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# Neuroscience in Education: Innovation and Change

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**Abstract**

The concept of applying neuroscience to education seeks to bridge the gap between scientific brain research and everyday pedagogical practice. It is not about turning teachers into neurologists, but rather providing them with a scientific framework that allows them to understand how the brain learns in order to design more effective and meaningful teaching strategies. The objective was to explore how neuroscience can contribute to the educational process; the methodology applied was a bibliographic review and the inductive-deductive method. The result was that neuroscience plays an important role in the process of innovation and change in the teaching-learning process, where 11th-century strategies play an essential role in improving the educational process and integrating students into them.



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## 1 Introduction

Educational neuroscience is an emerging interdisciplinary field that seeks to bridge the gap between the findings of neuroscientific research and pedagogical practice, aiming to transform teaching and learning processes based on empirical evidence. Its essential purpose is to replace intuitive conceptions, erroneous beliefs, or myths about brain function with educational strategies grounded in scientific knowledge, aimed at enhancing learning, memory, and the holistic development of students (Privitera & S.H.S. Ng, 2023).

Human learning is made possible by neuronal plasticity. This phenomenon describes the nervous system's ability to reorganize and strengthen its synaptic connections as a result of experience and environmental stimulation (Sierra & León, 2019). In this process, information enters through the senses, is processed in working memory, and, if it acquires relevance and meaning, is transferred to the memory system for temporary or permanent storage. The hippocampus plays a crucial role in long-term memory consolidation, while neurotransmitters act as chemical messengers that facilitate neuronal communication. Factors such as attention, motivation, and the emotional charge of experiences significantly modulate the effectiveness of this process (Carrillo, 2010).

Educational neuroscience is an interdisciplinary field that seeks to understand how brain processes influence learning and teaching, to optimize pedagogical practices. This discipline integrates knowledge from cognitive neuroscience, educational psychology, and didactics, providing a scientific basis for designing strategies that improve academic performance and the overall development of students (Goswami, 2006).

In recent decades, advances in neuroimaging techniques, such as functional magnetic resonance imaging (fMRI) and electroencephalography (EEG), have made it possible to explore how the brain processes, stores, and retrieves information, as well as the factors that facilitate or hinder these processes (Tokuhama-Espinosa, 2010). These findings have shown, for example, that learning is more effective when neural networks associated with motivation, attention, and long-term memory are activated (Sousa, 2017).

However, the application of neuroscience in education is not without challenges. One of the main ones is translating scientific findings into practical pedagogical strategies, avoiding oversimplification or misinterpretation of concepts (Howard, 2014). Furthermore, it is crucial to consider students' cognitive diversity, since factors such as age, sociocultural context, and individual differences influence how the brain learns (Immordino, 2016).

It is pertinent to note that educational neuroscience opens up transformative horizons for educational systems by offering tools that allow for personalized learning processes and more effectively address student diversity. The recognition that each brain learns uniquely drives the need to design flexible educational environments that are sensitive to individual differences and capable of stimulating both cognitive and socio-emotional skills. In this way, neuroscience not only enriches our understanding of the brain mechanisms involved in knowledge acquisition but also fosters the development of innovative methodologies that integrate creativity, motivation, and self-regulation as essential elements for quality education. Consequently, the incorporation of this approach into educational practice represents a paradigm shift that demands interdisciplinary collaboration between scientists, educators, and public policymakers, ensuring that neuroscientific knowledge translates into real and sustainable improvements in teaching and learning (Smith et al., 2013).

In this sense, neuroscience applied to education not only represents a scientific advance but also an opportunity for innovation and change in the way educational policies, teacher training, and classroom practices are conceived. This paper examines the theoretical foundations, practical applications, and limitations of neuroscience in education, with the goal of offering a comprehensive view that enables educational stakeholders and public policymakers to make informed decisions based on scientific evidence aimed at improving educational quality (Chen, 2011).

