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Book Review

A Review of *Mathematics and the Body: Material Entanglements in the Classroom*

Mathematics and the Body: Material Entanglements in the Classroom. Elizabeth de Freitas and Nathalie Sinclair. (2014). New York, NY: Cambridge University Press, 284 pp. ISBN 978-1-107-03948-3 (hb) $99.00, ISBN 978-1-139-95040-4 (e-book) $79.00.

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In *Mathematics and the Body: Material Entanglements in the Classroom*, Elizabeth de Freitas and Nathalie Sinclair present an approach to embodiment they term *inclusive materialism*. Their aim is to radically disrupt notions of "the body," primarily by decentering the body in accordance with an ontology categorizing physical matter, mathematical concepts, diagrams, sounds, gestures, and technological entities as an assemblage of "entanglements" constituting mathematical activity. Their perspective is explicitly influenced by feminist, queer, and critical race philosophies, which they channel to redefine what is considered human, to redraw the boundaries of what has historically been described as material and embodied, and to "rescue the body, so to speak, from a theory of discourse that denies its materiality in order to grant the body some measure of agency and power in the making of subjectivity" (p. 40).

This work is clearly intended for mathematics education researchers—there is little directed at classroom teachers—who have a background in epistemology and posthumanism. The authors leverage mathematical philosophy, primarily the work of Gilles Châtelet, to expand "the notion of the body to include not only the human one or the physical one (of tools and objects), but also the body of the concept" (p. 226). They apply this perspective to the analysis of classroom practice and pedagogy by arguing for a *pedagogy of the concept*, which positions learning as "an indeterminate act of assembling various kinds of agencies rather than a trajectory that ends in the acquiring of fixed objects of knowledge" (p. 52).

The first two chapters summarize the philosophical underpinnings of inclusive materialism, including posthumanist ontologies, materialist epistemologies, and feminist philosophy. These chapters are theoretically complex and linguistically dense, and they offer no immediate connection to mathematics education design or praxis. However, the next few chapters turn to the mathematics classroom. Chapter 3 provides the initial foray into classroom data on mathematical activity, using Châtelet's notion of *diagrams-as-gestures* to elucidate the role of diagrams in coconstituting mathematical meaning. Chapter 4 expands on this, exploring

how the diagram–gesture interplay enables children to create and invent new mathematical concepts. Chapter 5 investigates the role of language in coconstructed meaning making and expands on the notions of *invention* and *intervention*, proposing discourse as a "collective process of material *in*(*ter*)*vention*, not a translation of thought or only (or mostly) a semiotic act of representation" (p. 8), a point also made by Sfard (2008). The authors approach and analyze discourse as sensation and perception rather than a semantic act by focusing on prosodic elements such as tonality, volume, and speed to the near exclusion of linguistic elements. Chapter 6 aims to redefine "(dis)ability" from a critical and inclusive materialist perspective by arguing that a posthumanist ontology liberates the body from the materialist confines of "traditional" embodiment theories. This component of the book is perhaps the most explicitly political and social justice oriented. Chapter 7 returns to a purely theoretical approach by positioning the work of Foucault against that of Jacques Rancière, leveraging the latter's notion of *dissensus*—the process of attending to or vocalizing what was once invisible and inaudible—to redirect the researcher's attention to the "political-aesthetic forces" (p. 11) taking place during classroom activity. In Chapter 8, de Freitas and Sinclair delve into Châtelet's concept of *virtuality* as a bridge between the mathematical and physical universes. The authors utilize the notion of the *virtual* as a lens for rendering mathematical concepts not as abstract or intangible pieces of knowledge to be acquired but as agentic entities that are entangled with all other materiality.

There are several themes in the book that we felt were worthy of particular attention to *JRME* readers. The first relates theories of embodiment to gesture. One compelling contribution of the inclusive materialist framework is the analytic account of diagrams with respect to gesture production. Whereas the field of gesture studies views gestures as spontaneous hand and arm movements serving communicative and psychological roles, de Freitas and Sinclair draw instead from the work of Châtelet, whose study of gesture emerged from his analysis of the diagrams formed by mathematicians. In Chapters 3 and 4, the focus is on "reading" diagrams not as "representations" but as records of "inventive moments in mathematics by examining the gesture/diagram interplay from which they [the diagrams] emerged" (p. 62). Here, the virtual "becomes the animating force of the mathematical, giving flesh and mobility to what might otherwise have been considered abstract, idealized and inert" (p. 110). The authors argue that rather than offering a trace of one's mathematical reasoning, the diagram–gesture interplays materially bring new mathematical entities into being. The authors rightly indicate that this is a major departure for how diagrams are typically studied within mathematics education research.

Secondly, the authors offer methodological tools for mathematics education researchers to apply an inclusive materialist perspective to classroom data; for example, they reimagine and analyze students' diagrams as a diagram-action-gesture hybrid possessing mathematical agency, and they conduct a "material reading of speech" (p. 111) to elucidate the micropolitical, agentic, and material nature of classroom discourse. In their analysis of first graders who are learning

