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Review Article

Does the Embodied Cognition Paradigm Have Implications for Learning?

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Abstract

Cartesian dualism, distinguishing mind from body, has significantly shaped our understanding of cognitive functions, often leading to the perception that these processes exist independently of our physical and bodily experiences. This rigid division has also influenced our approach to educational practices, which tend to be based on a theoretical understanding of cognition. However, emerging theories of embodied cognition are challenging this view by highlighting the fundamental connection between cognitive processes and bodily experiences as well as our physical interactions with the environment. These theories are increasingly supported by neuroscientific research, which recognizes the body as a crucial component of the learning process. Indeed, numerous studies indicate that incorporating bodily experiences into educational settings not only enhances learning, but also makes it more meaningful. When students participate in activities that involve movement and direct engagement with their surroundings, their ability to process and retain information improves, enabling them to translate abstract concepts into tangible forms and internalize them more effectively. This article aims to support a shift in our understanding of cognition away from the rigid dualistic paradigm toward a more holistic perspective of the educational process.

Keywords: Bodily Experiences, Classical Cognitive Science, Embodied Cognition, Embodied Education, Learning

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1. INTRODUCTION

Cartesian dualism, characterized by the separation of mind and body, has influenced the philosophical debate on whether the bodily dimension should be considered as a marginal component of cognition. This dualistic view defines cognition from a disembodied perspective (Wilson & Golonka, 2013), in accordance with the classical paradigm of cognitive science that considers cognitive processes independent of physical properties.

The idea that the brain processes information through representations is one of the main assumptions of classical cognitive science (Fodor, 1983) that has dominated research in the field for decades, equating cognition with the capacity for mental representation by a cognitive agent.

This way of understanding cognition has contributed to progressively marginalizing the role of the body with respect to the emergence of cognitive processes.

Certainly, classical cognitive science marked a significant shift from behaviorist perspectives by emphasizing internal mental processes as essential components for understanding behavior. Rooted in the belief that cognitive processes could be understood using models similar to those of computer processing, classical cognitive science often drew analogies between the mind and computational systems, viewing cognition as a computation (Newell & Simon, 1972). Indeed, this framework assumes that the mind operates like a digital computer, manipulating symbols according to formal rules (Fodor, 1975).

Despite its successes, classical cognitive science has faced criticism, particularly from embodied cognition perspectives that argue that cognition cannot be fully understood without considering the body and the physical environment in which it occurs (Clark & Chalmers, 1998).

A significant and progressive paradigm shift, characterized by a shift from an idea of mind as an isolated entity to a view that actively integrates the body into the cognitive process, is known as *Embodied Cognition.*

This perspective, which has emerged in recent decades, has not only contributed to questioning the traditional mind-body dichotomy, but - more importantly - has highlighted the crucial role that the body plays in the cognitive process, opening up new research perspectives.

Interest in the role of the body in the emergence of cognitive processes has characterized numerous theoretical and experimental approaches that argue that cognition is deeply dependent on the characteristics of an agent's physical body (Farina, 2021). Furthermore, the paradigm of embodied cognition has also suggested new ways of investigating the nature of cognitive systems.

Cognition as a representation of an external world separate from the subject is no longer a conceivable view (Re & Malvica, 2023). For this reason, understanding cognitive systems on the basis of their input-output relations has forced us to revise many theoretical positions. Cognitive processes are not primarily internal, do not take place within the confines of the brain and are relatively independent of the physical body. Cognition is a more holistic process that involves our entire body and its engagement with the surrounding world.

The difference between these perspectives influenced how research was conducted and applications were developed. For instance, while a computational approach might focus on developing more sophisticated algorithms to mimic human thought, embodied cognition would emphasize creating technologies that enhance or extend our physical interactions and sensory experiences.

Thus, according to the embodied cognition approach, the mind is not a disembodied internal representation of the external world, nor as a system of neural symbols. Cognition is an active process directed by the body's potential action, indicating that individuals understand their environment in terms of their ability to act within it. The body, in fact, is constitutively present within a pre-reflective and original dimension (Re, 2017., Re & Malvica, 2023) that precedes intellectual comprehension.

Phenomenology sees the body as actively shaping experiences rather than passively receiving information, emphasizing its role in constructing reality.

Merleau-Ponty's exploration of the body (2003) articulated in phenomenological terms, proposes a crucial distinction between *"having a body,"* (an objective state where the body is observed, measured, and analyzed externally, and *"being a body,"* a subjective experience where the body perceives, experiences, and acts within the world. This conceptual framework highlights the dual aspects of the body as both an object in the world and a core element of personal, lived experience.