## 2 Materials and Methods

This research was conducted using a descriptive approach, based on a comprehensive analysis of scientific literature related to the application of neuroscience in education. The central objective was to identify and systematize the contributions of this interdisciplinary field, with a view to strengthening the continuity and quality of teaching performance, as well as the relevance of teaching methods in contexts of innovation and pedagogical change.

For data collection, inclusion and exclusion criteria were defined to define the scope of the study. Articles, books, and academic documents published in Spanish and English during the last two decades that directly addressed the relationship between neuroscience, learning, and education were considered. Non-refereed studies, popular publications without scientific support, and documents whose topics were not related to the research objectives were excluded.

The bibliographic search was conducted in international and regional databases such as Scielo, Scopus, Latindex, Dialnet, Google Scholar, and complemented with key sources in cognitive neuroscience, educational psychology, and pedagogy. Each selected source underwent a critical analysis process, assessing its methodological quality, thematic relevance, and relevance to the understanding of the object of study (Lam, 2024).

The information was systematized by identifying analytical categories that allowed the findings to be organized around main thematic axes: theoretical foundations of educational neuroscience, practical applications in the classroom, contributions to teacher training, and limitations in their implementation. To this end, data related to the objectives, methodologies, variables studied, and conclusions of the reviewed documents were extracted and compared.

This methodological approach enabled a comprehensive interpretation of the literature reviewed, favoring the identification of trends, research gaps, and significant contributions. This established a solid foundation for academic discussion on the role of neuroscience as a driver of innovation and change in contemporary education.

## 3 Results and Discussions

*Neuroscience in education*

It is a topic that must be addressed in the teaching process because there is a gap between what science knows about the brain and how it influences the learning process. In many cases, this lack of knowledge can immediately generate interest and debate. These combine research from various academic disciplines to collaborate with educators in the development of innovative teaching practices (Palma et al., 2025). These authors found that neuro-educational strategies, such as the use of neuroscientific principles and recreational activities, improve cognitive processes such as attention and memory.

Findings were also found in the use of neurodidactics to enhance learning. Some authors, such as Valverde et al. (2025), recognize the importance of understanding how the brain works in the learning process, as well as the need to address the individual needs of students to promote their academic success.

*Contribution of neuroscience to education*

Neuroscience offers fundamental tools and knowledge to transform education, allowing us to understand how the brain learns and how teaching processes can be optimized. Figure 1 below shows some of the main contributions of this discipline.

