Expert vs. Novice strategy Use During Multiple Integration Problems

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One of the most challenging tasks in multivariate calculus for students is correctly setting up integration problems. The limited research in multivariate calculus suggests that this is due to the need to coordinate algebraic and geometric representations of the problem while maintaining representational flexibility. The purpose of this study was to explore the approaches that both experts and novices take to set up and solve triple integral problems using data collected via Smartpen-recorded task based interviews. The initial analysis of the data suggests that a difference in representational flexibility is one of the main differences between expert and novice approaches to multivariate integration.

Key words: integration, multivariate calculus, representational flexibility

Research examining students' success in introductory mathematics courses consistently shows that students are not learning the intended material (Apkarian & Kirin, 2017). In fact, multiple studies have revealed that students that achieve a high grade in introductory calculus actually have a weak understanding of the course's key concepts. These results put in question whether or not the traditional calculus curriculum is preparing students to use ideas of calculus in future courses (Bressoud, Carlson, Mesa, & Rasmussen, 2013). Ongoing efforts to reform calculus instruction arise from concerns that students are learning calculus as simply a series of algorithms without conceptual understanding (Dawkins & Epperson, 2014). Such algorithmic learning is problematic for students in multivariate calculus, where students need to be able to recognize and convert to appropriate coordinate systems to complete many multivariate integral problems.

The purpose of this basic qualitative research interview study (Merriam, 1998) was to explore how students in multivariable calculus strategize how to solve multiple integrals compared to expert mathematicians. This exploration is significant because there has been no research on integral strategy use beyond introductory calculus (Speer & Kung, 2016). Both the students and experts participated in task based interviews where they will complete multivariable calculus problems using a Smartpen, which allows for an audio recording to be synced with the writing without the use of video recording. The Pencasts were then be analyzed to compare problem trajectories and strategy use with the ultimate goal to compare and contrast expert and novice multivariate calculus users. The research questions for this study were: (1) What are the strategies used by expert and novice multivariate calculus students when solving multiple integration problems? (2) To what extent do experts and novices employ similar strategies?

The expert participants for this study were three tenured faculty members who had all taught multivariate calculus at least five times with the most recent iteration of the course being within two semesters of data collection. The novice participants were six undergraduate sophomores and juniors who had recently completed a multivariate calculus course within one semester of data collection. Expert participants were interviewed alone while the novice participants were interviewed in pairs. All participants completed the same 45-minute task-based interview of representative multiple integration problems using a Smartpen to capture their written work and audio discussion throughout the process. These Pencasts were then open coded for strategy use.

References

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