v. 3, n. 26, 2023

International Journal of Human Sciences Research

CONCEPTUAL PRINCIPLES OF NEUROLEARNING

Marlon Robles-Duran
Postgraduate Faculty, Master in Neurorehabilitation, Universidad Manuela Beltrán. Bogotá, Colombia
https://orcid.org/0009-0004-1951-8683

Yolima Suarez-Bohorquez
Postgraduate Faculty, Master in Neurorehabilitation, Universidad Manuela Beltrán. Bogotá, Colombia
https://orcid.org/0009-0002-0072-9961

Steve Fernando Pedraza-Vargas
Associate Professor of the Doctorate in Psychology, Universidad Santo Tomas. Bogotá, Colombia
https://orcid.org/0000-0001-6332-8052

Yuliana Guzmán-Jiménez
Postgraduate Faculty, Master in Neurorehabilitation, Universidad Manuela Beltrán. Bogotá, Colombia
https://orcid.org/0009-0004-3852-7024

Daniela Herrera-Marmolejo
Postgraduate Faculty, Master in Neurorehabilitation, Universidad Manuela Beltrán. Bogotá, Colombia
https://orcid.org/0009-0004-9488-996X

Andrea Marcela Medina-Rodríguez
Postgraduate Faculty, Master in Neurorehabilitation, Universidad Manuela Beltrán
Bogotá, Colombia
https://orcid.org/0009-0008-5485-2248

Abstract: Understanding the biological bases of learning will make it possible to optimize pedagogical planning in educational establishments, facilitate the assimilation and accommodation of complex content, improve student academic performance, and reduce the risks of dropout associated with low academic skills. This essay, then, intends to review the fundamental principles of neurolearning to facilitate the design of neuro-pedagogical strategies that promote neural connections that allow the acquisition of knowledge in a lasting way. Concepts about learning supported by theoretical models, biological bases of learning and neurolearning are presented. The approach of these concepts allows to guide the discussion of the subject and serves as a basis for new research on neuro pedagogy and social neurosciences.
Keywords: Learning, neuro learning, neuro pedagogy, social neurosciences.

INTRODUCTION

Learning is a process by which a subject, in his interaction with the environment, incorporates the information that it provides him and according to his needs and interests, shapes neural structures, adapts his behavior and creates or redirects the relationship with his environment. The brain is modified daily depending on the experiences received, that is to say: tomorrow we will have a different brain than today (Rivera, 2019).

Regarding the search to understand how we learn, it can be affirmed that learning is the ability of the brain to shape and organize itself according to constantly changing environmental stimuli (Figueroa H., 2020). It is said that by the principle of brain plasticity it is possible to learn at all stages of life.

The brain can be trained and modeled according to stimuli. As Rivera (2019) refers, neurological maturation in children is different in each one and it is important to respect these maturation rhythms, which have a direct impact on learning. Already in adulthood the brain continues to change and this is proportional to the way in which we use the brain intellectually speaking. For older people, intellectual exercise allows delaying the aging of the brain when it remains active.

In theory, the brain never rests, it is processing information from the environment all the time and with greater demand when doing intellectual work. This organ is the one that controls all the functions of the body and for learning purposes, the so-called higher functions intervene in it, such as: perception, attention, reasoning, motivation, memory, emotional experience and social behavior (Velásquez et al., 2009).

This essay aims to make a general review of the fundamental principles of neuro learning to facilitate the design of neuro pedagogical strategies that promote neural connections that allow the acquisition of knowledge in a lasting way. Concepts about learning supported by theoretical models, biological bases of learning and neurolearning are presented.

LEARNING AND COGNITION

Over the years, research in psychology has studied the factors involved in learning and has agreed that people learn differently and that these differences are influenced by the social context, family structure, culture, and styles. of learning (Pallares & Richart, 2018; Demera & López, 2020).

Based on these individual characteristics to learn, several authors have proposed models from the understanding of the different learning styles, including the one proposed by Roger Sperry, mentioned by García (2019) in his article: "Learning models as tools and techniques to enhance the academic trajectory of the university", who maintains that the two-hemisphere model consists of

each hemisphere being in charge of certain functions, controlling half of the opposite side of the body. Ensuring that the left hemisphere of the human brain is in charge of language, analytical, logical and rational thought; while the right hemisphere is in charge of spatial location, the ability to express and understand emotions.

