

Luis Fernando González-Beltrán
(Organizador)

Educação no Século XXI:

Perspectivas
Contemporâneas
sobre
Ensino-Aprendizagem

VOL IX



**EDITORA
ARTEMIS**
2026

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Dados Internacionais de Catalogação na Publicação (CIP)
(eDOC BRASIL, Belo Horizonte/MG)

E24 Educação no século XXI [livro eletrônico] : Perspectivas Contemporâneas sobre Ensino-Aprendizagem IX / Organizador Luis Fernando González Beltrán. – 1. ed. – Curitiba, PR: Editora Artemis, 2026.

Formato: PDF

Requisitos de sistema: Adobe Acrobat Reader

Modo de acesso: World Wide Web

Edição bilíngue.

Inclui bibliografia.

ISBN 978-65-82858-26-0

DOI 10.37572/EdArt_300926260

1. Educação. 2. Ensino e aprendizagem. I. González Beltrán, Luis Fernando.

CDD 370

Elaborado por Maurício Amormino Júnior – CRB6/2422



Editora Artemis

Curitiba-PR Brasil

www.editoraartemis.com.br

e-mail: publicar@editoraartemis.com.br

PRÓLOGO

Los procesos de enseñanza y aprendizaje se desarrollan actualmente en escenarios caracterizados por una creciente diversidad estudiantil, nuevas formas de producción y acceso al conocimiento, transformaciones tecnológicas aceleradas y demandas profesionales cada vez más complejas. En este contexto, las instituciones educativas enfrentan el desafío de promover aprendizajes significativos e inclusivos y, al mismo tiempo, desarrollar prácticas pedagógicas capaces de incluir dimensiones cognitivas, motivacionales, sociales, corporales y tecnológicas.

El volumen *Educação no século XXI: Perspectivas Contemporâneas sobre Ensino-Aprendizagem IX* reúne investigaciones que permiten aproximarse a estos desafíos desde diferentes perspectivas. Sus contenidos destacan el análisis de los procesos de aprendizaje y acompañamiento de los estudiantes, las estrategias y metodologías utilizadas en distintos contextos formativos y las oportunidades y tensiones derivadas de la transformación digital y del creciente uso de la inteligencia artificial en la educación.

La obra se organiza en tres ejes temáticos. El primero, **Aprendizaje, Inclusión y Desarrollo del Estudiante**, concentra la atención en los sujetos que aprenden y en las condiciones necesarias para favorecer trayectorias educativas más equitativas y significativas. Los capítulos exploran la diversidad del estudiantado y las prácticas de acompañamiento universitario, la construcción de entornos neuroinclusivos en la educación superior, el desarrollo de estrategias de aprendizaje autorregulado, la relación entre interés situacional, motivación y permanencia académica, las competencias cognitivas necesarias para afrontar las exigencias del aprendizaje universitario y el papel del cuerpo y de la cognición incorporada en la construcción de aprendizajes significativos. En conjunto, estas investigaciones muestran que aprender es un proceso multidimensional que requiere atender tanto a las capacidades cognitivas como a las diferencias individuales, las motivaciones y las condiciones institucionales. Con ello se pueden estudiar, explicar y resolver problemas como los bajos desempeños en lectura y matemáticas en la prueba PISA 2025, la correlación negativa entre procrastinación y aprendizaje autorregulado, y el creciente abandono escolar.

El segundo eje, **Prácticas Pedagógicas y Formación Profesional**, muestra un sólido equilibrio al reunir experiencias y estudios centrados en las estrategias mediante las cuales la enseñanza se concreta en contextos educativos y profesionales diversos. La alfabetización académica y el aprendizaje de lenguas extranjeras, la creación de materiales por parte de los propios estudiantes, las estrategias para la enseñanza de las artes visuales, la formación deportiva en edades tempranas y el aprendizaje basado

en retos y procesos de mejora continua muestran distintas posibilidades de innovación metodológica. Más allá de sus particularidades disciplinares, estos trabajos comparten la búsqueda de experiencias educativas capaces de promover participación, autonomía, motivación y desarrollo de competencias.

El tercer eje, **Tecnologías, Inteligencia Artificial e Innovación en la Educación Superior**, aborda uno de los campos que actualmente experimenta transformaciones más aceleradas. Los capítulos analizan la relación entre experiencia digital y uso académico de herramientas de inteligencia artificial, la necesidad de una formación crítica frente a los sistemas generativos, los retos y oportunidades de la articulación entre aprendizaje presencial y virtual, las nuevas competencias profesionales demandadas por la transformación tecnológica, el empleo de Design Thinking y simulaciones gamificadas como arquitecturas de aprendizaje, el desarrollo de chatbots educativos con arquitecturas de recuperación de información y apoyo socioemocional para la tutoría universitaria, y las posibilidades de la inteligencia artificial aplicada a la formación docente y a la simulación clínica.

