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Movement Matters

How Embodied Cognition Informs Teaching and Learning

Edited by: Sheila L. Macrine, Jennifer M.B. Fugate

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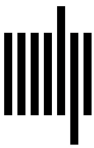

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Introduction

Sheila L. Macrine and Jennifer M. B. Fugate

Movement makes reason lucid
—Hozier, 2019

Understanding the mind and how thinking occurs has been a challenge for philosophers, scientists, theorists, educators, and artists throughout history. Ideas about how we learn have been mainly theoretical and intuitive. With the current advances in neuroscience, however, many unanswered questions are being addressed. As a result, a paradigm shift is taking hold in human cognition, pointing to a new science-based understanding about the way we think and, ultimately, the way we learn. That shift includes a move away from traditional notions of the mind to an "embodied" model of human thinking and learning. Backed by scientific evidence from neuroimaging techniques, there is a growing movement to not only understand thinking as inseparably linked with the body and the environment, but also to reimagine the learning that follows. When thinking (i.e., cognition) is embodied, it is deeply dependent on features of the physical body of the learner. Said another way, a learner's body plays a significant causal or physically constitutive role in cognitive processing (Wilson & Foglia, 2016). Therefore, the body (and the brain's representation of that information) is key to understanding how thinking occurs (Kumar, 2018).

The French philosopher Merleau-Ponty (1962) posited that an embodied approach emphasizes an intercorporeality of the "subjective, lived-body" and that cognition cannot be understood without the body's engagement with the world—a type of "enfleshment" of thought (see Gallagher & Varela, 2003; Leitan & Murray, 2014; Macrine, 2002; Marshall, 2008). For Merleau-Ponty, thinking is manifested, learned, and even relearned through bodily experiences (Bahler, 2016; Leitan & Chaffey, 2014). It is this philosophical theory of embodiment that eventually evolved into a testable theory in cognitive science called "embodied cognition" (Fincher-Kiefer, 2019). Embodied cognition scholars argue that the body is indeed essential in the production of cognition (Varela

et al., 1991) and that cognitive processes are based on—or are at least moderated by—sensorimotor processes (Barsalou, 2016; Mahon & Caramazza, 2008; Zona et al., 2018). Put differently, our physical interaction with the world influences or—in some cases—even determines our cognition (Kemmerer et al., 2013; Shapiro, 2014). Indeed, previous researchers have theoretically recognized that cognition is not only embodied but also socially constructed (Piaget, 1977; Vygotsky, 1978), situated (Lave, 1988), and culturally dependent (O'Loughlin, 1995; Rogoff, 1990). In addition, others pointed to the need for embodied metaphors (Lakoff & Johnson, 1980), concrete and hands-on experiences (Dewey, 1938; Montessori, 1912, 1973), such that the body is seen as the center of knowledge (James, 1890, p. 154). Further, Gibson (1979) argued that the person and the environment are mutually dependent on one another. Today, with advances in neuroscience, we have evidence confirming embodied views of cognition based on bodily and neural processes of perception, action, and emotion (Anderson, 2018; Aziz & Gomez-Djokic, 2016; Glenberg et al., 2013; Hauk et. al., 2004; James, 2010; Niedenthal, 2007; Niedenthal et al., 2010).

Although there are many "flavors" of embodied cognition, most recognize that thinking is grounded within the body and the environment, and that knowledge is simulated either directly or mediated by mental representations (for some examples, see Abrahamson & Lindgren, 2014; Barsalou, 1999, 2008; Clark, 2008; Gallagher as cited in Rowlands, 2010; Glenberg et al., 2005; Menary, 2010; Shapiro, 2011, 2014, 2019; Wilson, 2002). Recently, embodied cognition has expanded to incorporate the collective term "4E cognition," in which cognition is understood as not only "*e*mbodied," but "*e*mbedded" within a context, "*e*xtended" beyond the individual through enculturated practices, and "*e*nacted" as part of a dynamic system in which the body is self-producing and adaptive (see Hutto & Abrahamson, chapter 3 in this volume; Gallagher in Rowlands, 2010; Glenberg et al., 2005; Shapiro, 2014). So what does this mean for learning, and what are the implications for education?

Our current educational delivery systems (i.e., teacher education, teaching pedagogy, curriculum, environmental design, and educational psychology) and approaches can be traced back to "disembodied" views of human thinking. Accordingly, perceptual, sensory, and motor systems were presumed to be irrelevant in understanding brain processes (Wilson, 2002; Woodward et al., 2009). As a result, thinking was considered to be "limited" by the bodily senses and had to be freed from the corporeal trappings of the physical world (Young & Whitty, 2010).

