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Students' images of two-variable functions and their graphs.

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Summary: This paper presents a conceptual analysis for students' images of graphs and their extension to graphs of two-variable functions. We use the conceptual analysis, based on quantitative and covariational reasoning, to construct a hypothetical learning trajectory (HLT) for how students might generalize their understanding of graphs of one-variable functions to graphs of two-variable functions. To evaluate the viability of this learning trajectory, we use data from two teaching experiments based on tasks intended to support development of the schemes in the HLT. We focus on the schemes that two students developed in these teaching experiments and discuss their relationship to the original HLT. We close by considering the role of covariational reasoning in generalization, consider other ways in which students might come to conceptualize graphs of two-variable functions, and discuss implications for instruction.

Classification: I60

Keywords: two-variable functions; three dimensions; calculus; quantitative reasoning; covariational reasoning; conceptualization

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