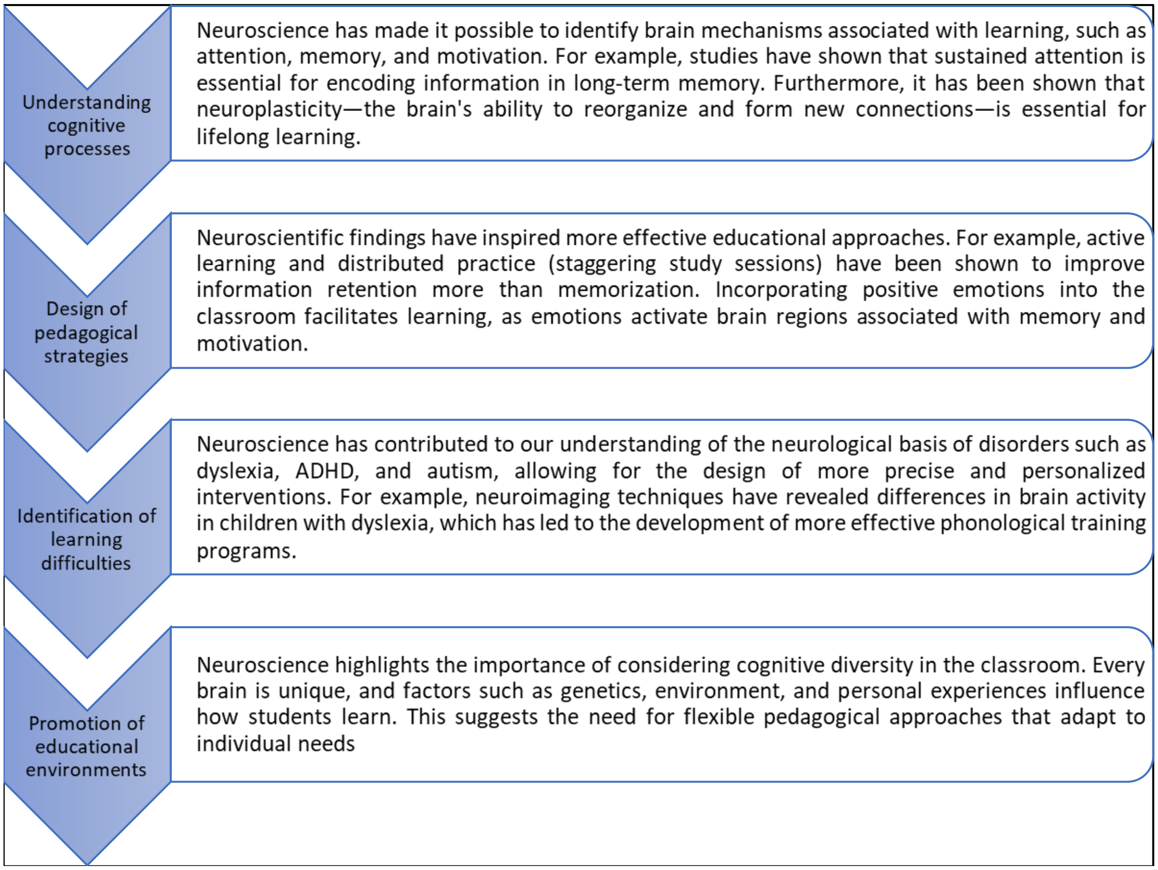


Figure 1. Main contributions of Neuroscience to education
Source: (Posner & Rothbart, 2007); (Mundkur, 2005); (Roediger & Butler, 2011); (Immordino & Knecht, 2020); (Shaywitz & Shaywitz, 2008); (Howard-Jones, 2014); (Goswami, 2006).

Another of the fundamental contributions of neuroscience to education lies in the promotion of student well-being, an aspect that constitutes a central axis in the relationship between emotional development and academic performance. Various studies have shown that emotional well-being not only influences motivation and disposition to learn but also acts as a direct modulator of memory, attention, and other higher cognitive functions. Chronic stress, for example, negatively affects neuroplasticity and the functioning of key brain structures, such as the hippocampus and the prefrontal cortex, which impacts the ability to concentrate, decision-making, and consolidation of long-term memory (McEwen & Gianaros, 2010). In contrast, a safe, inclusive, and emotionally stimulating school environment promotes the activation of neural circuits linked to intrinsic motivation, self-regulation, and deep learning.

Neuroscientific evidence underscores the need for teachers to design and implement pedagogical strategies that intentionally integrate the cognitive and socio-emotional dimensions of learning. This entails recognizing attention, motivation, individual diversity, and reflective practice as essential components of the educational process. Incorporating these variables into teaching practice allows not only to optimize academic performance but also to enhance the comprehensive development of students in their human dimension. Thus, the knowledge provided by neuroscience offers educators a solid foundation for structuring learning experiences that promote resilience, creativity, and emotional well-being, consolidating a more humane, inclusive, and effective pedagogical model.

Based on the findings of neuroscience applied to education, teachers must assume an active role in implementing pedagogical strategies that integrate both cognitive processes and socio-emotional aspects of learning. These strategies allow scientific evidence to be translated into concrete classroom practices, promoting not only academic performance but also the overall well-being of students. Table 1 summarizes the main actions that teachers can take to implement the contributions of neuroscience to education, aimed at strengthening motivation, attention, memory, and emotional development in the teaching-learning process.

