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Impact of explicit presentation of slopes in three dimensions on students' understanding of derivatives in multivariable calculus.

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Summary: In two dimensions (2D), representations associated with slopes are seen in numerous forms before representations associated with derivatives are presented. These include the slope between two points and the constant slope of a linear function of a single variable. In almost all multivariable calculus textbooks, however, the first discussion of slopes in three dimensions (3D) is seen with the introduction of partial derivatives. The nature of the discussions indicates that authors seem to assume that students are able to naturally extend the concept of a 2D slope to 3D and correspondingly it is not necessary to explicitly present slopes in 3D. This article presents results comparing students that do not explicitly discuss slopes in 3D with students that explicitly discuss slopes in 3D as a precursor to discussing derivatives in 3D. The results indicate that students may, in fact, have significant difficulty extending the concept of a 2D slope to a 3D slope. And that the explicit presentation of slopes in 3D as a precursor to the presentation of derivatives in 3D may significantly improve student comprehension of topics of differentiation in multivariable calculus.

Classification: I65 C35

Keywords: differentiation; multivariable calculus; representations; semiotic registers; slopes

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