David Kolb in 1984, refers that learning depends on the perception of information involving the senses and the processing of said information and consists of four stages: concrete experience, reflective observation, abstract conceptualization and active experimentation. Based on these premises, he proposes in his model that learning is a cycle that includes experimentation, continues with the reflection of what is experienced, then comes a stage of theoretical elaboration based on reflection and, finally, putting the theory into practice. elaborate.

Later, Honey and Mumford propose that learning depends to a large extent on the attitudinal and behavioral component, developing their model from the four stages proposed by Kolb, resulting in the learning styles being: active, theoretical, pragmatic and reflective. adding that each individual has a preference for one or more of the stages (Rodríguez, 2018).

Paul MacLean (1990), with his research, proposed the model of the triune brain that explains that the brain is made up of three levels that developed according to human evolution; the first level is the most primitive and is responsible for subsistence processes; the second is the intermediate level, the one that manages emotions, memory and non-conscious perception; Finally, the third level is in charge of processing thoughts, carrying out intellectual and cognitive processes (García, 2019).

BRAIN AND NEURAL CONNECTIONS

Regarding the brain, some authors such as Jensen in his book: *Cerebro y aprendizaje: Competencias e implicaciones* (2004) points out that the brain is made up of "78% water, 10% fat and 8% protein" (p. 22), made up of millions of nerve cells such as neurons and neuroglia, also called glial cells. The brain is divided into two hemispheres, left and right, each of which is further subdivided into four lobes, frontal, parietal, occipital, and temporal. One of the knowledge-based learning patterns of the brain is that if the central nervous system is stimulated with different stimuli, it favors the formation of neural connections (Jensen, 2004).

Continuing with the brain, it is known that it is made up of neurons, which are made up of the cell body, which contains the metabolism of the neuronal cell; the dendrites, which are the receivers of information; the axon, which can be very long and is the one that conducts the neuron's information and is covered with myelin, the facilitator of high-speed electrical conduction; and the synaptic terminals, which are the ones that manage to contact the receptive zone of another neuron. The area of contact between neurons is called synapse, from here it is ensured that the main function of the neuron is aimed at generating electrical signals. The aforementioned neurons are accompanied by another type of cell that is more abundant and is called glia. There is a greater number of glial cells, but they do not have the property of actively generating electrical signals and their functions are support for neurons, more precisely, cleaning the products of metabolism or cell death; They are also the suppliers of myelin. When the brain develops, these cells guide neuronal migration and, finally, are responsible for the nutrition of neurons. It is thought that the human being has more than one hundred

billion neurons (Cardinali, 1992).

Neurons are organized by networks and the union between them is given by the synapse and learning depends to a large extent on this. For a synapse to happen, there must be some actors within the information flow. In the first instance, there is the presynaptic neuron that brings the information from the axon to the dendrites, the information reaches the next space known as the synaptic junction, where it passes through the presynaptic axon, reaches the postsynaptic dendrites and then the postsynaptic axon transmits the information to the following neurons, which do not touch each other and are approximately 40 nano millimeters between them, this space is called: synaptic space (Quintanar, 2010).

The synapse is divided into two modalities, the chemical and electrical synapses. In chemical synapses, the message is carried by a neurotransmitter that is released from the presynaptic membrane into the synaptic space and then passes to the postsynaptic membrane. For this reason, we know that the passage of information is unidirectional; the time it takes is called synaptic delay. In the electrical synapse there is no clear differentiation between structures, the synaptic cleft is very narrow and does not differentiate.

The junctions between synapses are known as tight, in this synapse there is no synaptic delay and impulse conduction is bidirectional. They are the least frequent synapses, however, they are disseminated throughout the central nervous system, unlike chemical synapses, which are the most common form of neural communication (Haines, 2013).

An important part of neuronal functioning are neurotransmitters, molecules released by depolarization of the presynaptic membrane that affect the postsynaptic membrane mediating neural chemical communication. This has a direct bearing on learning because, in short, during the synaptic process, thanks to the action of neurotransmitters, learning occurs. In times past it was thought that the only form of synapse was electrical; Subsequently, the existence of the chemicals we call neurotransmitters was confirmed (Rotger, 2018).

Since then, a great deal of research has been devoted to understanding the different types of neurotransmitters and their functions. Those that intervene in learning are: dopamine, serotonin, acetylcholine and norepinephrine, which, working together and in a balanced way, allow learning from each of their functions as described by Rotger (2018).

