Exploring Calculus Students' Technology Use With Dynamic Graphing Technology

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Technology is commonly used in mathematics education to communicate ideas and support understanding of complex concepts. It can assist students by providing automated feedback on practice problems, such as in online homework environments (Dorko, 2020), and by individualizing problem sequences based on students' responses to prior questions (e.g., ALEKS). Drijvers (2012) describes students' use of technology as either doing mathematics or learning mathematics, with the latter including practicing skills and developing conceptual understanding. Roschelle et al. (2017) expand on this by considering productive and transformative perspectives of students' purpose to situate to describe the broader literature on educational technology.

Technology can support student understanding in several ways, such as reducing cognitive load by offloading calculations to technological tools, allowing students to focus more on conceptual reasoning (Paas, Renkl, & Sweller, 2004; NGA & CCSSO, 2010). Interactive technologies can also be programmed to follow formal mathematical rules, thereby supporting students' understanding of different representations (Heid & Blume, 2008). In this poster presentation, we explore how this framework helps us understand students' engagement with dynamic graphing software (Desmos) in a calculus context using Roschelle et al.'s framework.

Our data comes from one-on-one, task-based interviews with two undergraduate students enrolled in first-semester calculus. Students were asked to reason about function values, rates of change, and how these quantities vary when presented with a graph. They first interacted with a static image of the graph and were then given access to a dynamic version in Desmos.

We found that the students interacted with the technology in distinct ways and with seemingly different purposes. Roschelle et al.'s framework was useful in capturing this variation, as both students used Desmos in productive and transformative ways. Their engagement included doing mathematics, practicing skills, and developing concepts. For instance, one student used Desmos to practice a skill in a transformative way by alternating between reasoning with the printed static graph and the dynamic version. Notably, one student's understanding of changing quantities and slope evolved after leveraging Desmos features such as continuous sliding and zooming. We interpreted this as evidence of a transformative shift in their conceptual understanding. One student had taken a new understanding of an output $f(a)$ during the interview, and the task designer used the Desmos software to remind and reinforce that understanding– reducing cognitive load– by visually depicting the naming convention in the graph, supporting the student in maintaining that understanding throughout the task. Overall, we found the transformative categories to be more applicable to the data, possibly due to the nature of the graph interpretation task, which emphasize estimation from visualized measurements rather than numerical calculation. Future work will explore different tasks that incorporate other technologies (e.g., matrix calculators), which may yield different categorizations within Roschelle et al.'s (2017) framework.

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