For example, behaviorist theory prioritized stimulus-response action, which basically removed the individual from the equation and focused solely on

action and prescribed responses. This led to passive transmission models of learning in the 1940s and early 1950s. Even with the onset of the cognitive revolution, passive learning continued to dominate, although the ideas of stimulus-response were now thought to be mediated by the brain. By the mid-1950s, information-processing models of cognition began to take root, and cognitive processes were likened to software computations (see Turing, 1950; Miller, 2003). As a result, thinking was now viewed as a *computation* process, with perception seen as the *input* and action as the *output.*

These early computer metaphors of cognition have evolved into the present day's computational models, yet few consider the person as central to the process. The goal of this kind of computational modeling is to infer the structural and functional properties of a cognitive process from the behavioral data thought to be generated by that process (Pitt et al., 2002). Yet these working models still mostly view thinking as amodal (symbolic) computations that lack connections to the individual's body and sensory systems (Fodor, 1975, 1998), and they often fail to correspond to the semantic properties of mental states specific to human understanding.

While theories of embodied cognition continue to emerge, the American classroom has not kept pace. Teaching pedagogy and curriculum continue to view learning as abstracted and separate from the body. As a result, classroom teaching continues to rely on presenting and learning disembodied concepts, without the engagement of the sensory motor systems or understanding how the body influences internalization of these concepts (see Macrine & Fugate, 2020, for a recent review).

Alternatively, an "embodied learning" paradigm suggests that actions, emotions, sensations, and environment can influence what is learned. In addition to active bodily based learning, embodied learning can also be achieved through simulations, which are aided by the brain's mirror neuron system (see Butera & Aziz-Zadeh, chapter 16 in this volume). As an example, observing the actions of a teacher results in the neural underpinnings of action observations and simulations (see Barsalou, 1999).

This Volume

The goal of this book, *Movement Matters,* is to explain/translate the latest empirical and clinical research on embodied cognition and to demonstrate how embodied teaching and learning principles naturally follow. That said, *Movement Matters* presents a space where neuroscience, psychology, cognitive science, and technology meet education to inform learning theory and to inspire

an embodied approach to teaching the whole person. To accomplish this, we adopted and adapted an emerging approach called translational science research, historically found within the biomedical disciplines (McGaghie et al., 2012), to elucidate empirical and clinical findings for the public (NIH, 2020).

Such translational approaches have already been proven successful in the development of effective tools and interventions in the biomedical fields (NCATS, 2017). In other words, translational science (*bench to bedside*) is instrumental in closing the bio-medical research gap and is devoted to interpreting basic research findings to be used for tools, interventions, diagnoses, treatments, and prevention (Munro & Savel, 2016).

In 2013, Henry Roediger presciently wrote, "In an ideal world, Cognitive and Educational Psychologists would have created a translational educational science that would be eagerly adopted by education, schools and educators who would want to improve education on the basis of the latest research findings" (p. 1). He added that although such translational science has helped to disseminate new biomedical discoveries to broad audiences quickly, this has not been the situation in education despite more than a century of relevant psychological research (p. 1).

Evidenced-Based Practice

The call for research and evidence-based practice in education can be found in the No Child Left Behind Act of 2002, which mandated that "scientifically based" research be the norm for classroom instruction. Its updated replacement, the Every Student Succeeds Act of 2015, called for "evidence-based" interventions that are proven to be effective in leading to desired outcomes—namely, improving student achievement. Further, one of the nation's foremost education researchers and policy analysts, Linda Darling-Hammond has stated that the rapid pace of our knowledge of human development and learning has impacted the emerging consensus about the science of learning and development and increased our opportunities to shape more effective educational practices (Darling-Hammond et al., 2020). Yet, she added, to take advantage of these advances requires integrating insights across multiple fields and connecting them to our knowledge of successful approaches.

To face these challenges, we adapted a model of translational science (Rubio et al., 2010) called *Translational Learning Sciences Research* (Macrine & Fugate, 2021) specifically to address evidenced-based research on embodied cognition in an applied format for educators. We argue that this collection is the first to systematically gather, collate, translate, and disseminate the latest embod-

ied research geared toward improved learning outcomes. It also shares some of the most significant breakthroughs and applications that recent embodied cognition research has made on the science of learning across content areas.

In this volume, we apply our model to educational, psychological, and neuroscience research to inform embodied teaching and learning pedagogy for the classroom. It has four major goals: (1) to translate and inform the reader on the latest research in embodied cognition; (2) to develop and create appropriate embodied curriculum and instruction to improve teaching and learning outcomes; (3) to create resources and tools to develop a better understanding of embodied teaching and learning; and (4) to eventually develop taxonomies to track implementation and outcomes, which will assess whether competencies are being met (adapted from Rubio et al., 2010).

To accomplish this, our contributors specifically review and report on the impact of sensorimotor activity in the academic content areas of language, STEM (science, technology, engineering, and mathematics), applied technologies, and social and emotional competencies. Each of the contributors presents their embodied cognition research within these areas and translate their findings for classroom application. In doing so, we hope to encourage educators, educational psychologists, and others involved in schooling to adopt, apply, and develop their own embodied educational pathways. As a result, this book demonstrates how learning can be brought to new heights when the principles of embodied cognition are empirically applied to learning theory and teaching pedagogy. Finally, this collection helps us to understand what we know about how we learn and how this knowledge should inform the way we teach.

