What Would the Research Look Like? Knowledge for Teaching Mathematics Capstone Courses for Future Secondary Teachers

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Abstract. *Mathematics Capstone Course Resources* is a 14-month proof-of-concept development project. Collaborators across three sites aim to: (1) develop and pilot two multi-media activities for advanced pre-service secondary mathematics teacher learning, (2) create guidance for college mathematics faculty for effective use of the materials with target audiences, and (3) gather information from instructors and students to inform future work to develop additional modules and to guide subsequent research on the implementation of the materials. The goal of this poster presentation is to provide information about capstone module development and brainstorm research design suggestions with the long term aim of developing a grant proposal to research the knowledge college mathematics faculty use to effectively teach mathematics to future teachers.

Research Questions

The preparation of the highest quality teachers of mathematics is a national imperative. There is a notable need for future math teacher "capstone" course materials, including guidance for math faculty, that deliberately and explicitly connect undergraduate mathematics content to the knowledge needed for teaching secondary mathematics. The poster includes details about the development processes and content of two capstone pilot modules. Our goal is that RUME attendees will discuss a preliminary research study design and outline the tools and analysis processes that will help us address the questions:

(1) How does incorporating the modules into instruction shape instructor mathematical knowledge for teaching future teachers (MKTFT; and how might we define MKTFT)?
(2) What are the relationships among varying conditions of implementation (differing degrees of fidelity of implementation) and the extent to which students are achieving the desired results?

Background & Conceptual Framework

Several NSF-funded efforts have been made in the past to create *courses* in mathematics departments that are secondary teacher candidate capstone courses. These courses appear to belong to three categories: connecting big ideas, connecting big ideas with deep content understanding, and connecting big ideas, deep content, *and* an applied understanding (where the application is to teaching). Some departments have a capstone course that emphasizes upper-division mathematical content with some connections to the topics found in secondary school curricula. Other departments' capstone courses also provide opportunities for pre-service teachers to enrich their knowledge of content *and* place more of an emphasis on developing mathematical knowledge for teaching, often in the form of knowledge of how students may think (productively and unproductively) about particular mathematical ideas. The range of needs such courses may fulfill for programs make it challenging for instructors to find and/or create an adequate supply of appropriate materials (Banilower, et al., 2013).

Results

We are aiming for a design that will allow reporting on results about the development of math knowledge for teaching future teachers. This includes articulating specifics for that type of knowledge/knowing. By definition, pedagogical content knowledge (PCK) is the collection of knowledge teachers and other instructional personnel need about the challenges learners encounter, strategies for helping students, ways to listen to identify not only learners' thoughts

but also thinking processes, and skills for regulating teaching practices (Shulman, 1986). Teachers at all levels acquire PCK in many ways: grading, examining their own learning, observing and interacting with students, observing and interacting with colleagues, and reflecting on and discussing practice. Since Shulman's seminal statement on the blends of pedagogical and content knowledge needed for teaching, a rich collection of theories and models of it has grown in mathematics education (Depaepe, Verschaffel, & Kelchtermans, 2013).

The framing of knowledge for teaching mathematics has centered on the question: What mathematical reasoning, insight, understanding, and skills are entailed for a person to teach mathematics effectively? We want to add to the end of that question: …to teach mathematics effectively *to future teachers*? Work on math knowledge for teaching in secondary and post-secondary settings (Hauk, Toney, Jackson, Nair, & Tsay, 2014; Speer, King, & Howell, 2015) builds on Ball's model of three types of subject matter knowledge (SMK) and three types of pedagogical content knowledge as categories in the domain of *mathematical knowledge for teaching* (MKT; Figure 1). Recent work on secondary and post-secondary models of MKT note that aspects of mathematical semantics, definitions, and discourse may be very important (Hauk et al., 2014).

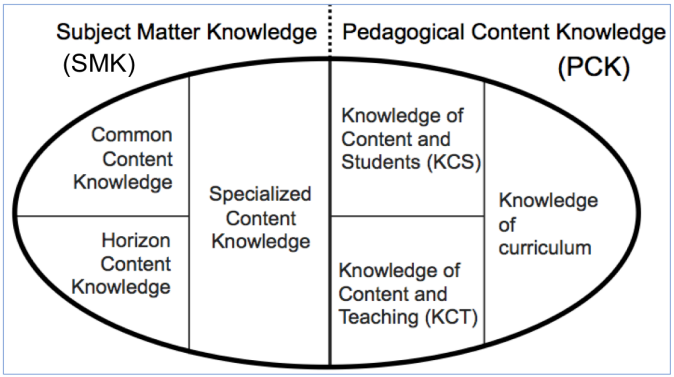

Figure 1. Dimensions of mathematical knowledge for teaching (MKT; Hill et al., 2008)

Implications for Practice

We seek advice from RUME poster session attendees to identify and categorize the potential implications for practice (and future research). We also hope to gather ideas for communication of implications to college instructors, department chairs, and other stakeholders.

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