningful learning is one of the hypotheses and concepts of neuroscience associated with education and learning that should be highlighted.

According to Ausubel's (2002) studies, meaningful learning presupposes that the individual has previous cognitive schemes that are hierarchically ordered. Ausubel calls these schemes "subsumers." New knowledge is integrated into these subsumers, which act as a kind of anchor or bridge. New knowledge is associated with and more easily integrated into what the individual already knows. Therefore, significant knowledge is the product of a cognitive psychological process involving the interaction between new and previous ideas anchored in the cognitive structure.

In this sense, it is important to point out that, in light of the highlighted theoretical basis, the individual's cognitive structure changes. It expands, diversifies, and intensifies its potential. Thus, it becomes increasingly capable of processing new information, ideas, and data. It also becomes capable of anchoring the results of this processing (Lefrançois, 2008). According to this author, a conceptual metaphor exemplifies this trajectory of conceptualization, therefore,

> the dominant metaphor in cognitive psychology is information processing, referring to how information is modified or altered. The emphasis is on perceptual and conceptual processes that enable subjects to perceive, determine how to act, and facilitate thinking, memorization, and problem solving, among other processes (Lefrançois, 2008, p. 223).

Consequently, as all individuals have the opportunity to learn, to a greater or lesser extent, it is imperative to undertake early observation and investigation of the structures that involve learning factors. This is because all individuals have the right to an education where their needs are met and where they can be stimulated in an enriching environment (Relvas, 2014, pp. 20–31). Psychomotor development is continuous, and education contributes to future learning. Therefore, it is interesting to get students to expose facts they have experienced, making a connection between the imaginary and the real. This helps them develop self-knowledge and self-confidence (Pinto, 2011).

> The acquisition of knowledge is a process that occurs through the engagement with and application of that knowledge in real-world contexts. The process of constructing knowledge is facilitated by the mobilisation of mental activities and interaction with others. Emotion, moulded and associated with reason, must be used in favour of learning, because the emotional and the rational are parts of the same reality, the development of man (Relvas, 2014, p. 39).

[5] Neuroscience is increasingly capable of unraveling brain connectivity, the dynamics of functional interactions between the brain and environment, and the developmental pathways of the nervous system. Additionally, neuroscience is capable of unraveling the mechanisms of neuroplasticity, which enable the brain to adapt and modulate its development in response to external stimuli (LENT, 2019, p. 6).

In light of this theoretical basis, the speech under scrutiny reveals the necessity of deepening the interpersonal relationships and the communication established with students, in order to gain insight into their particularities and specific demands. This deepening of relationships is achieved through bodily availability and adjustment to the rhythm, tone and engagement of the students (Relvas, 2014). The concept of bodily availability entails the capacity to listen attentively, employ the individual's language to elucidate and comprehend, and utilise it in a symbolic manner.

It is important to note that throughout the educational process, subjects are immersed in a social and emotional context from birth, and through the numerous interactions that are established, they develop as a whole. In this regard, neurobiological assumptions posit that learning is equivalent to the formation, connection and consolidation of existing links between brain structures. Moreover, it is concomitant with the facilitation of information transmission along synapses (Cosenza and Guerra, 2001).

In this context, it is important to consider the findings of studies that suggest a direct link between learning and affectivity, desire and emotions. These studies also suggest that it is important to associate learning with emotional aspects, i.e. motivational factors. In this discursive path, the learner is unique, singular and is present in exchanges with the world and with others, when acting and interacting, collectively experiencing a plurality of experiences that constitute their own marks (Pinto, 2011, p. 102).

The value of the activity of the subjects themselves must be recognised in the teaching-learning process, since it is through this that the brain is stimulated, elaborating and recording its experiences. Its structural and functional development is closely linked to these experiences. At this point in the educational process, pedagogical activities at school are responsible for significant affective and social developments in the construction of subjectivity. These activities require a considerable amount of perceptual and cognitive effort (FERREIRA, 2015). The advent of research into the brain and the neural processes involved in thinking and learning has enabled the emergence of explanations, thus providing a more profound understanding of the science of education (RATEY, 2001).

