Undergraduate Students' Conceptualizations of Four Big Ideas of Mathematical Modeling

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Mathematical modeling situates mathematical problem solving and critical thinking squarely in students' day-to-day experiences, broadening students' understanding of mathematics in everyday decision-making. Mathematical modeling is the *process* of creating mathematical representations to understand and make decisions about the world. When students model, they bring their individual experiences to understand a problem and inform their solution strategy. Thus, it is likely that the *modeling process* will unfold in different ways for different problems. Rather than focusing on modeling as a series of steps in a cyclic process, Arnold et al. (2021) described mathematical modeling in terms of four big ideas that characterize it.

1. Modeling begins and ends outside the mathematical world.
2. Modeling deals with situations that are open and complex.
3. Modelers exercise judgment when investigating problems.
4. Modelers decide when a solution is good enough.

We investigated how undergraduate students conceptualized these four big ideas during their study of and engagement with mathematical modeling. We designed and taught an upper-division, semester-long course in mathematical modeling at two different public land-grant universities. We created and implemented four modeling projects throughout the semester in our respective courses, with each project illuminating the four big ideas of modeling. We collected student work on these projects, along with survey data, and facilitated a written correspondence between undergraduates at the two universities. In those communications, our undergraduates reflected on their overall understanding of mathematical modeling and described their conceptualization of these four big ideas.

We conducted a thematic analysis (Braun & Clarke, 2006) on these data using an open and axial coding scheme (Strauss & Corbin, 1998). In our initial read of the data, we noted which of the four big ideas of mathematical modeling were prevalent. Then, using descriptions of the big ideas, we developed and used codes to describe the undergraduates' conceptualization of the four big ideas. Overall findings indicate that the big ideas were a tool to help undergraduates organize their own understanding of the process of mathematical modeling. We found that within undergraduates' conceptualizations, the four big ideas were connected and interdependent; when discussing one big idea, undergraduates also included connections to at least one other big idea. Tension also was evident between undergraduates' conceptualizations of Big Idea 2 and Big Idea 4; while they expressed excitement about the openness of a modeling problem, they also struggled with the notion of having to decide for themselves when their model and its solution were good enough. Lastly, we detected evidence of empathetic critical thinking skills in undergraduates' conceptualizations as they described how the modeling projects that focused on addressing justice in their own communities fostered their sense of mathematics and community.

In this poster, we (a) summarize the four big ideas of mathematical modeling, (b) describe the modeling projects we developed and implemented, (c) describe undergraduates' conceptualizations of the four big ideas, (d) summarize our findings, and (e) provide recommendations on how to facilitate undergraduates' learning of and engagement with the four big ideas of mathematical modeling.

References

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