Table 1
Teacher strategies to complement the contributions of neuroscience to education.

| Contribution of Neuroscience | Teaching Strategy |
|---|---|
| The brain learns best in safe and positive environments. | Create a climate of trust, use positive reinforcement, and foster empathy. |
| Meaningful learning is enhanced by relating new content to previous experiences. | Connect lessons to everyday life and design practical activities. |
| Attention is key to memory and learning. | Vary resources (visual, auditory, kinesthetic), take active breaks, and segment content. |
| Brain plasticity is strengthened with repeated and varied practice. | Propose graded exercises, with continuous feedback and application in different contexts. |
| Every brain learns differently. | Address the diversity of learning styles through different methodologies and technologies. |
| Metacognition improves autonomy and self-regulation of learning. | Teach how to plan, supervise, and evaluate one's own learning process. |
| Movement stimulates concentration and cognitive performance. | Incorporate active breaks, group dynamics, and small physical exercises. |
| Motivation and curiosity release dopamine, which promotes learning. | Propose projects, educational games, and motivating intellectual challenges. |
| Sleep and rest consolidate memory. | Regulate academic load, avoid homework overload, and promote healthy habits. |
| Feedback improves the consolidation of learning. | Use formative assessment, provide constructive feedback, and value the process, not just the outcome. |

Source: Own elaboration

As can be seen, there are different strategies that will help teachers to fulfill the contributions of neuroscience in education. This can be achieved; they only need to be able to plan according to the needs of their students so that they can improve learning in the classroom.

Neuroscience offers a scientific framework for understanding and improving learning, providing tools for designing more effective pedagogical strategies, identifying and supporting struggling students, and promoting inclusive and emotionally healthy educational environments. However, educators and policymakers must rigorously interpret and apply these findings to ensure the proposal's success in the classroom.

In order to clearly visualize the relationship between neuroscience and pedagogical practices, a conceptual diagram was developed that organizes the main methodological approaches used by teachers in the teaching-learning process. This graphic representation facilitates the understanding of how neuroscientific findings can be integrated into educational practice, showing in a structured way the connection between cognitive processes, teaching strategies, and results in the integral development of students. In Figure 2. This conceptual diagram is presented, which details the methodologies applied by teachers and their connection with the optimization of learning.

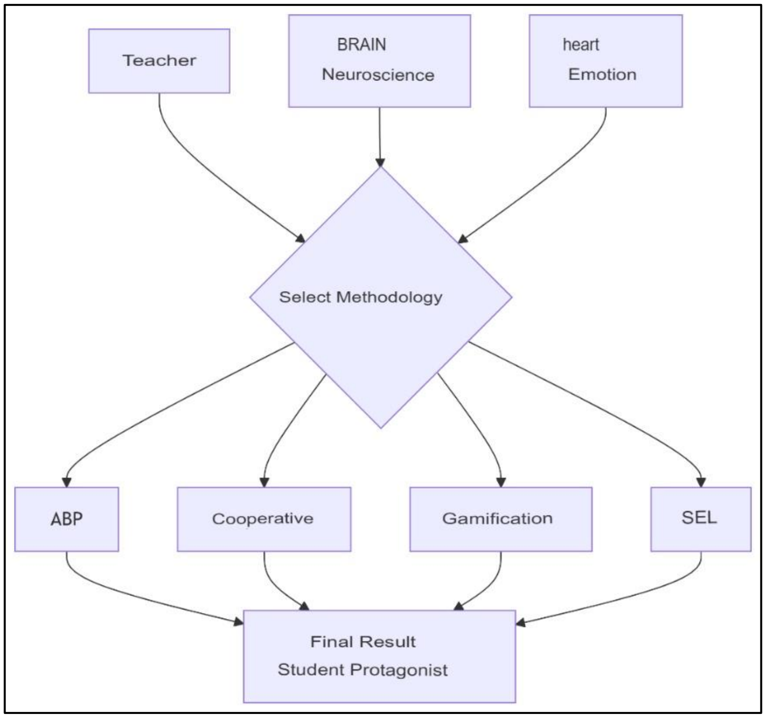


Figure 2. Methodologies applied by teachers
Source: (Portero & Medina, 2025)