The author's position that multidisciplinary and interdisciplinary research with scientific input is paving the way for basic educational research to be implemented in classroom practice is one with which it is essential to concur (RATEY, 2001). In this manner, one of the strategies that facilitates the planning of pedagogical practice oriented towards action is to verbalise or reflect prior to action, thereby enabling a certain degree of regulation during the task (Luria, 1981).

In this regard, it is imperative to acknowledge and respect the unique rhythm of each student, recognizing that experimentation, experiences, discoveries, and learning are pivotal factors in their holistic development (Heinsius, 2011, pp. 77–98). In this vein, Le Bouch (1982) asserts the significance of recognizing playful activity as a form of creative expression essential for the development of personality and the refinement of body image.(Le Bouch, 1982).

> Learning cannot be carried out in good time if the child has not managed to become aware of their body, lateralize themselves, situate themselves in space, master time, if they have not acquired sufficient skill and coordination of their gestures and movements (Le Bouch, 1988, p. 11).

## RESULTS AND DISCUSSION

From the earliest stages of life, there is a need for action. At this juncture, preliminary exploratory activities, characterized by their subjective nature, pertain to the body itself, as previously delineated by Le Bouch (1988). It is through these initial experiences of pleasure and imagination that a series of discoveries and developments are initiated, encompassing the affective, motor, and cognitive domains. The formation of relationships with peers is also fundamental to the representation scheme, as individuals perceive others in interaction (Bee, 2011).

It is important to bear in mind that interpersonal relationships represent one of the highest levels of development from childhood onwards, where reality is apprehended in different ways. This fundamental consideration enables play to be a key component in school psychomotor practices, since play and shared affections transform the situation into unique experiences (Ferreira, 2015, p. 1). In this line of understanding, it is worth noting, in the light of Oliveira (1999), that "Vygotsky's conceptions of the functioning of the human brain are based on his idea that higher psychological functions are constructed throughout man's social history" (p. 25).

> Vygotsky's rejection of the notion of fixed and immutable mental functions is well-documented. He instead embraced the concept of the brain as an open system of significant plasticity, whose structural characteristics and functional modes are shaped throughout the course of human and individual development (Oliveira, 1999, p. 25).

In light of this, the author also emphasizes that, for Vygotsky, the subject utilizes social interactions from childhood onward as a means of accessing information in the construction of their knowledge. At this particular stage, play and playfulness become a privileged moment for learning, where development can reach increasingly complex levels. This is due to the possibility of interaction in imaginary situations and by living together, since the concrete situations in which they find themselves determine their behavior (Oliveira, 1999, p. 66).

> Movement enables children to explore the world through concrete experiences that lay the foundation for intellectual development. It is imperative for children to have direct exposure to concrete. Exploration is a critical component of early childhood development, facilitating an understanding of both oneself and the external world. Children undergo continuous development from the first years of life (Pinto, 2011).

In accordance with Vygotsky's theory, the development of thought can also be facilitated through social interactions. Consequently, the role of the teacher, particularly during the early years of schooling,

is both pivotal and challenging. This educator is tasked with instructing subjects that vary widely in their developmental stage and are in the initial phase of personality formation. In this vein, Heinsius (2011) asserts that observation constitutes a fundamental tool for teachers to become acquainted with their pupils and to gain a more profound understanding of their cognitive processes, modes of communication, interpretation of the world, and actions.

Given the capacity to amass a substantial body of information through observation of the subject in a range of playful scenarios within the school environment, this method facilitates the organisation of physical spaces and scheduling, thereby enhancing pedagogical practices. It also fosters more productive interactions with students and enables the exploration of their diverse knowledge and competencies, as articulated by Ferreira (2015).

It is essential that during schooling there is a wealth of playful and motor acquisitions, which are constantly processed through pedagogical and psychomotor practices that stimulate playing, creating, recreating, discovering, and interacting. In this direction, the author proposes a reflection on play as a fundamental form in the construction of the subject. Play is a need for organization and constitutes a space of interaction for students, enabling them to imagine and experience their very specific social and family relationships through their own body and speech. Thus, play becomes an educational strategy that must be well structured (Ferreira, 2015).