La tecnología, en estos estudios, no se reduce a un fin en sí misma, sino a un elemento que modifica las formas de aprender, enseñar y ejercer profesionalmente. Su incorporación educativa exige, por ello, reflexión pedagógica, desarrollo de nuevas competencias, análisis crítico y capacidad para reconocer tanto sus posibilidades como sus límites.

Los tres ejes que componen este volumen convergen en una misma preocupación: comprender cómo ofrecer experiencias educativas pertinentes ante estudiantes, contextos y formas de conocimiento que están cambiando rápidamente. Inclusión, autorregulación, innovación pedagógica, formación profesional, cultura digital e inteligencia artificial forman parte de un escenario en el que la educación debe seguir colocando en el centro los procesos humanos de aprendizaje, pensamiento y construcción de conocimiento.

Esperamos que los trabajos reunidos en esta obra contribuyan al intercambio académico y profesional y estimulen nuevas investigaciones, experiencias y propuestas capaces de responder de manera crítica, creativa e inclusiva a los desafíos educativos del siglo XXI.

Dr. Luis Fernando González Beltrán

Universidad Nacional Autónoma de México (UNAM)

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THE BODY AS A LEARNING TOOL: AN EMBODIED PERSPECTIVE ON MEANINGFUL LEARNING

Data de submissão: 25/08/2026

Data de aceite: 10/09/2026

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and cognition as a set of capacities that emerge from the interaction among the brain, the different biological systems of the human body, and the environment. We then provided a brief explanation of how some principles of embodied cognition resonate with Piaget's theories of child development as well as with studies of psychomotor development in children, particularly the contributions of Ajuariaguerra. Finally, we discuss the relevance and potential applications of this perspective across different disciplines, including mathematics, language, science, history, and geography.

KEYWORDS: embodied cognition; meaningful learning; sensorimotor processes; mathematics; language.

ABSTRACT: Current educational approaches increasingly seek to promote meaningful learning, leading to the development of different methodologies aimed at achieving this goal. However, results from different types of assessment – international, national, and local – show that we are still far from reaching it. Teachers' qualitative observations also point to students' difficulties in appropriating knowledge and using it across different contexts. In this chapter, we propose the use of the body as a learning tool that can contribute to the construction of meaningful learning. We draw on embodied cognition theory, which understands the body as a knowing agent

1. INTRODUCTION

In recent years, there has been growing interest among researchers and teachers in making learning meaningful and useful for students, based on the understanding that this contributes to the development of lasting learning that can be transferred across different contexts. At the same time, there is an interest in helping students maintain a positive attitude toward educational processes. However, different assessments and studies show that a substantial proportion

of students still experience difficulties in achieving expected learning outcomes and using their knowledge to solve problems across different contexts (Díaz-López & Kong-Toledo, 2020; Ordaz Villegas & Acle Tomasini, 2021; UNESCO, 2021). These results suggest, among other things, that a gap remains between the acquisition of certain forms of school knowledge and the possibility of using that knowledge meaningfully in different situations.

Although competency-based approaches have brought important changes to curriculum design and to teaching and learning dynamics in the classroom, not all the processes involved in the development of thinking are given equal relevance in the everyday life of schools. Abstract activities – such as mental calculation – are often overvalued because they are regarded as indicators of greater cognitive development. This may lead students, from an early age, to be pushed toward processes of mental representation, discouraging the use of the body as a learning tool and overlooking the role it may play in building and maintaining cognitive scaffolds throughout development.

It is from this problem that we put forward the need to reflect on the importance of the body as a learning tool and its place within educational processes. In this chapter, we briefly explain the principles of embodied cognition, an approach to cognition and a research program that has gained increasing relevance within the cognitive sciences. We also discuss its relationship with learning in formal educational contexts and offer examples of how this perspective can be applied across different disciplines. We argue that the use of the body can contribute to the development of meaningful learning by engaging different cognitive resources during learning and promoting interaction among different processes. With this proposal, our intention is to encourage and invite teachers at all educational levels to design activities that allow students to interact with their context through sensorimotor action, thereby contributing to the development and maintenance of cognitive scaffolds that can support the learning of increasingly complex skills.

