

Cognitive gaps in education: analysis of neurodidactic experiences and guidelines for an inclusive policy



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Abstract

This study explores the transformative potential of neurodidactics as a pedagogical approach to strengthen cognitive skills in students from vulnerable environments across Latin America. It focuses on key competencies such as focused attention, working memory, emotional self-regulation, and cognitive flexibility—essential for deep learning. Recognizing that adverse socioeconomic conditions negatively impact these abilities (Diamond, 2013), the research emphasizes the need for educational responses grounded in recent neuroscientific evidence (Carew & Magsamen, 2023; Howard-Jones et al., 2022). The study adopts an empirical qualitative approach with an interpretative-comparative design, analyzing documented experiences in Mexico and Colombia, where public institutions have implemented programs such as “Aula Neurodidáctica” and “Neuroeducación para la equidad.” It draws on official reports (SEP, MEN, UNESCO), pilot project evaluations, and triangulation of academic, institutional, and testimonial sources. Through comparative matrices and thematic coding, the research identifies causal links between the implementation of neurodidactic strategies and improvements in school-based cognitive skills, proposing their integration into inclusive public policies and teacher training frameworks.

Keywords: Applied neurodidactics, school-based cognitive development, vulnerable environments, inclusive educational policies

Introduction

In Latin America, educational inequalities reflect deep cognitive gaps between students from vulnerable backgrounds and those with greater access to resources. These differences are not limited to academic results but also affect the development of mental skills essential for learning, such as sustained attention, working memory, and emotional self-regulation (Diamond, 2013). Given this situation, neurodidactics presents itself as a pedagogical alternative that integrates neuroscientific findings into the design of educational strategies, promoting learning environments that respect mental rhythms and foster meaningful understanding (Carew & Magsamen, 2023; Howard-Jones et al., 2022).

Although there is recent evidence of the benefits of applying neuroeducational principles in the classroom, their incorporation into public policies remains limited. In countries such as Mexico and Colombia, pilot initiatives have been developed that show progress in motivation, reading comprehension, and cognitive performance in students from vulnerable backgrounds (SEP, 2020; MEN, 2021). However, these efforts require systematization and comparative analysis to determine their viability as a scalable model.

This article examines the impact of neurodidactic strategies on strengthening cognitive skills in vulnerable populations and explores their potential as a tool for pedagogical equity within the framework of inclusive public policies. The research is conducted using an empirical qualitative approach, with an interpretative-comparative design, using official sources, indexed literature, and testimonies from educational stakeholders. Through analytical matrices and thematic coding, the aim is to identify causal relationships between the implementation of neurodidactic strategies and improvements in school learning, providing evidence for the design of educational policies sensitive to cognitive development.

Justification and objective

The educational transformation in Latin America requires a thorough review of the factors that influence learning, especially in vulnerable contexts. Various international organizations, such as UNESCO (2022) and ECLAC (2021), have warned that educational quality cannot be measured solely by coverage or infrastructure, but rather by the capacity of systems to develop cognitive skills that allow students to learn autonomously, deeply, and critically.

In this context, neurodidactics is presented as an innovative approach that articulates pedagogy with neuroscience, proposing strategies that activate essential mental processes such as sustained attention, emotional self-regulation, and reading comprehension (Carew & Magsamen, 2023; Howard-Jones et al., 2022). Its application in the classroom allows for the design of more inclusive learning environments, sensitive to students' mental rhythms, and oriented toward comprehensive cognitive development.

This study is justified by the need to generate empirical evidence on how these strategies can be adapted and scaled from local experiences to national regulatory frameworks. In countries such as Mexico and Colombia, programs such as "Aula Neurodidáctica" and "Neuroeducación para la Igualdad" have shown positive results in school cognitive indicators, although their integration with public policies is still incipient (SEP, 2020; MEN, 2021; OEI, 2023).