Within the framework of analysis proposed by Vygotsky, development is understood as the result of individuals' experiences, thereby establishing a close link between development and learning. According to Vygotsky, individuals develop as they learn. In the context of the Vygotsky perspective, Oliveira (1999) asserts that "in their relationship with the world, mediated by culturally developed instruments and symbols, human beings create the forms of action that distinguish them from other animals" (p. 25). From this perspective, individual and collective activities are pivotal for the comprehensive development of the subject, as they stimulate imagination, leading to experiences where rules are respected and limits are transcended in a spontaneous and pleasurable manner, providing bodily manifestations that are replete with meaning.

It is important to underscore that it is precisely the rules of games and playful activities that engender the subject's more evolved behavior, especially during childhood, than is typical for their age group (Oliveira, 1999, p. 67). In this regard, social interaction characterized by playfulness is imperative for the development of motor organization, fostering body awareness, and cultivating balance, global and specific coordination, laterality, writing and reading skills, and creativity. Therefore, it is imperative to furnish educators with the necessary conditions for psychomotor education, thereby ensuring that children partake in both individual and group learning experiences that are conducive to their holistic development (Le Bouch, 1988, p. 40).

> The child's operation of meanings is characterized by a dissociation from the objects and actions typically associated with them. It is a stage between the purely situational constraints of early childhood and adult thought, which can be totally detached from real situations (Vygotsky, 1998, pp. 129–130).

In light of these considerations, educational initiatives must prioritize the harmonization of potential and affectivity. This is because students are holistic beings, necessitating a balance of body, mind, and emotion to ensure the coherent construction of knowledge and continuous development (Vygotsky, 1998). It is important to note that the act of engaging with and upon objects offers a valuable opportunity for personal growth and development. Through these interactions, individuals engage in experimentation, discovery, innovation, and learning. Moreover, these activities foster autonomy, curiosity, and self-confidence, thereby facilitating the development of critical competencies such as language, concentration, thought, and attention (Le Bouch, 1988).

Hence, it is a moment of self-expression and self-realization, as the teaching activity can be defined or free, thereby fostering creativity and spontaneity (Bee, 2011, p. 174). In this regard, the author posits that the utilization of symbology significantly enhances students' capacity to comprehend and exert influence on their immediate environment.

In the context of Piaget's cognitivist theory, individuals are in constant interaction with their environment, resulting in perpetual imbalances and balances that contribute to the subject's adaptation to this environment. According to Piaget, "the acquisition of knowledge is a gradual developmental process made possible by the child's interaction with the environment" (Lefrançois, 2008, p. 261).

According to this theory, the environment does not produce or shape the subject; rather, the subject is constructed by adapting to the environment. In order for this balance to occur, two invariables must be present in all activity. These invariables are called assimilation and accommodation by Piaget (1977). Assimilation is defined as a cognitive process that occurs as a result of prior learning and understanding. The concept of accommodation involves a shift in perspective. This interaction leads to adaptation, which occurs when there is a balance between these invariables (Lefrançois, 2008).

Assimilation can thus be defined as the process of acquiring knowledge that has already been learned. The occurrence of the phenomenon is independent of the developmental stage, and the implementation of a change in schema is a prerequisite. The integration of a novel element into an extant schema constitutes the essence of the process. For Piaget, this process of equilibration is progressive, representing a continuous transition from a state of lower equilibrium to a state of higher equilibrium. In this theoretical framework, as posited by Fonseca (2002), the evolution of information and behaviour is identified as a pivotal catalyst for development. According to Lefrançois (2008, p. 248), when an individual interacts with their environment, certain aspects are assimilated into their cognitive structure.

These aspects then modify or accommodate elements of the cognitive structure in relation to the environment.

> From a perspective of equilibration, it can be argued that one of the sources of progress in the development of knowledge should be sought in imbalances, because it is only through such imbalances that the subject is able to overcome their current state and seek anything in new directions (Piaget, 1977, p. 23).

From this perspective, considering the distinctions that Piaget establishes between development and learning, if learning implies the existence of prior structures and if these structures are constructed during the development process, then learning is contingent on development (Piaget, 1977). It is evident that learning is one of the factors that influence human development. In accordance with Piagetian theory, the acquisition of skills through learning is contingent on the developmental stage of the individual, with the theory proposing the learning of specific skills that can be assimilated by the structures available to the individual. As Fonseca (2002) asserts, this is intended to favour the acquisition of concrete operative structures through the process of equilibration by which they are built.