In "*Phenomenology of Perception"* (2003) Merleau-Ponty describes this dual aspect of the body as marked by an irreducible ambiguity. This ambiguity reflects the complex, dual nature of the body: on one hand, it is a physical object integrated into the material world, on the other, it is the center of subjective experience through which we engage with and perceive the world around us. Merleau-Ponty suggests that this ambiguity, while conceptually clear, often dissolves in actual lived experience. When we are engaged in everyday activities, we do not typically experience our bodies as objects. Instead, there is an integration of the subjective and objective dimensions of the body. This dissolution of ambiguity is not a resolution of the conceptual distinction but a testament to the deeply integrated nature of our experience where the body is simultaneously both subject and object.

The sense of self and the interaction with the world are thus inextricably linked to our physical embodiment. This dissolution of ambiguity is not a resolution of the conceptual distinction, but evidence of the deeply integrated nature of our experience, in which the body is simultaneously subject and object.

2. SOME EVIDENCE ON EMBODIED COGNITION

Dominant theories within classical philosophy of mind and cognitive science have viewed the body as secondary in understanding the nature of mind and cognition, favoring the idea of the mind as an information processor.

The embodied cognition approach emerges with the aim of overcoming the limitations of a computational and representational conception of the human mind, with the transition from the study of internal processes to the experiences that derive from having a body with specific perceptual and motor properties. No longer just the brain, but the brain inserted into a body and the sensorimotor interaction with the environment become the crucial elements to consider to adequately describe a cognitive system.

Embodied cognition framework argues that human cognition is fundamentally grounded in bodily interactions with the environment (Lakoff & Johnson, 1999., Shapiro, 2012).

Varela, Thompson and Rosch (1991) further articulated this perspective by emphasizing the interaction between agents and their environment, rather than viewing cognition as an agent-internal process. This perspective emphasizes the importance of action in the formation of cognition, implying that cognitive processes are profoundly influenced by physical abilities and bodily experiences. Therefore, unlike traditional theories that treat cognition as a computation that occurs primarily in the brain, embodied cognition sees cognitive processes as emerging from a continuous cycle of perception and action.

A plethora of empirical studies have reinforced the principles of embodied cognition, for example, Glenberg and Kaschak (2002) showed that action-related language processing depends on the simulation of physical actions in the brain, supporting the embodied nature of cognition. Their experiment involved participants making judgments about sentences that implied physical movement, and results indicated that comprehension was facilitated when the direction of movement in the sentence matched the physical response required by the task.

A study has shown that the processing of emotional states and the concepts used to refer to them rely in part on perceptual, motor and somatosensory systems (Carr *et al.*, 2018). Dijkstra *et al.* (2007) have explored how body position affects memory recall in a study focused on autobiographical memory. This was done to investigate the effects of embodied cognition on memory performance. During the study, participants were asked to adopt body positions that were either the same as or different from those during the original events they were trying to remember. Findings indicated that participants who matched their body positions to those of the original events were able to recall memories more quickly than those who did not. This led to the conclusion that body position can enhance access to autobiographical memories.

3. FROM EMBODIED COGNITION TO EMBODIED EDUCATION

While the traditional view of education is often focused on abstract learning, embodied education applied the principles of embodied cognition to educational practices, incorporating sensory experiences, movement and physical engagement as fundamental elements of the learning process.

Research in cognitive science and education suggest that body movements, such as hand gestures during explanations, not only help people better understand and remember information but they also facilitate the cognitive process itself (Shapiro & Stolz, 2019).

The implications of embodied education are vast and varied. For example, students could develop a deeper understanding of the abstract concepts using physical tools to explore them. In mathematics (Pires *et al.*, 2019) this might involve using building blocks to physically explore geometry or algebraic structures. Moreover, there has been a push to incorporate movement and physicality into learning environments to improve engagement and retention (Barsalou, 2008) an approach based on evidence that physical engagement can anchor abstract concepts in concrete experiences, thus improving understanding and recall.

In the field of artificial intelligence, the concept of embodied cognition has led to a reconsideration of how intelligent systems are designed. Pfeifer and Bongard (2007) argued that robotic systems could achieve more sophisticated levels of intelligence if they were equipped with bodies capable of interacting with the physical world, a principle that has guided many recent developments in robotics.

Integrating technology can further enhance embodied learning. In fact, virtual reality (VR) and augmented reality (AR) could provide more engaging experiences that allow students to interact with three-dimensional representations of teaching material even for complex and abstract subjects that can benefit from an embodied approach.