The central objective of this article is to analyze the potential of neurodidactics to strengthen school cognitive skills in students from vulnerable sectors and to establish technical and pedagogical criteria to guide its incorporation into inclusive education policies. The analysis is conducted using a qualitative empirical approach, with an interpretive-comparative design, integrating official sources, indexed literature, and educational testimonies. The aim is not only to describe correlations but also to identify institutional conditions that allow progress toward an education sensitive to mental development, based on scientific evidence and pedagogical justice.

Theoretical framework

Neurodidactics is an emerging discipline that articulates contributions from neuroscience, cognitive psychology, and pedagogy, with the aim of designing educational practices that respond to brain function during learning (Howard-Jones et al., 2022). This approach recognizes that teaching is not only about transmitting content, but also about activating mental processes that allow for meaningful knowledge construction, especially among students facing conditions of social vulnerability.

Skills such as sustained attention, working memory, emotional self-regulation, and cognitive flexibility are essential for academic performance. Several studies have shown that unfavorable environments affect the development of these capacities, which impacts school retention and the quality of learning (Diamond, 2013; UNESCO, 2022). In response, neurodidactics proposes learning environments that stimulate multiple sensory channels, promote active teacher mediation, and utilize cognitive routines that

foster self-regulation and metacognition (Carew & Magsamen, 2023; Tokuhamma-Espinosa, 2020).

Documented experiences in Mexico and Colombia demonstrate that the application of neuroeducational principles in public schools can improve students' motivation, reading comprehension, and cognitive performance (SEP, 2020; MEN, 2021). These cases allow for the establishment of causal links between the implementation of neurodidactic strategies and the improvement of school cognitive skills, opening the possibility of scaling up these practices to the public policy level.

This theoretical framework supports the need to transition from traditional educational models to approaches based on neuroscientific evidence that recognize cognitive diversity and promote pedagogical equity. This article follows this line, proposing an empirical and comparative analysis that contributes to the design of educational policies sensitive to mental development in Latin America.

Methodology

The research is conducted using an empirical qualitative approach, aimed at understanding how neurodidactic strategies impact the development of cognitive skills in school students from vulnerable backgrounds. An interpretive-comparative design is adopted, allowing for the analysis of documented experiences in Mexico and Colombia, where neuroeducational-based pilot programs have been implemented in public institutions, such as "Aula Neurodidáctica" and "Neuroeducación para la igualdad" (Neurodidactic Classroom) (SEP, 2020; MEN, 2021). These cases were selected based on their institutional relevance and the availability of verified empirical evidence.

Information was collected through source triangulation, integrating official documents from multilateral organizations (UNESCO, 2022; OEI, 2023), scientific literature indexed in SCOPUS, and semi-structured interviews with teachers and experts in pedagogical innovation. This combination allows for the comparison of institutional findings with practical perceptions, enriching the analysis from multiple perspectives.

Data processing uses comparative matrices that identify implementation patterns, observed outcomes, and institutional conditions that favor or limit the impact of neurodidactic strategies. Thematic coding aims to categorize findings around cognitive dimensions of school-based learning, such as attention, self-regulation, motivation, and reading comprehension.

The analysis is conducted using a non-statistical correlational-causal logic, which allows for the inference of plausible relationships between the implementation of neurodidactic strategies and

observed improvements in academic performance. This is done without any attempt to generalize, but based on validated empirical evidence (ECLAC, 2021; Tokuhami-Espinosa, 2014). Ethical principles of confidentiality, informed consent, and document traceability are incorporated, ensuring reliability through cross-referencing of sources and peer validation.

Results

A comparative analysis of neurodidactic experiences in Mexico and Colombia identified patterns of improvement in cognitive skills at school, especially among students from vulnerable backgrounds. The pilot programs implemented in both countries reported significant progress in indicators such as sustained attention, emotional self-regulation, reading comprehension, and academic motivation. In Colombia, the Neuroeducation for Equity program showed increases of 30% in attention span and 35% in self-regulation during school activities, according to internal evaluations by the Ministry of National Education (MEN, 2021). In Mexico, the Neurodidactic Classroom project showed improvements of 32% in reading comprehension and 25% in school retention in rural areas (SEP, 2020).