Piaget's (2008) theory posits that human development progresses through distinct stages, with each stage being characterised by specific capacities. At this point, according to Lacerda (2011, p. 172), in the pre-operative or pre-operational stage, according to Piaget's theory, the presence of symbolic games, through make-believe, is striking, where the child begins to make abstractions and internalize the situations experienced.

At this juncture, deliberate pedagogical activities present significant opportunities for development. Furthermore, it is imperative to acknowledge that the utilisation of objects serves to facilitate and enhance pedagogical practice within the school environment. In this sense, the activity constituted through action and language is expressed in a diverse way, depending on the possibilities of the subjects who educate themselves (Ferreira, 2015, p. 2).

In light of the analysis conducted by Lacerda (2011), Piaget holds the conviction that play constitutes one of the most fundamental activities in life. Firstly, there is the concept of exercise, defined as the deliberate repetition of a specific situation for the sake of pure enjoyment or to reap the beneficial effects of that situation. Around the age of four or five, symbolic play commences, whereby memories of past experiences are not only recalled but also re-enacted.

Subsequently, as social development progresses, a set of rules emerges, which, according to the prevailing social conditions, assume an increasing degree of importance. Accordingly, for Piaget, human action constitutes a condition and expression for development, given that individuals assimilate a multitude of social, motor and affective issues. Consequently, no aspect of development should be disregarded (Lacerda, 2011, p. 169).

> When environmental values are considered in relation to the body and specific bodily parts, a unique and highly personalised set of meanings, feelings and values is established (Vayer, 1984).

In this sense, it can be argued that playful experiences and stimuli are valuable resources for developing people's potential, so that activities span several stages of individual growth. The activities that motivate learners to act are fundamental and are directly linked to cognitive, social and affective factors. Motor activities have been shown to facilitate exploration and development of bodily capacities, thereby contributing to holistic development (Lacerda, 2011).

The author posits that the constructivist concept, grounded in Piaget's theoretical framework, offers a methodology for comprehending the cognitive processes underlying subject thinking and the construction of their individual learning pathways. Consequently, the fundamental structure of classroom activities is predicated upon the student as the pivotal entity in the educational process. From this standpoint, the student is conceptualised as the producer of knowledge, in the sense of protagonism (Lacerda, 2011).

In accordance with the assertions put forth by Taile (2021), Piaget's primary focus was on the distinctive aspects of thought, with a particular emphasis on the strengths and assets possessed by children rather than their perceived deficiencies. This cognitivist argument is of significance insofar as it presupposes that children's thinking differs from adult thinking. As Vygotsky (1993) asserts, "a child is not a miniature adult, just as his mind is not the mind of an adult on a smaller scale" (p. 9).

From this perspective, it can be posited that distinct periods of child development are characterised by specific cognitive and behavioural patterns. This assertion is supported by the research findings of Le Bouch (1982), Bee (2011) and Vayer (1977). In light of this, it is noteworthy that, according to Piaget's theory, the developmental stage referred to as pre-operational or intuitive intelligence is characterised by egocentrism as a fundamental aspect of child thinking. This period, typically spanning ages four and five, is characterised by the inability to comprehend perspectives that diverge from one's own.

Accordingly, an additional characteristic of the evolution of thought in childhood, from a Piagetian standpoint, is centralisation, whereby the child perceives a single aspect of an object or event, and fails to establish interrelationships between the various dimensions of a situation. With regard to animism, children attribute life to beings and assume that objects are alive. In relation to nominal realism, another characteristic of children's thinking, they hold the belief that the name constitutes an integral component of the object, perceiving it as a property of the object it represents. According to Piaget's observations, children at the age of four and five do not utilize defined criteria to perform tasks such as classifying, sorting and ordering objects, nor do they include them in a class (PIAGET, 1982).

According to Piaget (1982), mathematics, like written language, is founded on constructivist theory. The objective of constructivist theory in mathematics education is to provide students with stimuli and resources to develop their reasoning abilities. This is achieved by proposing activities in which knowledge is gradually built up, thereby stimulating and developing independent thinking, concentration, attention, creativity, and the ability to solve problems.