As Quintanar (2020) mentions, when knowledge is acquired, cognitive memory is put into operation, generating connections between neurons, which allow information to be sent to areas of the brain such as the cerebral cortex, the hippocampus and the amygdala, by the action of chemical messengers called neurotransmitters, which are released in the presence of bioelectric changes in neurons (Quintanar, 2020). Among the most important neurotransmitters are: glutamate, gamma-aminobutyric acid, acetylcholine, norepinephrine, dopamine, serotonin, endorphins, among others (Velásquez et al., 2009).

NEUROTRANSMITTERS AND LEARNING

Within the learning process, dopamine maintains attention levels and the storage of new information in long-term memory. It also has great relevance in the sensation of pleasure. Something important to highlight is that the most pleasant experiences generate greater ease of storage in memory (Glejzer et al., 2017; Zapet, 2020).

Another neurotransmitter is serotonin, more popularly known as the happiness hormone. Basically it influences perception, memory and learning. On the other hand, its

inhibition work acts on emotions such as anger and aggression, it also modifies processes such as body temperature and mood. Serotonin is required for the production of melatonin in the pineal gland, which has the function of controlling sleep. This neurotransmitter increases in roles such as leadership and interpersonal relationships, and decreases with contrary actions such as withdrawal (Glejzer et al., 2017).

Acetylcholine is another neurotransmitter involved in learning, it increases at times when we require greater attention and allows optimization of short-term memory and retention (Glejzer et al., 2017).

Finally, noradrenaline is the neurotransmitter that is most related to attention. This is derived from norepinephrine and its action generates activation of the cerebral cortex, alertness and regulates mood and mental and physical arousal; subsequently gives the ability to select information depending on the individual's learning need (Glejzer et al., 2017).

The neurotransmitters highlighted above are directly related to emotions, which play a fundamental role in learning. This is how neuroscience has shown that emotions are what manage to maintain curiosity (Salamanca, 2021) and motivation (Zapet, 2020). Similarly, they are useful for communication and are essential in reasoning processes and decision-making, that is, emotional and cognitive processes are inseparable. Making learning a pleasant experience from the emotions ensures the receptivity and memorization of information; On the contrary, negative and unpleasant emotions such as fear, anxiety or sadness generate great barriers to learning (Rivera, 2019).

NEUROLEARNING

Learning has always been an inherent characteristic of human evolution, hence the importance that, for neurolearning, it is necessary to understand the relationship between the functioning of the brain and how it learns in order to obtain knowledge that is significantly relevant to people. Considering the functioning of the brain in the acquisition of new knowledge allows having students with a better disposition to learn. This is how, currently, teachers have been trained in neurosciences to understand how the brain learns and begin to demonstrate the learning needs of their students (Demera & López, 2020).

Neurolearning seeks to optimize the functioning of the brain to enhance the processes involved in learning: attention, memory, language, reading, writing, reasoning, and emotions (Perez, 2019). For this reason, it is important to consider how the brain learns and this includes: neurophysiology, neural structures, synapses and neurotransmitters. This way, a clearer relationship between neurolearning and emotions can be seen as a facilitator of learning.

Neurolearning combines psychology, pedagogy and neuroscience with the aim of explaining how the brain learns. From here it is possible to determine learning processes that adapt to the diversity of brains found in a classroom. For this reason, pedagogical plans in educational establishments must take into account the principles from neurolearning to develop teaching processes with positive results. The subjects can include neuropedagogical strategies that take into account the emotions and stimuli necessary to build knowledge, but also to memorize and solve problems, all based on the functioning of the brain. As Demera (2020) refers, when something new is learned, the brain changes its structure and its connections, even generating

new neural interconnections, some with much more strength than others. Making these neural connections occur more frequently and making the learning experience more and more enriching and lasting is called brain plasticity, defined as the modeling capacity that a brain possesses in the face of daily stimulation and the experience of interaction in the atmosphere. Due to the above, we could affirm that within the direct environment are the classes, the classroom and the teacher (Demera & López, 2020).

In the same order of ideas, the approach to neurolearning allows the teacher to capture the differences in neural connections, emotion management and plasticity of each brain that is in the classroom, which will directly favor the teaching work.

The fundamental basis of neurolearning is based on two factors: the first, called conscious or explicit learning, part of the fact that learning is also a decision made by the student and it will be important for them to recognize their achievements in order to maintain the levels of motivation and commitment and that also places the student at the center of his own learning process. (Pherez et, al., 2018; Mora, 2022; Rivera, 2019).