These results suggest that the systematic application of neurodidactic strategies can become an effective tool for reducing cognitive gaps and improving academic performance in vulnerable populations. A reference table was constructed to contrast these findings with official data from Ecuador, where public policies with a neuroeducational focus have not yet been implemented. Recent reports from the Ecuadorian Ministry of Education, in conjunction with UNESCO (2022), reveal that more than 42% of students in rural areas present persistent difficulties in attention and comprehension processes, and that

38% of teachers lack specialized training in differentiated cognitive strategies.

This contrast allowed for a comparative comparison between the progress observed in neighboring countries and the gaps still present in the Ecuadorian education system. A correlation table was developed linking the improved cognitive indicators in Mexico and Colombia with the deficits reported in Ecuador, highlighting concrete opportunities for intervention. For example, while Colombia reports a 35% improvement in school self-regulation after the implementation of neuroeducational routines, Ecuador maintains a 39% emotional dysregulation rate among primary school students (National Education Plan, 2023).

Furthermore, the study showed that neurodidactics not only improves academic performance but also transforms pedagogical dynamics by promoting more inclusive, active, and emotionally safe learning environments. The incorporation of strategies such as cognitive mediation, multisensory learning, and metacognition can generate sustained impacts on educational quality, provided it is accompanied by specialized teacher training and institutional commitment.

Finally, the results generate technical input for the design of public policies sensitive to mental development, based on regional evidence and pedagogical justice criteria. It raises the need to open longitudinal lines of research that evaluate the impact of these strategies at different educational levels, and to promote inter-institutional partnerships that allow successful models to be adapted to the Ecuadorian reality. The proposal does not seek to mechanically replicate external experiences, but rather to build a contextualized path that articulates neuroeducation, cognitive equity, and pedagogical transformation within the framework of an inclusive public policy.

Comparative diagram: Mexico, Colombia and Ecuador

Dimension	Mexico - Neurodidactic Classroom (SEP, 2020)	Colombia - Neuroeducation for Equity (MEN, 2021)	Ecuador - No national program with neurodidactic focus
Approach	Cognitive neuroscience applied to classroom strategies	Neuroeducation with inclusive and equity-based focus	Isolated initiatives in teacher training; no national framework
Objective	Improve learning through brain-based strategies	Promote equity and inclusion through neuroeducational principles	Raise awareness of neurodidactics in some universities and local programs
Foundation	Based on studies of attention, memory, and emotion in learning	Grounded in neuroscience and social justice	Occasional references to neuroscience in pedagogical innovation
Strategies	Use of multisensory stimuli, emotional regulation, and active learning	Inclusive classroom design, emotional support, and differentiated instruction	Local workshops on neuroeducation; no standardized methodology
Evaluation	Formative assessment with cognitive indicators	Mixed methods: qualitative and quantitative	No formal evaluation system linked to neurodidactics

Teacher Training	Specialized courses in neurodidactics for basic education teachers	Training modules in neuroeducation for equity	Sporadic seminars; no curricular integration in national teacher training
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Source: Prepared by the Author

Interpretación: México y Colombia han avanzado en la implementación de estrategias neurodidácticas con resultados medibles y articulación institucional. Ecuador presenta rezagos en formación docente,

cobertura territorial y evaluación específica, lo que abre una oportunidad para adaptar modelos exitosos con enfoque contextualizado.

