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EMBODIED DESIGN: BRINGING FORTH MATHEMATICAL PERCEPTIONS

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Embodied design (Abrahamson, 2009, 2014, 2015, 2017) is a theory-based pedagogical framework for building content-oriented learning environments, where students ground STEM concepts through first solving non-symbolical control-and-anticipation problems and then adopting normative disciplinary forms as means of enhancing their enactive, cognitive, and discursive interactions. In particular, the action-based genre of embodied design specifies how to create conditions for students to develop new goal-oriented sensorimotor perceptions of situations (i.e., affordances) as the prospective meanings of mathematical concepts. In this talk, I will motivate embodied design within the E-turn in the cognitive sciences and situate the framework among the current range of design rationales for interactive STEM educational products. Demonstrating empirical findings from multimodal evaluation studies of embodied designs for mathematics (proportions, geometry, trigonometry, parabolas, etc.), in which we analyzed and integrated audio–video, clinical, and eye-tracking data, I will argue that the framework implements key principles of Enactivism, namely that: "(1) perception consists in perceptually guided action and (2) cognitive structures emerge from the recurrent sensorimotor patterns that enable action to be perceptually guided" (Varela, Thompson, & Rosch, 1991, p. 173; see Hutto, Kirchhoff, & Abrahamson, 2015). Specifically, the embodied meanings of mathematical concepts—that is, the situated, invariant, and dynamical sensorimotor perceptual structures that students discern, generate, and maintain in response to challenging interaction tasks—emerge spontaneously as their tacit, adaptive, pragmatic means of facilitating and regulating the coordination of motor actions that enact control movements (Abrahamson, Shayan, Bakker, & van der Schaaf, 2016). I will end by reissuing a call for the learning sciences to adopt perspectives and methodologies of the movement sciences, in particular coordination dynamics, as tools for investigating, characterizing, and engineering embodied design for mathematics (Abrahamson, 2019; Abrahamson & Trninic, 2015; Abrahamson & Bakker, 2016; Abrahamson & Sánchez–García, 2016). In sum, at the Embodied Design Research Laboratory, we design for a particular inclination of prehensile cognitive architecture—human's ecologically adaptive propensity to seek, grope for, grasp, and use multimodal perceptual structures that facilitate bimanual motor control, where these dynamically invariant perceptual structures may be imaginary. The ambitious hypothesis emerging from our work is that the phenomenology of inventing and imagining mathematical objects is a sociocultural exaptation of this evolutionary inclination (cf. Gould & Vrba, 1982). Future design-based research on the cultivation of math cognition will pursue this hypothesis.

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