The pedagogical process begins with the teacher as a designer of learning experiences, responsible for selecting and implementing methodologies based on clearly defined educational objectives. This selection is not arbitrary, but is based on two essential cross-cutting dimensions: on the one hand, neuroscientific evidence, which provides rigorous knowledge about the cognitive and emotional processes involved in learning; and, on the other, the socio-emotional dimension, which recognizes the determining role of emotions in motivation, attention, and memory consolidation.

Within this framework, methodologies such as Project-Based Learning (PBL), Cooperative Learning, Gamification, and Social-Emotional Learning (SEL) gain relevance by focusing on the development of specific competencies in students. Each of them contributes to stimulating key cognitive and socio-affective processes, such as creativity, collaboration, intrinsic motivation, and emotional self-regulation, promoting comprehensive and meaningful learning.

Specifically, PBL represents a transformative pedagogical strategy, transforming the classroom into a dynamic space where theory is directly linked to practice. Under this approach, students are not limited to passively receiving information, but actively participate in problem-solving and creating tangible products that respond to real-life contexts. This methodology fosters critical thinking, research skills, autonomy, and the transfer of knowledge to everyday situations, preparing students to more robustly face the academic and social challenges of today's world. Table 2 summarizes the main contributions of PBL to the teaching-learning process in the classroom, highlighting its impact on both cognitive development and the comprehensive training of students.

Table 2
Contributions of PBL to the teaching-learning process

| Impact Area | Input |
|---|---|
| Academic | Deep understanding, practical application of knowledge, integration of disciplines. |

| Impact Area | Input |
|---|---|
| Skills | Critical thinking, creativity, collaboration, communication, problem solving. |
| Emotional | Motivation, autonomy, sense of purpose, resilience. |
| Social | Teamwork, empathy, responsibility, civic awareness. |

Source: (Zambrano, Hernández, & Mendoza, 2022)

Within the set of active methodologies based on the contributions of neuroscience to education, cooperative learning occupies a prominent place, promoting not only the acquisition of knowledge but also the strengthening of social and emotional skills essential for students' comprehensive development. This methodology is based on group interaction as a driving force of learning, allowing students to construct shared knowledge, enhance communication, develop empathy, and strengthen their ability to work as a team. In this way, cooperative work contributes to the creation of more inclusive, collaborative, and meaningful educational environments. Table 3 presents the main contributions of cooperative learning to the teaching-learning process, highlighting its unique and transformative benefits within the school environment.

Table 3
Contributions of cooperative work

| Impact Area | Input |
|---|---|
| Academic | Greater retention and understanding of content through discussion and peer teaching. |
| Skills | Collaboration, communication, critical thinking, and interpersonal problem-solving. |
| Emotional | Emotional intelligence, empathy, self-esteem, and a sense of usefulness within a group. |
| Social | Inclusion, group cohesion, social responsibility, and democratic citizenship. |
| Assessment | Complete overview of individual and group skills. |

Source: (García & De la Peña, 2024)

Cooperative learning transcends the traditional notion of group work, becoming a structured methodology that fosters co-responsibility, positive interdependence, and the collective construction of knowledge. Through this dynamic, students learn that collaboration enhances results and that cooperation is a fundamental skill for academic, professional, and social life.

Likewise, it is important to highlight the relevance of emerging methodologies such as gamification and social-emotional learning (SEL). While each provides specific benefits to the educational process, their strategic integration generates a synergistic effect capable of enhancing motivation, active participation, and emotional management in the classroom. While gamification introduces playful dynamics that increase intrinsic motivation and task persistence, SEL strengthens essential social-emotional skills such as self-regulation, empathy, and resilience. The combination of both methodologies offers an innovative pedagogical framework that more comprehensively responds to students' current needs. Table 4 presents a summary of the fundamental contributions of gamification and socio-emotional learning, highlighting their individual and joint contribution to improving the quality of the teaching-learning process.

