Investigating Student Learning and Sense-Making from Instructional Calculus Videos

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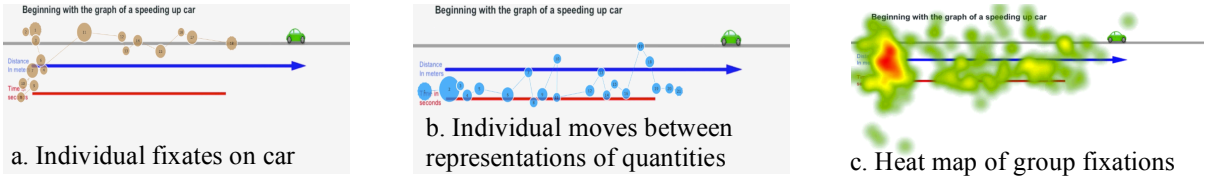
Growing interest in "flipped" classrooms has made video lessons an increasingly prominent component of post-secondary mathematics curricula. This format, where students watch videos outside of class, can be leveraged to create a more active learning environment during class. Thus, for very challenging but essential classes in STEM, like calculus, the use of video lessons can have a positive impact on student success. However, relatively little is known about how students watch and learn from calculus instructional videos. This research generates knowledge about how students engage with, make sense of, and learn from calculus instructional videos.

Keywords: Calculus, Eye-Tracking, Flipped Classrooms, Sense-Making, Quantitative Reasoning

To help instructors design videos for flipped classrooms, we have collected data from four different calculus classes using instructional videos. Videos used in this study have ranged from innovative approaches to calculus proven successful by supporting students' development of covariational reasoning (e.g., Martin & Oehrtman, 2015; Thompson, Byerley, & Hatfield, 2013) to videos of more traditional whiteboard type lecture. We investigate:

- The ways students interact with video lectures, including how they pause, skip, and re-watch portions of the videos;
- The aspects of the videos students attend to – and report attending to – as they watch;
- The ways students make sense of and learn from these videos, and how this relates the other aspects described above (e.g. Weinberg & Thomas 2016a, 2016b);
- How various ways of structuring the video-watching experience, such as providing an outline, can influence each of these aspects (e.g. Johnson & Mayer, 2009).

Data consists of student responses to mathematical content questions before and after watching videos, timestamps of students' interactions with videos (i.e. playing, pausing, and time-shifting videos), student responses to interview questions as they watch videos, and eye-tracking data from students watching videos. Our analysis yields knowledge about how students learn and interact with these videos. For example, Figure 1a. and b. demonstrates how eye-tracking data shows distinctions between student fixations (the brown and blue circles) while watching a video of a moving car. Figure 1c. indicates how the participant group tended to still be reading the labels when the car started traveling before moving their fixations between the representations for time elapsed, distance traveled, and the moving car.



a. Individual fixates on car

b. Individual moves between representations of quantities

c. Heat map of group fixations

Figure 1. Eye-tracking data indicating individual and group fixations in the context of a car speeding up.

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