


**NEUROSCIENCES, COGNITION, AND EDUCATION: THEORETICAL-PRACTICAL  
INTERFACES FOR TEACHING PRACTICE** <https://doi.org/10.63330/aurumpub.022-019>

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**Education and Knowledge: Past, Present and Future**



## **ABSTRACT**

The integration between neurosciences, cognition, and education has significantly contributed to the understanding of teaching and learning processes, providing scientific support for teaching practice. This study aims to analyze the interfaces between neurosciences, cognition, and education, focusing on the contributions of neuroscience to the improvement of pedagogical practices and the promotion of meaningful learning. This is an integrative literature review with a qualitative, exploratory-descriptive approach, conducted in the SciELO, ERIC, and CAPES Periodicals databases, including studies published between 2015 and 2025. After applying the inclusion and exclusion criteria, twenty-two studies were selected for analysis. The results indicate that learning emerges from the interaction between cognitive, emotional, neurobiological, and contextual processes, highlighting the role of attention, memory, motivation, emotional self-regulation, and executive functions in academic performance. Furthermore, the findings emphasize that brain plasticity, respect for individual differences, the intentional use of educational technologies, and evidence-based teacher education are central elements for enhancing pedagogical practices. It is concluded that the integration between neuroscience and education provides solid foundations for a more reflective, inclusive, and scientifically grounded teaching practice.

**Keywords:** Neurosciences; Cognition; Education; Neuroeducation; Learning.



## INTRODUCTION

The rapprochement between neurosciences, cognition, and education has significantly contributed to understanding teaching and learning processes, offering scientific support that helps teachers make more effective pedagogical decisions. Studies in the field of neuroeducation indicate that knowledge about brain functioning enables the development of instructional strategies more closely aligned with the ways students learn, process information, and construct knowledge (Al Khassawneh; Al Sharif, 2025).

In this context, teaching practice comes to be grounded not only in empirical approaches but also in scientific evidence related to cognition, memory, emotions, and attention. Grossi, Oliveira, and Fonseca (2024) highlight that incorporating neuroscience contributions into the curriculum and teacher education fosters more reflective pedagogical practices, contributing to improved school performance and the promotion of meaningful learning.

Moreover, neuroeducation makes it possible to understand how emotional and cognitive factors directly influence the learning process. Silva, Santos, and Santos (2024) emphasize that emotions, memory, and motivation are central elements for learning, reinforcing the need for teachers to consider such aspects when organizing instruction. This approach broadens the view of the student, recognizing them as an integral subject with interdependent cognitive and affective dimensions.

The relationship between neuroscience and pedagogical practices also becomes evident in the construction of more effective teaching strategies. Coelho and Malheiro (2024) point out that using indicators of cognitive skills can help teachers plan activities that respect individual differences and enhance students' intellectual development.

Similarly, Brandão (2025) underscores that pedagogical strategies based on brain functioning positively impact school performance by promoting active methodologies and practices that stimulate participation, attention, and the consolidation of learning.

Given this, the present study aims to analyze the interfaces between neurosciences, cognition, and education, focusing on teaching practice, considering the contributions of neuroscience to improving pedagogical practices and promoting meaningful learning.

## METHODOLOGY

The study was developed through an integrative literature review, conducted in December 2025, with a qualitative approach and exploratory–descriptive nature. This type of review, as stated by Whittemore and Knafl (2005), allows for the collection, comparison, and synthesis of different types of scientific evidence, favoring a comprehensive and structured understanding of a given phenomenon.



## SEARCH PROCEDURES

The searches were guided by the leading question: “How do the interfaces between neurosciences, cognition, and education contribute to improving teaching practice and to qualifying teaching and learning processes?”

The Scientific Electronic Library Online (SciELO), Education Resources Information Center (ERIC), and the Portal de Periódicos of the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES Periodicals) were consulted, in addition to institutional repositories. Descriptors were used in Portuguese and English, combined with the Boolean operators AND and OR, including *(neurociência)*, *(cognição)*, *(educação)*, *(neuroeducação)*, *(aprendizagem)*, and *(processo cognitivo)*; and, in English, (neuroscience), (cognition), (education), (neuroeducation), (learning), and (cognitive process).

### **Inclusion and exclusion criteria**

Studies published between 2015 and 2025, available in full, that presented a direct interface between neuroscience and learning in educational contexts were included. Theoretical and empirical productions, reviews, and applied studies discussing the role of cognitive or emotional mechanisms in the learning process were selected. Duplicated articles, productions with an exclusively biomedical focus, and studies that mentioned the theme only superficially were excluded.