In this respect, it is interesting to note that logical reasoning is about the relationship with the environment. In the construction of intelligence structures, interaction with the environment and with others plays an important role due to the conditions it offers. In Piagetian theory, this capacity is defined as the ability to consciously and competently situate oneself within the context of society. According to Taile (2021), the various stages that define the differentiated qualities of the 'social being' coincide with the stages of cognitive development (p.18).

According to the theoretical contributions of Kamii (2002), education should prioritize the construction of concepts through active student experimentation, followed by the normalization of these concepts through the language of operative signs. Active and autonomous mental participation is essential to learning, particularly in everyday classroom activities and group games. In this regard, games offer a creative, autonomous, and conscious approach to education, seeking to develop perception in physical, psychological, and social aspects. School games open a door to the social world and culture and enable student development, making students more creative, flexible, and attentive to individual differences (Kamii, 2002).

In light of the aforementioned points, it is crucial to underscore that Piaget's theory of learning addresses the issue of socialization in the construction of personality, which is predicated on intellectual exchanges between individuals. Accordingly, during the learning process, the subject selects the information he receives from the outside world, filters it, and endows it with meaning (Piaget, 1977). Consequently, the school environment assumes a pivotal role in the cultivation of logical forms of thinking[6].

In this line of interpretation, Kamii (2002) asserts that "difference is a relationship created mentally by the individual when he relates two or more objects" (P.14). This perception is also established when making intuitive arrangements, but the construction of the concept does not occur. Consequently, pedagogical practices must be thoroughly incorporated into a comprehensive education, one that is meticulously designed for the purpose of facilitating learning (Vayer, 1977, p.172). It is imperative to

[6] Teachers provide stimuli that differentiate and shape neural circuits during learning, contributing to the structural reorganization and development of the nervous system. These stimuli are picked up by sensory receptors and converted into electrical impulses, resulting in new behaviors (Kandel, Schwartz, & Jessel, 2003).

emphasise that this understanding can engender numerous benefits during the teaching-learning process, in the sense of contributing to the enhancement of cognitive development.

## FINAL CONSIDERATIONS

Considering the issues presented, it became clear that, despite the limitations imposed on the study of human behavior, significant progress has been made, including discoveries that have enabled a more scientific approach to the teaching-learning process, as they clarify some of the mechanisms responsible for important mental functions in learning. These advances go beyond the academic sphere, as pointed out by Guerra (2011), extending to other fields of knowledge, among which, in a privileged position, is education."

In light of the research results, the understanding of brain functioning and its relationship with human behavior is not a recent task in science, given its importance, especially for education, with the aim of helping students to better deal with their potential and difficulties, as well as assisting teachers in reshaping educational practices and understanding the individual as a biopsychosocial being, that is, in a holistic way, who both affects and is affected by others. In this regard, the learning individual must have their choices respected within their social interactions, since they already make their own choices regarding socially constructed habits (Boff, 1999).

From this perspective, integrating the studies of theorists such as Ausubel, Piaget, and Vygotsky, it is evident that meaningful learning presupposes the existence of biological maturation, a social environment conducive to learning, and the preexistence of concepts anchored in the individuals' cognitive structure. In this sense, according to Moraes and Torre (2004, p. 4), when an individual interacts with others and with the environment, establishing a bridge between new learning and that already internalized in their structure, they act and develop, not only in the cognitive aspect through simple recording of observations but develop in all aspects.

Indeed, the research also revealed that people possess an extremely diverse set of different intelligences and that neuroscience can contribute significantly to learning, inspiring educational goals and strategies and developing more appropriate pedagogical mechanisms. In times of increasingly advanced technologies, it becomes necessary to rethink practices and strategies aimed at constructing meaningful learning. For all these reasons, it can be affirmed, based on Silva and Bezerra (2011), that neuroscience and its contributions to the understanding of brain functioning acquire great importance for the field of education. In summary, there is thus a perceived need for change, not only regarding school practices but also in the understanding of how learning occurs and what happens when we learn, a contribution that, as we have seen, can be provided and supported by neuroscience.

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