about intersecting and parallel lines in a lesson taught by Sinclair using Geometer's Sketchpad, de Freitas and Sinclair state that the creative acts of students and teachers in mathematics classrooms—specifically, the gesture–diagram interplays that they engage with as part of the learning assemblage—are "unexpected in the sense that they are not *directly caused by* the software, by the teacher or by any individual student" (p. 98). Further, the gestures "actualize infinitely extending lines and their invisible points of intersection" (p. 98) as they create and predict future, unobserved behaviors. Their analysis clearly foregrounds the collective nature of the classroom process and the actualization of intersecting and parallel lines as material assemblages of talk, gesture, and mathematical display. For example, we see instances of gestures used by one person taken up by another over the course of the discussion, presumably as a social form of *catchment,* as previously described by David McNeill (e.g., McNeill & Duncan, 2000). However, we could not tell what about their analysis was uniquely indicative of the toolkit from inclusive materialism. An interesting comparison is to the work of Bieda and Nathan (2009), who reach similar conclusions about students' mathematical reasoning based on an analysis of their gestures, speech, and diagrams regarding seen and unseen behaviors of lines but do so using a Grounded and Embodied Cognition (GEC) framework. As Barsalou (2008) notes, *grounded cognition* explores "the assumption that cognition is typically grounded in multiple ways, including simulations, situated action, and, on occasion, bodily states" (p. 619). Bieda and Nathan (2009) demonstrate the ways that students' mathematical reasoning is grounded in the particular visual–spatial properties of graphs, which then constrain some forms of generalization.

Third, the authors explicitly state the caveat that they provide no direct recommendations for mathematics educators, but they do discuss pedagogy and curriculum throughout the book. De Freitas and Sinclair make such connections most explicitly by discussing how the pedagogy of the concept aims to reconstrue learning as ontological instead of epistemological—that is, they seek to emphasize the materially embodied nature of concepts, knowing, and learning. De Freitas and Sinclair further introduce the notions of *surprise* and *inventiveness* to connect their theory to classroom practice. Surprise, here, is an act of dissensus; for the authors, it is crucial both aesthetically for mathematics problems and pedagogically for mathematics instruction. Inventiveness within the classroom setting is regarded as a "sensuous" (p. 109) relationship between the student (or teacher) and the material world, such that learning and creativity do not take place within the body of the student but instead are distributed across multiple entities that constitute the assemblage.

One last theme is how inclusive materialism forces embodied theories to redefine disability. Central to this discussion is how mathematics is integrally related to the senses. Yet, as de Freitas and Sinclair argue, sensation is ephemeral—it is composed in the moment as new bodily assemblages emerge. They argue that sensory organs are one component of such assemblages, so we may only consider how they are operating at the time of the phenomenon under investigation. This

leads the authors to reframe disability as (*dis*)*ability*—although they do not explicitly provide a definition for their term. Instead, they argue for a posthumanist pedagogy that focuses not on accommodations for students but on how the body itself is a collection of transient and provisional assemblages and entanglements. In this way, an inclusive materialist perspective does not recognize a dichotomy of ability versus disability but considers the unique in-the-moment assemblage of entanglements for any person's set of physical and sensory abilities because these afford different ways of knowing. Although the authors dedicate a great deal of space to discussing how inclusive materialism combats traditional notions of disability, they do minimal explicating of their posthumanist pedagogy or the sociopolitical implications of their revised ontology of (dis)ability.

We found several points of the book challenging or neglected. First, throughout the broader literature, different perspectives of embodiment address different time scales of behavior: Neural/Embodied Simulation Theory speaks to biological behaviors, typically operating in milliseconds; Conceptualist accounts address concerns at cognitive and rational scales on the order of seconds; Interactionist accounts speak to sociocultural phenomena that unfold over days; and inclusive materialist–political concerns address organizational phenomena, typically operating over years. The authors' theoretical perspective primarily stakes out this largest time scale, and although their methods seem most applicable to sociocultural scales, they seem to dismiss methodologies and research traditions speaking to embodiment along finer grained sizes.

Additionally, the authors assert a need to reframe the traditional philosophical distinction between epistemology (ways of knowing) and ontology (ways of being). De Freitas and Sinclair offer a blended form, which at various points in the book are labeled *onto-epistemology* and *epistem-ontology*, with the justification that they reject the separation of the knower and the known and want the reader to apprehend the materiality of mathematical concepts. The point is a potentially enlightening one, were they able to provide a warrant for the proposal and, further—because this is a treatise intended for research praxis—to exhibit forms of analysis that are unfeasible without this blended construct. However, the authors do not deliver on either the warrant or the exhibits and often seem to slip back to traditional language that continues to dichotomize ontological and epistemological considerations.

A third and related challenge for us is the liberal use of complex terminology throughout the book. Although such terms have a similarly enlightening potential, their prevalence can bog readers down more than elucidate the utility of an inclusive materialist perspective for mathematics education research. Consequently, although various constructs the authors discuss—such as virtuality, dissensus, the pedagogy of the concept, in(ter)vention, and (dis)ability—aim to connect their theoretical framework to mathematics classrooms explicitly, these connections are at times disjointed and often obfuscated by demanding prose. The authors write that "this book is first and foremost about a rethinking of school mathematics in terms of an inclusive materialist philosophy of mathematics" (p. 12), yet we could

find little guidance as to how such a perspective may inform, reform, or transform pedagogy or research praxis. Nevertheless, we believe that their philosophical and epistemological stance provides a valuable viewpoint on embodiment that may imbue critical mathematics education researchers with a revised focus on mathematical concepts, knowledge, and learning.

Overall, de Freitas and Sinclair provide a novel approach to theories of embodiment by applying phenomenological methodologies to a feminist, sociopolitical philosophy of mathematics education. Although mathematics educators and those researchers coming from more cognitive traditions may not find their perspective to be immediately useful, their critical approach to embodiment is one that offers a new perspective on the role of the body within research on mathematics classrooms and forces the research community to rethink previously held notions of what constitutes the body, mathematical concepts, and the material world itself.

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