## STUDY SELECTION AND SAMPLE

The initial search resulted in 289 studies. After removing duplicates, 174 publications remained. Reading titles and abstracts led to the exclusion of 96 productions that did not meet the established criteria. Of the 85 articles submitted to full reading, 22 studies met all the requirements and comprise the final sample used for analysis.

## ANALYTICAL TECHNIQUES

The analysis followed Bardin’s (2016) procedures for thematic analysis, beginning with a floating reading of the material, which enabled familiarization with the content and the identification of the first units of meaning. After this stage, an initial coding was performed, grouping relevant excerpts that addressed the research objective. Next came categorization, when the codes were organized into broader thematic groups, eliminating repetitions and establishing relationships among ideas. This process made it possible to construct an interpretive synthesis that presents, in an integrated manner, neuroscience’s contributions to learning.



## RESULTS AND DISCUSSION

The twenty-two studies analyzed show that the interfaces between neurosciences, cognition, and education offer consistent theoretical and practical foundations for teaching practice. In general, the results indicate that learning stems from the interaction among cognitive, emotional, neurobiological, and contextual processes, reinforcing the need for pedagogical practices aligned with the scientific evidence produced in the field of neuroeducation.

### COGNITIVE AND EMOTIONAL PROCESSES IN THE CONTEXT OF LEARNING

The analyzed studies converge in indicating that cognition and emotion are inseparable dimensions of the learning process. Silva, Santos, and Santos (2024) show that memory and emotion operate in an integrated manner, directly influencing the consolidation of information and the permanence of school knowledge. These findings reinforce that positive emotional states favor attention, retention, and retrieval of information.

Complementarily, Brandão (2025) shows that pedagogical strategies grounded in brain functioning contribute to greater student engagement and better academic performance. Fraix (2025) deepens this discussion by indicating that understanding cognitive mechanisms enables teachers to select methodologies better suited to students' mental capacities, promoting more effective learning. Beltrão (2024) adds that applying neuroscience in the school context fosters the construction of educational environments more sensitive to students' cognitive and emotional needs. In this sense, Santos Ribeiro and Johnson (2023) point out that initial mastery of neuroscientific concepts contributes to pedagogical planning and the intentional organization of teaching practices.

### BRAIN PLASTICITY AND RESPECT FOR INDIVIDUAL DIFFERENCES

The results show that brain plasticity is a central principle for organizing pedagogical practices. Guimarães et al. (2023) demonstrate that recognizing neural plasticity favors teaching practices that stimulate multiple cognitive routes, expanding the possibilities for meaningful learning. These authors emphasize that a diversity of instructional strategies enhances cognitive development by respecting different learning styles and rhythms.

From the same perspective, Coelho and Malheiro (2024) indicate that constructing indicators of cognitive skills makes it possible to monitor students' development more individually and systematically. The systematic review conducted by Oliveira and Silva (2025) reinforces that educational practices aligned with cognitive neuroscience contribute to addressing the heterogeneity present in elementary education. In addition, Prediger, Carvalho, and Cardoso (2025) show that neuropsychopedagogical



interventions grounded in neuroscientific principles favor more inclusive educational processes, especially in contexts marked by school diversity.

## BRAIN MATURATION AND DEVELOPMENT THROUGHOUT SCHOOLING

The analyzed studies emphasize that knowledge about brain maturation is essential for teaching practice at different stages of schooling. Oliveira et al. (2022) point out that the development of executive functions directly influences skills such as planning, self-regulation, and decision-making, which requires that instructional practices respect students' neurodevelopmental timing and capacities.

Convergently, Peregrina Nievas and Gallardo-Montes (2023) show that initial teacher education still presents significant gaps regarding the approach to neuroeducation, which limits the application of this knowledge in pedagogical practice. The study by Siqueira, Aguiar, and Colares (2020) reinforces that early-childhood teachers' continuing education needs to incorporate neuroscientific foundations to align teaching with children's brain development processes, fostering more adequate pedagogical interventions.

## TEACHER EDUCATION AND THE PEDAGOGICAL USE OF NEUROSCIENCE

The results indicate that teacher education is a structuring axis for the proper application of neuroscience in the educational context. Grossi, Oliveira, and Fonseca (2024) show that the articulation among curriculum, neuroscience, and teacher education fosters more reflective pedagogical practices grounded in scientific evidence. McMahon (2022) shows that including neuroscience and cognitive psychology content in initial training broadens teachers' understanding of learning processes.