2. EMBODIED COGNITION AND ITS RELATIONSHIP WITH COGNITIVE DEVELOPMENT

Since the mid-1980s, the approach known as embodied cognition has gained increasing prominence within the cognitive sciences, reshaping the way in which the interaction among the brain, body, and environment is understood in cognitive processes. For much of the twentieth century, the dominant view of cognition was based on the computational metaphor adopted by traditional cognitivism, which regarded the brain as an information processor and the central agent of cognitive processes. From this perspective, cognition could ultimately be understood as the abstract processing of amodal symbols,

with the body and senses assigned a primarily peripheral role in transmitting signals and carrying out tasks directed by a central processor.

In contrast, embodied cognition emphasizes the idea of an embodied mind, understanding the body as a whole as a knowing agent and the brain as part of a complex system. From this perspective, cognition does not depend exclusively on the brain, but on its interaction with different biological systems of the human body and with the context in which the person acts. The term *embodiment* specifically emphasizes the role of the human body in different cognitive processes and in the construction of meaning through experience (Peral, 2017). This approach brings our attention back to the sensorimotor processes through which we appropriate the world, understand it, and act within it.

These processes can be traced back to birth, a period in which exploration of the world is primarily based on the senses and movement. Through them, we build our first cognitive scaffolds from the experiences that our environment provides. From that moment onward, we use our whole body to know the world, inhabit it, approach its characteristics, experience them, and learn from them. González-Gradón y Froese (2018) explain that knowledge and meaning are grounded in a person's bodily experience, which itself emerges through interaction with the world upon which the person acts. This suggests that the body can be understood as inherently meaningful and action-based, so that meaning is also related to a person's possibilities for action and sensorimotor experience.

From this perspective, cognition depends on experiences originating in the body and on its different sensorimotor capacities. What we perceive through the senses participates in the construction of learning because our sensory structures are embedded within both a psychological context – in which our experiences and beliefs participate in perception – and a cultural context shaped by the society in which we are immersed (Varela et al., 1997). This suggests understanding the body as a whole and cognition as a set of processes that cannot be explained solely in terms of an isolated organ, but rather by considering the interaction of the brain with the rest of the nervous system, the body, and the environment. This does not diminish the role of the brain, a fundamental component of many cognitive processes in human beings. Rather, it invites us to understand the embodied nature of mental processes and to move beyond the traditional separation between mind and body.

Embodied cognition thus directs our attention toward the processes we engage in every day as we learn, focusing on the stimuli we receive through sensation and movement and on the role these may play in the development of cognitive processes.

For this reason, we argue that teaching and learning processes in schools should seek to provide students with enriching sensorimotor experiences that can become resources for subsequent learning: opportunities to actively experience concepts, explanations, and phenomena. These experiences may contribute to the development and maintenance of cognitive scaffolds that subsequently support the construction of meaningful learning and its use in solving both school-based and everyday problems.

Incorporating the body into learning does not, however, mean remaining exclusively within concrete experiences. Bodily experience can provide a starting point for constructing meanings that can subsequently be connected with more abstract forms of representation. In this regard, McNeil and Fyfe (2012) found that a progressive transition from concrete to abstract representations – *concreteness fading* – promoted the transfer of mathematical knowledge. These results show that concrete and abstract forms of learning do not necessarily need to be understood as opposites. Instead, they can form part of a process in which initial experiences and representations function as scaffolds for accessing knowledge that can later be used in other contexts.

The principles of this approach are compatible with different theoretical developments that have become important points of reference in education. Here, we will focus on only one. Among the various theories of children's cognitive development, one of the most influential has been Piaget's (1964), which identifies four stages in the development of cognitive structures that support learning. The first two, the sensorimotor and preoperational stages, refer to a period in which learning is strongly connected to action and to the use of different perceptual channels through which children come to know themselves and the world around them. Ajuriaguerra (1983), though his work in child psychiatry and psychomotor development also highlights the importance of sensations, perceptions, and movement in acquiring new forms of action, which children progressively organize into schemas.

The processes of assimilation and accommodation proposed by Piaget allow new knowledge to be incorporated into previously constructed structures and these schemas to be transformed in response to new experiences. The coordination of actions and perceptions is necessary for children to appropriate the world around them and progressively move toward symbolic acts. Play has an important role in this process because it allows children to experience, transform, and represent different aspects of the world. From Ajuriaguerra's (1983) perspective, symbolic play also constitutes a means of both intellectual and affective adaptation.

During the concrete operational stage (7-12 years), children are expected to continue drawing on their intuition and their own activity as they move toward new

levels of socialization and objectification of thought. Concrete operations are supported by manipulation and by the possibility of drawing on representations constructed from children's experiences (Ajuariguerra, 1983). Many primary-school children are within this developmental period, precisely when the formal study of different school subjects begins. In mathematics, for example, Piaget (1991) proposes that children are expected to be able to solve problems involving seriation and classification, establish numerical equivalence, relate concepts such as distance, time, and speed, and begin to consider the causes of different events. Bodily experience and interaction with the environment can provide important reference points for constructing the meaning of these concepts and subsequently moving toward more abstract forms of thought.