In the first years of a child's life, their tendency to explore the surrounding world to learn new things is predominant, which parents and teachers are called upon to support with the aim of developing each child's learning potential. This is why in recent years the awareness of the role of the body and movement in teaching has seen - starting from primary school - an increasingly greater attention towards the development of sensorial and perceptive abilities. As Sibilio (2011) argues, for teaching to be truly effective it is necessary to combine the physical and theoretical dimensions of knowledge, in order to create connections between declarative knowledge (linked to conceptual knowledge) and procedural knowledge (linked to non-conceptual knowledge)

Although exponents of a certain pedagogical activism have often placed the cognitive value of embodied experience as fundamental to the learning experience, we can affirm that only today is the bodily dimension truly recognized as a resource for learning.

An ever-increasing number of studies, in fact, is aimed at exploring the potential of bodily and embodied knowledge in school contexts with the aim of reconsidering, on the one hand, the nature of learning processes, and on the other, designing application scenarios based on interaction. sensorimotor (Gomez Paloma & Damiani 2021).

The objective is to overcome the idea of exclusively theoretical and abstract knowledge by enhancing knowledge of the body. Such interdisciplinary approaches are crucial for unraveling the complex ways in which our bodily experiences shape our cognitive processes. The integration of embodied tools into educational experiences is underscored by numerous studies highlighting the role of spatial skills in enhancing STEM education.

Early training in spatial skills through hands-on exploration and activities (Terlecki *et al.*, 2008) supports the importance of integrating spatially focused curricula in childhood education. Burte *et al.* (2017) further demonstrate the positive impacts of an embodied spatial education program on elementary students' spatial and mathematical thinking, showing improvements in real-world math problems. Similarly, Byrne *et al.* (2023) advocate for incorporating physical manipulation interventions into early learning experiences to boost children's spatial abilities.

Clifton *et al.* (2016) discussed the correlation between spatial skills and STEM success, proposing the design of tangible, embodied interfaces that engage spatial cognition and integrate interaction with digital content into the physical environment. This approach leverages the relationship between the body and spatial cognition, highlighting a direct application of spatial skills in enhancing STEM education.

Other studies (Fernandez-Mendez *et al.*, 2020) showed that spatial reasoning and mental rotation significantly influence mathematical performance in children, particularly in younger age groups. This suggests a foundational role of these skills in early mathematical education.

Hostetter & Alibali (2019) proposed that gestures accompanying speech emerge from perceptual and motor simulations, further supporting the notion of embodied cognition in educational settings. Moreover, integrating physical activity into academic time has been shown to enhance executive functioning, with studies (Norris *et al.*, 2019., De Greef *et al.*, 2018., Benzing *et al.*, 2016) documenting improvements in children's planning, problem-solving, inhibition, and cognitive flexibility.

In conclusion, the enhancement of educational strategies and interventions through the application of spatial skills and embodied learning concepts not only improves understanding, but also promotes outcomes in STEM education. Embodied education represents a shift towards a more holistic view of learning, in which the role of the body in cognitive processes is valued and used within educational practices. By recognizing and implementing strategies that engage the body in learning, educators can create more effective and engaging learning environments that accommodate a wider range of learning styles and needs.

4. CONCLUSION

While classical cognitive science has made significant contributions to our understanding of various mental phenomena, its focus on mental processes as essentially computational has deeply influenced how we think about learning and education. According to classical cognitive science, the mind functions like a computer, manipulating symbols according to formal rules (Fodor, 1975). These symbols are thought to represent real-world objects and concepts, enabling complex thought and reasoning. However, the theory of embodied cognition challenges some of the computational assumptions of traditional cognitive science, emphasizing the essential role of the physical body in cognitive abilities and prompting a reevaluation of teaching methods. This approach aligns with the understanding that bodily experiences are central to development and learning (Gomez Paloma, 2017). For some years, evidence supporting the impact of movement on learning has highlighted the potential of embodied educational approaches in various learning domains (Mavilidi et al. 2018). More importantly, the field of STEM education appears to benefit from an approach that is situated within an embodied cognitive framework by promoting an understanding of spatial concepts through physical engagement, facilitating more efficient knowledge construction.

Despite the considerable efforts and numerous experimental evidence supporting the importance of teaching based on an embodied approach, we are far from its effective application in the school context. Many educational programs are still based on traditional models, which means that application efforts are insufficient, because they are not supported by a real programming of the educational goals and by a full awareness of the importance of an educational practice that unites mind and body.

In this direction, future research should focus on developing practical approaches to enhance educational practices through school-university collaboration. While training teachers in embodied learning represents a significant opportunity, it is essential to make this approach concrete, by designing environments that shift away from passive learning. Instead, these environments should engage students in the *active exploration of content*, integrating both body and environment. This approach is particularly beneficial for students, as it mirrors the natural, experiential way they learn in the real world. Additionally, fostering collaboration between schools and universities can provide ongoing support and resources to teachers as they implement embodied learning strategies. These collaborations can facilitate the sharing of research insights and practical tools, ensuring that embodied learning becomes a sustainable approach in several educational settings.

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