Table 4
Combination of gamification and Socioemotional learning

| SEL Skill | Application with Gamification (Example) |
|---|---|
| Self-management | Managing frustration at not passing a level the first time and persisting to try again. |
| Self-awareness | Reflect on how to overcome stress and assess what your best skills are. |
| Decision making | Strategically choose between different missions that may affect the team, and what would be the best decision. |
| Social Skills | Collaborate to achieve a good reputation for the team, which requires listening to and valuing everyone's ideas. |
| Empathy | In a role-playing game, understand the motivations of a historical or literary character. |

Source: (Peñafiel et al., 2025)

The culmination of the educational process, supported by the contributions of neuroscience and the application of active methodologies, is realized through authentic assessment, understood as a tool that transcends the mere measurement of content to evaluate the student's holistic development. This type of assessment focuses on the practical application of knowledge, the resolution of real-life problems, and the demonstration of transferable skills, which allows for the demonstration of not only cognitive achievements but also the social and emotional skills acquired throughout the educational process.

In this way, authentic assessment makes students the protagonists of their own learning, promoting autonomy, self-reflection, and the capacity for self-assessment. At the same time, it strengthens the connection between school learning and everyday life, facilitating the translation of acquired knowledge into meaningful and useful actions. In this sense, it constitutes an essential component to ensure that strategies derived from educational neuroscience not only generate academic results, but also a comprehensive and sustainable lifelong learning.

## 4 Conclusion

Neuroscience applied to education is a fundamental pillar of pedagogical innovation, allowing us to more deeply understand how the brain learns, processes information, and responds to various stimuli. This perspective offers teachers valuable tools to design and implement teaching strategies that not only promote knowledge acquisition but also enhance students' holistic development. In this context, teaching transcends its traditional role and becomes an exercise in mediation and support based on scientific evidence, ensuring that the teaching-learning processes respond to the cognitive, emotional, and social characteristics of each student.

The implementation of active methodologies such as PBL, Cooperative Learning, Gamification, and Socio-Emotional Learning finds solid support in neuroscientific findings. PBL stimulates the frontal lobes through the resolution of complex situations, promoting analytical skills, decision-making, and critical thinking. Cooperative

Learning, for its part, relies on synaptic plasticity by strengthening social skills, effective communication, and collective knowledge construction, elements that consolidate neural networks associated with social interaction. Gamification, thanks to the activation of dopaminergic reward circuits, fosters intrinsic motivation, enjoyment of learning, and persistence in the face of academic challenges. Finally, Socio-Emotional Learning contributes to strengthening the prefrontal cortex and circuits related to emotional self-regulation, which positively impacts stress management, empathy, and resilience.

In this way, the combination of these methodologies not only impacts academic performance but also promotes the development of transversal skills necessary for the contemporary context, such as creativity, collaboration, motivation, and emotional self-regulation. Evidence suggests that a pedagogical approach based on neuroscience is not limited to the transmission of knowledge but also enables the development of autonomous, critical, and emotionally balanced students, prepared to face the challenges of 21st-century society.

*Conflict of interest statement*

The authors declared that they have no competing interests.

*Statement of authorship*

The authors have a responsibility for the conception and design of the study. The authors have approved the final article.

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## References


Carrillo, P. (2010). Memory systems: historical review, classification, and current concepts. Part II: Long-term memory systems: Episodic memory, non-declarative memory systems, and working memory. *Mental health, 33*(2), 197-205.