The importance of embodied cognition lies in recognizing that activities that give students opportunities to move through different moments of their learning process using movement and the senses can foster the establishment of connections and the construction of meaningful learning. Varela et al. (1997) explain that cognitive structures emerge from sensorimotor patterns that allow action to be perceptually guided. Likewise, Piaget's program of generic epistemology explains development from a biologically immature organism toward the emergence of progressively more complex forms of reasoning (Varela et al., 1997). Both perspectives allow us to think of the child as an embodied agent who develops through constant interaction with the environment and whose knowledge begins deeply connected to the sensorimotor system.

The importance of movement in learning is also described by Carpenter (2015), who refers to children's use of gestures while reading and solving problems and to the possible contribution of these bodily resources to the comprehension and retention of new knowledge. This idea is supported by Barsalou's work on simulation, which helps explain how the reactivation of perceptual and motor experiences may participate in the construction of meaning. Designing and experiencing learning situations grounded in lived experience may therefore expand the repertoire of embodied experiences that can later be evoked or simulated to support the understanding and appropriation of concepts, meanings, or events.

The intentional incorporation of movement into the classroom has also been explored from an applied perspective. McClelland et al. (2015) implemented a physical activity intervention based on principle of embodied cognition with students aged 7 to 13 years. Their results showed improvements in academic performance, particularly among students with lower initial achievement. Although these findings need to be understood within the specific characteristics of the intervention, they provide evidence of the possibilities of intentionally integrating bodily experiences into school contexts.

3. APPLYING THE PRINCIPLES OF EMBODIED COGNITION ACROSS SCHOOL SUBJECTS

Across the different subjects taught in basic education, we can find countless opportunities to use the body as a cognitive tool. These experiences can support the initial construction of meaning and subsequently help student move toward more abstract forms of thought and use them across different situations and contexts. In what follows, we outline some principles of applying the theoretical ideas discussed in the precious section to different school subjects, with the hope that this brief exploration will encourage teachers to develop creative and enriching activities.

In mathematics, the body can be used to experience notions of number and quantity, as well as addition and subtraction, through counting parts of the body, using the fingers, and physically “taking away” or “adding” fingers to keep track of quantities. Moving the body through space also makes it possible to experience concepts such as distance, time, speed, estimation, and approximation. These experiences can become reference points for subsequently understanding units of time, distance, and weight, as well as increasingly abstract concepts encountered in other disciplines such as physics and chemistry.

An example can be found in Valencia-Quiroz (2021), who describes an activity that provides students with an embodied experience of concepts such as number, class, order, family, and position in the construction of numbers up to the hundred millions. The activity, called the “living board” (*tablero viviente*), uses movement through space to help sixth-grade students understand the basic notions underlying the construction of numbers, from smaller to increasingly larger numbers. It also provides a tool for comparing numbers and understanding notions such as absolute value, relative value, and the role of zero, among others.

The role of the body in constructing mathematical concepts is not limited to the direct manipulation of objects. Gestures can also provide a resource for moving between action and more abstract form of thought. Novakc et al. (2014) compared the learning of mathematical equivalence through actions performed directly on objects, concrete gestures representing those actions, and more abstract gestures. Although all three types of movement supported learning on the problems that students had practiced, students who used gestures were able to generalize what they has learned to new problems. The authors propose that gesture may support this process precisely because it retains characteristics of bodily action while progressively distancing itself from action on concrete objects. This allows us to think of the body not only as a resource for

experiencing concepts, but also as a possible bridge toward abstraction and the transfer of knowledge.

This idea is compatible with the *concreteness fading* proposed by McNeil and Fyfe (2012), in which concrete representations are progressively replaced by more abstract ones. From this perspective, the goal is not to choose between concrete experiences and abstract thought, but to design experiences that allow students to construct meaning from what they can perceive, manipulate, or represent and, subsequently, to use those meaning in contexts where concrete referents are no longer present.

Exploring the environment through the body is a natural experience in childhood and is fundamental during the earliest stages of development. We are natural explorers, and it is through our embodiment that we gain our first knowledge of the world and how it works. For this reason, in science education, the body can remain an important tool throughout students' educational lives as they approach learning in biology, physics, chemistry, and other sciences. Notions displacement or speed can be explored through learning situations that involved the body and interaction with the environment. These experiences, in turn, can contribute to understanding more abstract concepts such as species, heat, force, hardness, direction, and balance.