The study "Impact of educational neuroscience teacher professional development: perceptions of school personnel" (Frontiers in Education, 2022) shows that teacher professional development programs grounded in neuroscience principles promote positive changes in pedagogical practices, especially in lesson planning and the selection of teaching strategies. Cordeiro (2025) highlights that neuroscience applied to school teaching contributes to qualifying pedagogical practices and to teacher decisions more aligned with students' cognitive functioning. Complementarily, Soares, Costa, and Paschoal (2025) reinforce that the articulation among neuroscience, education, and technology expands the possibilities for pedagogical innovation and strengthens educational practices consistent with contemporary demands.

## EDUCATIONAL TECHNOLOGIES AND LEARNING

The analyzed studies show that educational technologies enhance learning when grounded in neuroscientific principles. Marinho et al. (2024) show that technology-mediated environments favor multisensory stimuli capable of activating different neural networks, increasing student engagement.



Nascimento et al. (2022) corroborate this perspective by showing that educational technologies contribute to developing cognitive autonomy in the teaching–learning process.

The study by Montiel and Medeiros (2024) indicates that the use of technologies in language teaching expands learning opportunities in multilingual contexts. Complementarily, Al Khassawneh and Al Sharif (2025) show that instructional strategies grounded in neuroeducation favor the implementation of educational technologies that are more effective and aligned with brain functioning.

## NEUROSCIENCE CONTRIBUTIONS TO SPECIFIC AREAS OF KNOWLEDGE

The results show relevant contributions of neuroscience to specific areas of knowledge, especially Mathematics and Science. Andrade et al. (2025) show that mathematical skills are associated with specific neural circuits, which guides the development of targeted pedagogical strategies. Oliveira et al. (2022) indicate that understanding these cognitive bases helps overcome persistent learning difficulties.

In Science education, Ribeiro et al. (2025) show that neurolearning promotes the understanding of complex scientific concepts by connecting cognitive processes and meaningful experiences. Complementarily, Oliveira et al. (2022) point out that integrating neuroscience and education strengthens teaching–learning processes by bringing theoretical foundations closer to pedagogical practice.

## CONCLUSION

It is understood that the study achieved its objective by analyzing, through an integrative review, the interfaces among neurosciences, cognition, and education, highlighting their contributions to improving teaching practice and qualifying teaching and learning processes. The analysis of the selected studies made it possible to identify that learning is a complex phenomenon resulting from the interaction among cognitive, emotional, neurobiological, and contextual processes, which reinforces the need for instructional practices grounded in scientific evidence.

The results show that functions such as attention, memory, motivation, emotional self-regulation, and executive functions have a direct influence on academic performance, establishing themselves as central elements for pedagogical planning. The integration between cognition and emotion, widely discussed in the analyzed studies, shows that educational environments that are emotionally safe and pedagogically intentional favor engagement, learning consolidation, and students' holistic development.

It was also shown that brain plasticity is a fundamental principle for recognizing individual differences in the school context. Diverse pedagogical practices aligned with brain functioning and different learning rhythms expand the possibilities for cognitive development and favor more inclusive educational processes. Likewise, knowledge about brain maturation throughout schooling proved essential for adapting instructional strategies to students' neurodevelopmental capacities.

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### **Education and Knowledge: Past, Present and Future**



Another relevant finding concerns the role of educational technologies which, when used intentionally and grounded in neuroscientific principles, enhance learning by favoring multisensory stimuli, cognitive autonomy, and problem-solving. Furthermore, specific areas of knowledge such as Mathematics and Science benefit significantly from pedagogical strategies based on understanding neural circuits and emotional factors that affect school performance.

With regard to research perspectives, it is recommended to expand empirical studies that investigate the direct application of neuroscientific principles in the classroom, as well as research analyzing the impact of initial and continuing education programs in neuroeducation. Future investigations can also deepen analyses of the use of educational technologies aligned with brain functioning and of pedagogical strategies that consider students' cognitive and emotional diversity.

Therefore, neuroscience should not be understood as accessory knowledge but as a field that provides essential support for contemporary teaching practice. By integrating science and pedagogy, we increase the likelihood of promoting more meaningful, contextualized, and lasting learning, strengthening educational practices that are more humane, inclusive, and scientifically oriented



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