That said, embodied cognition represents one of the most important research programs in contemporary neuroscience and cognitive science. *Movement Matters* responds by translating the latest research on embodied cognition and critically examines its implications for classroom learning and teaching pedagogy. This book, written by a distinguished group of international scholars and emerging researchers, both charts embodied cognition's conceptual and philosophical roots and interprets and translates the supporting empirical evidence into effective teaching and learning strategies. The aim of this volume is to begin to build interdisciplinary connections among the theoretical and applied advances in the field of embodied cognition with applications for education and the Learning Sciences. Mindful of the fact that this research cuts across multiple disciplines and is rapidly expanding, *Movement Matters* is both a timely and important collection for educators and scholars. It bridges the gap between research and curriculum-content silos of knowledge by bringing

together experts from all content areas in one collection. The goal of this book, therefore, is to help educators better understand the current scholarship and research in the new Learning Sciences—specifically, embodied cognition and its extensions, the "4E's" of cognition (Gallagher as cited in Rowlands, 2010).

Organization

These are indeed exciting times for education, where our previous understanding of the importance of the body in learning was mostly theoretical (i.e., Montessori, 1973; Piaget, 1977; Rogoff, 1990; Vygotsky, 1978). Now behavioral and neural evidence from psychology, neuroscience, cognitive science, and artificial intelligence has empirically supported these assumptions. Consequently, all these fields have undergone paradigm shifts in their view of the way knowledge is acquired, produced, and represented.

Each chapter provides discussions within the content areas to reveal why embodied principles, approaches, and techniques facilitate learning and should therefore be integrated into the K-12 curriculum and beyond. Realizing the continuous interactions among the learner's body, brain, mind, and environment provides a powerful mediating tool for the construction of an embodied learning curriculum, environmental design, and teaching pedagogy. Therefore, *Movement Matters* has much to offer educational practitioners, scholars, and researchers toward recognizing the untapped impact of embodied cognition as it can help students reach their full potential.

This book is organized into five major parts. The foreword, written by Lawrence Shapiro, Ph.D. (Philosophy, University of Wisconsin–Madison), explicates the foundations of the philosophy of mind and philosophy of psychology. He does this brilliantly through a compelling metaphorical description using *The Matrix* movie and its characters to unpack embodied cognition. Shapiro notes that psychologists and educators who have embraced embodied views of cognition now seek to understand how a student's gestures might indicate something about their grasp of mathematical concepts and how a teacher's gestures might in turn illuminate these concepts. He further argues that embodied cognition has inspired new and promising educational strategies (including many found in this book), which have already proven superior to the "learning-by-recipe" route.

Part I, "Philosophical and Theoretical Background," discusses the mind/body dichotomy, the foundations of cognitive psychology, and computational models of mind (cognitivism). The authors in this section address the first step in our *Translational Learning Sciences Research* (Macrine & Fugate, 2021) model by tracing the history of thinking. These chapters highlight the promise

of embodied cognition for education, in which the mind and body work together to aid cognition and ultimately learning.

Part II, "Language," applies the principles of embodied cognition in the content areas of handwriting, vocabulary acquisition, language development and comprehension, and computerized reading. This section, based on the first and second steps in *Translational Learning Sciences Research* (Macrine & Fugate, 2021), introduces literacy-based research into tools and interventions to help us to understand that both physical and imagined manipulation leads to large gains in memory and comprehension.

Part III, "STEM," contains four chapters dedicated to mathematics and sciences. Similar to the focus of part II, our model translates STEM-based research into tools and interventions that emphasize the importance of early finger counting and manipulatives, as well as the importance of hand and body gestures in understanding physical forces.

Part IV, "Applied Technology," contains four chapters relating the principles of embodied cognition to learning technologies developed for various digital platforms, including kinesthetically active games using sensors and motion capture, as well as those for augmented and virtual reality. In a special chapter, some of these embodied educational techniques are adapted for use with individuals with special needs. These authors translate the latest systematic efforts to convert basic research knowledge into practical applications to enhance teaching and learning.

Part V, "Social Cognition, Emotion, Mindfulness," explores how mirror neurons within the brain serve as the biological mechanism for social connectedness and emotion, as well as how individuals with disordered sensorimotor experiences might learn differently. Finally, it elucidates an understanding of how emotion is embodied, and how emotional and mindfulness interventions benefit classroom behavior and learning.

In the conclusion, we link back to the core message of the volume: the importance of embodied approaches to teaching and learning. We reflect on the clear signals from the research to provide insights that would not have been possible had this book not been researched and written and these findings not translated and developed. For example, we show how embodied approaches can change the way we teach and learn and how they can inform curriculum development, teacher education programs, education psychology courses and textbooks, and special education. Further, we discuss how this collection serves as a useful road map and source for future educators, researchers, and scholars as they make their own connections for teaching and learning. Finally, we discuss the importance of getting this vital information into the hands of teachers and learners, educational psychologists, and curriculum designers. We

hope to encourage others to investigate and explore approaches and applications to embodied learning—and the science behind it.

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