Chen, J. L. (2011). The effects of education compatibility and technological expectancy on e-learning acceptance. *Computers & Education*, *57*(2), 1501-1511. https://doi.org/10.1016/j.compedu.2011.02.009

García, V. R., & De la Peña, G. (2024). Collaborative work as a pedagogical strategy to promote children's school coexistence. *Minerva Magazine, 5*(14), 40-5.

Goswami, U. (2006). Neuroscience and education: from research to practice Nature Reviews Neuroscience, 7, 406–413.

Goswami, U. (2006). Neuroscience and education: from research to practice?. *Nature reviews neuroscience*, *7*(5), 406-413.

Howard, P. A. (2014). Neuroscience and education: Myths and messages. *Nature Reviews Neuroscience, 15*(12), 817-824.

Immordino, M. H., & Knecht, D. R. (2020). Constructing meaning strengthens adolescents' brains. *ASCD, 7*(8).

Immordino, Y. M. (2016). Emotions, learning, and the brain: exploring the educational implications of affective neuroscience.APA PsycInfo.

Lam, T. N. (2024). Enhancing the quality of competency assessment for elementary school students in modern education. *International Research Journal of Management, IT and Social Sciences*, *11*(3), 93–101. https://doi.org/10.21744/irjmis.v10n3.2429

McEwen, B. S., & Gianaros, P. J. (2010). Central role of the brain in stress and adaptation: links to socioeconomic status, health, and disease. *Annals of the New York Academy of Sciences*, *1186*(1), 190-222.

Mundkur, N. (2005). Neuroplasticity in children. *The Indian Journal of Pediatrics*, *72*(10), 855-857.

Palma, S. P., Rizzo, M. O., Vera, M. A., & Palacios, S. M. (2025). Strategies in neuroeducation and emotion-based learning for classroom motivation. *Multidisciplinary Journal of Research Perspectives, 5*(1), 18–24.

Peñafiel, P. V., Ordoñez, B. K., & Fernández, L. (2025). Games and gamification as facilitators of student learning. *Inve Com Magazine, 5*(3).

Portero, F., & Medina, R. P. (2025). Theoretical study on Active Methodologies in basic education. *Espacios Magazine, 46*(1), 68-82.

Posner, M. I., & Rothbart, M. K. (2007). Research on attention networks as a model for the integration of psychological science. *Annu. Rev. Psychol.*, *58*(1), 1-23.

Privitera, A. J., Ng, S. H. S., & Chen, S. H. A. (2023). Defining the science of learning: A scoping review. *Trends in Neuroscience and Education*, *32*, 100206. https://doi.org/10.1016/j.tine.2023.100206

Roediger, H. L., & Butler, A. C. (2011). The critical role of retrieval practice in long-term retention. *Trends in cognitive sciences*, *15*(1), 20-27.

Shaywitz, S. E., & Shaywitz, B. A. (2008). Paying attention to reading: The neurobiology of reading and dyslexia. *Development and psychopathology*, *20*(4), 1329-1349.

Sierra, E. M., & León, M. Q. (2019). Brain plasticity, a neuronal reality. *Journal of Medical Sciences of Pinar del Río, 23*(4), 599-609.

Smith, P. F., Ganesh, S., & Liu, P. (2013). A comparison of random forest regression and multiple linear regression for prediction in neuroscience. *Journal of neuroscience methods*, *220*(1), 85-91. https://doi.org/10.1016/j.jneumeth.2013.08.024

Sousa, D. A. (2017). How the Brain Learns.

Tokuhama-Espinosa, T. (2010). *Mind, brain, and education science: A comprehensive guide to the new brain-based teaching*. WW Norton & Company.

Valverde, M. F., Ortiz, C. G., & Ortiz, W. (2025). Using neurodidactics to enhance seventh-grade students' learning. *Multidisciplinary Journal of Research Perspectives, 5*(1), 18–24.

Zambrano, M. A., Hernández, A., & Mendoza, K. L. (2022). Project-based learning as a teaching strategy. *Conrad, 18*(84), 172-182.