Affordances and Grounding Within Concreteness Fading When Learning Proof in STEM's Geometry

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Abstract

The Fourth Industrial Revolution's technological innovations are driving demand for high skill jobs in a global Knowledge Economy, precipitating Learning Scientists to advocate for developing Deeper Conceptual Understanding of STEM domains. In this study, Concreteness Fading is employed to develop Deeper Conceptual Understanding of Deductive Proof in geometry: enactive stage grounds justifications in spatial relationships through manipulating object-shapes; iconic stage grounds justifications in perceptual relationships through drawing images of object-shapes; symbolic stage grounds justifications in rule-based relationships through writing numbers in formulas about object-shapes. Think-aloud protocols were analyzed of post-secondary non-math majors (N = 8, male = 2, female = 6) randomly assigned to four conditions: enactive-iconic-symbolic (n = 2), enactive-symbolic (n = 2), iconic-symbolic (n = 2), symbolic (n = 2). Findings reveal reliance on affordances of spatial-based and perceptual-based proofs by participants after reaching a perceived impasse – demonstrating fascinating cognitive flexibility crucial for 21st century problem solving.