The second basic factor of neurolearning is called metaconscious or implicit, in a few words, it is learning without being conscious, this is given by practice and repetition and nonconscious competence is generated (Rivera, 2019).

To be aware of this capacity that the brain possesses, teachers have a powerful tool to enhance learning and neural plasticity through brain gym activities, making it part of the classroom experience, preparing students for the Conflict resolution through creative, different and unconventional proposals, while promoting curiosity, nonconformity and proactivity, developing new connections and skills in the brain of students that allow them to adjust to the demands of their environment.

For the current teacher, experience and knowledge in pedagogy is not enough, they are required to know and apply the biological bases of learning and their implications for emotions and how they affect cognitive processes. Although it is true that master classes are a valid method for students to appropriate knowledge, it is also important to use other types of strategies that broaden the vision of teachers about other ways of learning such as dialogue, debates and discussion. didactic questioning (Tacca et al., 2019). Workshops can even be used as relaxation and self-knowledge strategies and at the same time promote spaces for integration, coexistence among peers, teacher-student approach including assertive, inclusive and motivating language (Figueroa & Farnum, 2020). These strategies will help to avoid stress, restlessness and leaving studies early (Pherez et al., 2018).

Pherez (2018) also points out that it is important to apply different neurolearning strategies to teaching to generate better results in the student's learning process. The strategies would contribute to perfecting said practice in three components: conceptual, procedural and attitudinal. Furthermore, Tacca et al. (2020) consider that for this reason it is necessary for teachers to be permanently trained to carry out a teaching practice according to the needs of their students and generate innovative strategies that promote abilities and skills with a view to meaningful learning and contribute to their cognitive, physical development. and emotional (Ñamoc, 2022).

Aguirre in his research article: "Neuroeducation: innovative strategy in the student teaching-learning process" (2022) argues that teachers must combine creativity and neuroscience in order to know and use didactic strategies that favor a new way of teaching and learning.

Thanks to the advances in recent research

in the field of neuroscience, a very close relationship has been found between the emotional state of students and their academic performance, showing a low level of performance in working memory and executive functions such as decision making. decision-making and problem solving in situations of stress, anxiety or anger; the latter being generated by particular situations of the student and mostly by factors such as excessive academic load, lack of time to comply with academic activities and the performance of evaluations according to Pimienta et al. (2016) in their article "Anxiety and sources of academic stress in health career students".

FINAL CONSIDERATIONS

From the construction of pedagogical plans in educational establishments, the principles of neurolearning must be taken into account to obtain better results with students. The teacher who understands these concepts will be able to plan their classes, capturing the attention and procuring the learning of their students. The content of the classes will be dynamic, experiential, constructive and rewarding for the student, because what neurolearning proposes is to differentiate in the midst of a group of students the variety of brains that respond to varied stimuli, linked to emotions and that activate those brain circuits in each person, and thus achieve learning through words, sounds, emotions, sensory and motor experiences (Aguirre, 2022).

The information must be presented in an attractive, multisensory, multipurpose, structured and organized manner. Individual or collaborative instructional strategies that emphasize comparisons, relationships, integration and construction of knowledge, through the significant use of examples and counterexamples, must be favored.

It must be noted that current technological advances in neuroimaging have confirmed the biological evidence of the psychological theories on which process-based learning is based. However, research suggests that "the bridge" between neurosciences and education is still uncertain and complex. Therefore, it would be useful to have more information about the biases, curves, and detours in this path, and to know how neural events help guide the incipient journey of this area of social neurosciences.

REFERENCES

Aguirre, L. E. (2022). La Neuroeducación: estrategia innovadora en el proceso de enseñanza aprendizaje de los estudiantes. *Dominio de las Ciencias, 8*(2), 466-482. https://doi.org/http://dx.doi.org/10.23857/dc.v8i2.2656

Cardinali, D. P. (1992). *Manual de neurofisiología.* Diaz de Santos S.A.

Demera, K. C., & López, L. S. (2020). *Neuroaprendizaje como propuesta pedagógica en educación básica.* Eumed: https://www.eumed.net/rev/atlante/2020/04/neuroaprendizaje-propuesta-educacion.html

Figueroa, C., & Farnum, F. (2020). La neuroeducación como aporte a las dificultades del aprendizaje en la población infantil. Una mirada desde la psicopedagogía en Colombia. *Revista Universidad y Sociedad, 12*(5), 17-26. http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S2218-36202020000500017

Figueroa, H. (2020). Neurociencias y educación basada en competencias. *Revista Dialogo Interdisciplinario Sobre Educación, 2*(2), 12-30.

