Supporting undergraduate teachers' instructional change

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Teaching Inquiry-oriented Mathematics: Establishing Supports (TIMES) is an NSF-funded project designed to study how we can support undergraduate instructors as they implement changes in their instruction. One factor in the disconnect between the development and dissemination of student-centered curricula are the challenges that instructors face as they work to implement these curricular innovations. For instance, researchers investigating mathematicians' efforts to teach in student-centered ways have identified a number of challenges including: developing an understanding of student thinking, planning for and leading whole class discussions, and building on students' solution strategies and contributions. This research suggests a critical component needed to take curricular innovations to scale: supports for instructional change. In this poster we address our current research efforts to support undergraduate teachers' instructional change.

Keywords*: Instructional support, Inquiry-oriented, instructional change*

Purpose

The main goal of this NSF funded project, Teaching Inquiry-oriented Mathematics: Establishing Supports (TIMES), is to study how to support undergraduate instructors as they implement changes in their instruction. Additional goals of this project are to: 1) understand how best to support undergraduate mathematics instructors in effectively implementing inquiry-oriented instruction, 2) understand the relationships and interactions between instructional supports, instructors, and instructional practices, 3) characterize and measure inquiry-oriented instruction, and 4) assess student learning in inquiry-oriented instructional settings.

Inquiry-Oriented Instruction

We adopt Rasmussen and Kwon's (2007) characterization of inquiry, which applies to the activity of both the students and the instructor. Here, students learn new mathematics by: engaging in cognitively demanding tasks prompting exploration of important mathematical ideas, engaging in mathematical discussions, developing and testing conjectures, and justifying their thinking. Instructor inquiry seeks to reveal students' intuitive and informal ways of reasoning, especially those that can serve as building blocks for more formal ways of reasoning. Instructors inquire into students' emerging ideas to facilitate and support the growth of students' self-generated mathematical ideas. The instructor's role is to guide and direct the mathematical activity of the students by using their reasoning to support the development of new conceptions. The instructor's role is to guide and direct the mathematical activity of the students as they work on tasks by listening to students and using their reasoning to support the development of new conceptions. With an inquiry-oriented instructional approach, instructors: elicit student thinking, build on student thinking, develop a shared understanding, and connect student ideas to standard language and notation.

The Three Curricula

TIMES is centered on three sets of research-based, inquiry-oriented curricular materials being scaled-up for post-calculus undergraduate mathematics courses: linear algebra (e.g. Wawro, Rasmussen, Zandieh, and Larson, 2013), differential equations (Rasmussen, Kwon, Marrongelle, Allen, & Burtch, 2006), and abstract algebra (Larsen, Johnson, Weber, 2013). The instructional design heuristic of Realistic Mathematics Education formed the foundation on which these curricula were developed and, as such, each aims to foster student reinvention of important mathematical concepts (Freudenthal, 1973). To support this reinvention, the curricular materials contain task sequences developed to utilize and build on student reasoning. Such task sequences form the basis of inquiry-oriented instruction.

Instructional support

We currently have a three-pronged instructional support model consisting of curricular support materials, summer workshops, and online instructor work groups. Each of the curricular documents include a set of support materials created by the researchers responsible for developing the respective curricular innovations. These include: student materials (e.g., task sequences, handouts) and instructor support materials (e.g., learning goals and rationales for the tasks, examples of student work, implementation notes). The summer workshops span 2-3 days and have two main goals, 1) building familiarity with the materials, and 2) developing an understanding of the intent of the curricula, and inquiry-oriented instruction. Lastly, during the semester the participants meet in small groups for one hour a week to discuss selected lessons from the curricular materials. For each of the focal lessons, the groups discuss the mathematics embedded in the lesson and plan for implementation. The goal is to help instructors develop their ability to interpret and respond to student thinking in ways that support student learning.

Data

There are currently 18 instructors participating in this project in various universities across the united states. In order to address the research goals, data is being collected from a multitude of sources including: an instructor background survey, video recordings of the summer workshops, post summer workshop surveys, one-on-one interviews with instructors participating in the online working groups, video recordings of the online working group meetings, clips of instruction from the online working groups, video recordings of the participants' instruction, and student content assessments.

Research Progress

Currently TIMES is refining the instructor support materials utilizing data collected from the first group of participants, and leveraging findings from prior work - that indicates early implementers tend to be successful at eliciting but not building on student thinking, whereas whole class discussions facilitated by repeat implementers are statistically more likely to entail both eliciting and building on student thinking. Preliminary analysis suggests that the instructors felt the weekly online working group meetings had the highest impact on their successful implementation of the curricula, but that they desired more experiences discussing examples of how to utilize student thinking in their instruction. Additionally, a preliminary version of the inquiry-oriented instructional measure has been created and will be piloted on the data collected as part of reliability and validity testing. The next steps include continuing the investigation of how to support teachers' instructional change, analyzing the student assessment data (from both inquiry-oriented and more traditional non-IO classrooms), further refining the inquiry-oriented measure and assessing student learning in IO settings.

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