Experiments in which students initially use their bodies as reference points or measuring instruments can subsequently facilitate the transition toward using external instruments, understanding how they work, and applying them. It is important for students to have opportunities to go out into their surroundings to make observations, compare properties, estimate distances and results, construct objects, and engage in related activities. It should be noted that, although these experiences are common in many schools through laboratory activities or teaching suggestions included in some books or curricula, pedagogical mediation is necessary to help establish connections among sensation, perception, and thought, so that embodied experiences can serve as scaffolds for conceptual understanding.

In language education, lived experiences create the need to use language in precise, accurate, and harmonious ways. They open possibilities for constructing dialogues and narratives that describe what has been lived, observed, and learned. It is in these situations that language gives expression to experience and that rhetorical devices such as comparison and metaphor can be used. Learning to read and write different types of texts can also draw on the evocation of experiences that reading allows us to recreate. It is here that grammatical concepts become necessary so that our voice can be heard, so that it can have a body and a sound of its own. Although language has traditionally

been considered one of the representative examples of cognition understood as the manipulation of abstractions, different studies of language and cognition highlight the role that perceptual, motor, and affective simulation may play in language comprehension (Barsalou, 2008).

The study of history also offers different opportunities for an embodied cognition approach that moves beyond memorization. One of the most important abilities to be developed in this discipline is an understanding of historical events, their relationship with sociopolitical processes, and their role in shaping present-day reality. In this respect, the narrative dimension of history can be extensively used because it allows emotional and imaginative engagement with the situations being described and can contribute to the meaningfulness with which they are understood.

A narrative should evoke emotions and sensations that help us approach the causes and consequences of the characters' actions and understand the motives that may have been behind important decisions, such as participating in a war, taking part in a battle, or protecting others. History should help us understand our present, understand why some ideas prevail while others disappear, and recognize that our actions have consequences and participate in shaping the times in which we live. Understanding ourselves as part of a historical process also helps us examine human behavior. Activities in history education can foster these understandings through experience, narrative, and comparisons between personal situations and broader social and historical events.

Space is understood through exploration, and geography should therefore encourage this encounter with the earth, its elements, their analysis, comparison, and exploration. Basic processes such as observation, recording, hypothesis generation, and experimentation can support the understanding of concepts related to the behavior of tectonic plates, volcanoes, seas, rivers, and rainfall. In this way, the application of knowledge can be understood as bidirectional: we use what we already know and our most basic abilities to approach new knowledge and, once these new understandings have been constructed, we can use them to solve problems or access more complex learning.

4. CONCLUSIONS

As teachers, it is essential to understand our students as beings in movement who need experiences to perceive their context and discover relationships among the different objects and phenomena within it. We need to break away from the idea that “the older they get, the less movement they need to learn,” and that, as students advance through school, they should rely exclusively on abstract thought. This chapter is an invitation to

move away from excessively passive learning practices in which sitting in a chair, taking notes, drawing figures, and performing calculations are considered sufficient.

Our aim is to encourage activities that, regardless of age, provide richer and more varied bodily experiences that allow students to interact with the world they are discovering; experiences that help them find relationships among the objects they are becoming aware of and the phenomena they encounter. As we grow, the body does not necessarily lose its relevance for learning. On the contrary, previous experiences can become reference points from which increasingly complex relationships can be constructed, represented, and understood.

Sometimes, students' judgments about whether a class is boring or enjoyable are related to the quantity and quality of the experiences they have during it – what they often refer to as a “dynamic class.” Dynamic because they can move, put their abilities into action, and face challenges that allow them to use different resources, even if they are not always fully aware of doing so. Activities in which students can manipulate materials, move, use their bodies, and interact with space provide experiences that can help them progressively develop this awareness, take ownership of their learning processes, and use them to their advantage. Rather than a criticism or rejection of other forms of teaching, this proposal should be understood as an invitation to return to the body, movement, and exploration as important principles of learning.

Moreover, embracing a form of teaching grounded in an understanding of human beings as embodied cognitive agents also gives us, as teachers, an opportunity to become active participants in our own teaching processes through continuous inquiry and the implementation of new strategies grounded in evidence from the study of cognition. This means developing new forms of mediation, understanding our own processes and those of others, developing new skills, but also learning to use our bodies in ways we may not have considered before and helping others discover their own possibilities.

It is a perspective that brings us back to ourselves, inviting us to pay attention to our sensations and movements and to observe how they participate in the way we teach and in the experiences we create for our students. We are people fostering learning in other people. Our experiences are among our most valuable tools, and what we ourselves use to learn can also become a tool for helping others construct new learning.

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