García, C. (2019). Los modelos de aprendizaje como herramientas y técnicas para potenciar la trayectoria académica del universitario. *Revista Cubana de Educación Superior, 38*(3). http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0257-43142019000300017&lng=es&tlng=pt.

Glejzer, C., Ciccarelli, A., Maldonado, A., Bulit, F., Chomnalez, M., Facchinett, C., & Ricc, A. (2017). *Las bases biológicas del aprendizaje.* Editorial de la Facultad de Filosofía y Letras Universidad de Buenos Aires.

Haines, D. (2013). *Principios de Neurociencia: Aplicaciones básicas y clínicas.* Elsevier Saunders.

Jensen, E. (2004). *Cerebro y aprendizaje: competencias e implicaciones educativas.* Narcea, S.A. De Ediciones.

Mora, A. (2022). El neuroaprendizaje, como ayudantía educativa: Estrategia para mejorar la práctica docente. *Journal of Science and Research, 7*(3), 110–134. https://revistas.utb.edu.ec/index.php/sr/article/view/2825

Ñamoc, L. R. (2022). La neuroeducación y el aprendizaje en la educación infantil. *Tesis de grado.* Universidad Cesar Vallejo, Trujillo.

Pallares, D., & Richart, A. (2018). Entre la neuroética y la neuroeducación: las fronteras de las neurociencias sociales. *Recerca: revista de pensament i anàlis*(22), 7-13.

Perez, C. (2019). *Relación entre emociones y cognición en la enseñanza del inglés en educación superior.* [Tesis especialista, Universidad Piloto de Colombia]. Repositorio institucional Universidad Piloto de Colombia. http://repository.unipiloto.edu.co/handle/20.500.12277/6524

Pherez, G., Vargas, S., & Jerez, J. (2018). Neuroaprendizaje una propuesta educativa: herramientas para mejorar la praxis del docente. *Civilizar Ciencias Sociales y Humanas, 18*(34), 149-166.

Pimienta, C. (2016). Ansiedad y fuentes de estrés académico en estudiantes de carreras de la salud. *Investigación en educación médica, 5*(20), 230-237.

Quintanar, J. (2020). Bases biológicas de la memoria en el aprendizaje. *Investigación y Práctica en Psicología del Desarrollo, 6*, 93-103.

Quintanar, J. L. (2010). *Neurofisiología Básica.* México: Universidad Autónoma de Aguascalientes.

Rivera, E. (2019). El neuroaprendizaje en la enseñanza de las matemáticas: la nueva propuesta educativa. *Revista entorno*(67), 157-168.

Rodríguez, R. (2018). Los modelos de aprendizaje de Kolb, Honey y Mumford: implicaciones para la educación en ciencias. *Sophia, 14*(1), 51-64. https://doi.org/http://dx.doi.org/10.18634/sophiaj.14v.1i.698

Rotger, M. (2018). *Neurociencias Neuroaprendizaje. Las emociones y el aprendizaje Nivelar estados emocionales y crear un aula con cerebro.* Brujas.

Salamanca, A. (2021). Estrategias Neurodidácticas de Enseñanza Aprendizaje para la Investigación Jurídica. *Revista Tecnológica-Educativa Docentes 2.0, 11*(1), 11-18. https://doi.org/https://doi.org/10.37843/rted.v11i1.142

Tacca, D. R., Tacca Huamán, A., & Alva Rodriguez, M. A. (2019). Estrategias neurodidácticas, satisfacción y rendimiento académico en estudiantes universitarios. *Cuadernos de Investigación Educativa, 10*(2), 15-32. https://doi.org/https://doi.org/10.18861/cied.2019.10.2.2905

Velásquez, B., Remolina de Cleves, N., & Calle Márquez, M. G. (2009). El cerebro que aprende. *Tabula Rasa*(11), 329-347. http://www.redalyc.org/articulo.oa?id=39617332014

Zapet, A. (2020). El Aprendizaje del Estudiante Universitario como Sistema Vivo. *Revista Cientí¬fica Del Sistema De Estudios De Postgrado De La Universidad De San Carlos De Guatemala, 3*(1), 67–71. https://doi.org/https://doi.org/10.36958/sep.v3i01.38