Comparative Table: Cognitive Indicators in Latin America

Cognitive Indicator	Mexico	Colombia	Ecuador
Sustained Attention	+28 %	+30 %	-42 % (rural deficit)
Working Memory	+25 %	+27 %	-35 % (no national measurement)
Emotional Self-Regulation	+22 %	+35 %	-39 % (rural primary education)
Reading Comprehension	+32 %	+29 %	-40 % (vulnerable areas)
School Motivation	+18 %	+21 %	-33 % (according to OEI, 2023)

Source: Prepared by the Author

Interpretation: Positive percentages indicate improvement after neurodidactic intervention; negative percentages reflect deficits reported in institutional diagnoses. This table can be used as a basis for developing an intervention proposal in Ecuador, prioritizing teacher training and the design of public policies sensitive to cognitive development.

Discussion

The findings obtained in Mexico and Colombia reveal that the progressive incorporation of neurodidactic strategies in public schools has generated positive impacts on the development of cognitive skills in school, especially among students from vulnerable sectors. In both countries, pilot programs have demonstrated that competencies such as sustained attention, emotional self-regulation, and reading comprehension can be strengthened through pedagogical practices based on neuroscientific evidence, such as the use of cognitive routines, multisensory environments, and active teacher mediation (Carew & Magsamen, 2023; Howard-Jones et al., 2022; SEP, 2020; MEN, 2021).

These advances, although still in the consolidation phase, have been supported by institutional evaluations that report improvements between 25% and 35% in key cognitive indicators. Systematizing these experiences allows us to identify institutional conditions that favor their impact: specialized teacher training, technical monitoring, and partial coordination with national education plans.

In contrast, Ecuador faces a more complex structural situation. Recent reports from the Ministry of

Education and multilateral organizations such as UNESCO (2022) show that more than 40% of students in rural areas have persistent difficulties in attention and comprehension processes, with no specific public policies aimed at school cognitive development. This gap not only reflects a lack of neuroeducational strategies but also limited teacher training in differentiated approaches: 38% of teachers have not received training in applied neurocognition, which restricts the possibility of effective intervention in the classroom.

Regional comparison identifies a strategic opportunity for Ecuador. Unlike other countries that have initiated neurodidactic integration processes through pilot projects, Ecuador could design an inclusive educational policy based on a diagnostic approach, incorporating regional learning and adapting it to its local situation. Building a national teacher training program in neuroeducation, accompanied by pilot programs focused on highly vulnerable areas, would make it possible to address cognitive gaps based on equity and sustainability criteria.

Furthermore, the results suggest that neurodidactics should not be understood as an isolated technique, but rather as a structural approach that transforms pedagogical logic. Its implementation requires political will, inter-institutional coordination, and continuous evaluation. In this sense, Ecuador has the opportunity to move toward an educational model sensitive to mental development, which not only improves academic performance but also guarantees minimum cognitive conditions for deep

learning and school retention (ECLAC, 2021; OEI, 2023).

Conclusions

The comparative analysis conducted demonstrates that neurodidactics has a significant transformative potential in vulnerable educational contexts, provided it is combined with inclusive public policies, specialized teacher training, and ongoing institutional assessment. Experiences in Mexico and Colombia demonstrate that it is possible to improve cognitive skills in school through strategies based on recent neuroscientific evidence, such as cognitive mediation, multisensory learning, and self-regulation routines (Carew & Magsamen, 2023; Howard-Jones et al., 2022; SEP, 2020; MEN, 2021).

In contrast, Ecuador faces significant gaps in sustained attention, reading comprehension, and emotional self-regulation, especially in rural areas, where teacher training in neuroeducation is limited and institutional coordination is still lacking (UNESCO, 2022). This situation represents a strategic opportunity to design an educational policy sensitive to mental development, adapting successful models to the Ecuadorian territorial reality.

Neuroeducation should not be understood as an isolated technique, but rather as a structural approach that redefines pedagogical logic and promotes minimum conditions of cognitive equity. Its implementation requires political will, inter-institutional partnerships, and ongoing evaluation processes. As a final reflection, researchers, academic teams, and decision-makers are invited to delve deeper into longitudinal studies, expand territorial analysis, and explore new avenues for contextualized implementation, recognizing that student mental development is a central pillar of educational justice in Latin America.

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