Knowledge Used in Teaching Undergraduate Courses: Insights from Current Literature on Knowledge for Teaching Across STEM Disciplines

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Research on Mathematical Knowledge for Teaching has helped the education community understand the complex, knowledge-related factors that shape instructors' practices and the learning opportunities they create for students. Much of this work has occurred in the context of K-12 teaching. Although expanding, research on knowledge for teaching undergraduate mathematics is not extensive. A similar situation exists in science education. To help support these research efforts and theory development, we analyzed existing literature on knowledge for teaching undergraduate STEM content. Findings take the form of cross-disciplinary themes and differences that can help inform research efforts in this area. We seek feedback from the RUME community about our representations of knowledge for teaching, ideas about findings from research on Mathematical Knowledge for Teaching that have been especially useful, and/or ideas for research investigations that would be particularly useful to inform curriculum development, professional development for teaching or theory.

Keywords: knowledge for teaching, novice college instructor professional development, STEM disciplines

Evidence-based instructional strategies can improve outcomes for all students and the retention of students from underrepresented groups in undergraduate STEM degrees (Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, 2014; Laursen, Hassi, Kogan, & Weston, 2014). As a result of this potential, there have been repeated high-profile calls for substantial reform in teaching practices in undergraduate STEM. Achieving widespread adoption and effective use of evidence-based teaching strategies demands attention to the role of college instructors, including what instructors know and are able to do as evidence-based teachers. Although work in this area has increased in recent years, undergraduate mathematics instructors' knowledge and teaching practices have not been extensively researched (Speer, Smith III, & Horvath, 2010). Examining the role of teaching knowledge in evidence-based instruction and how to support its development is crucial to progress in reforming undergraduate instruction.

Although also not extensive, research also exists on undergraduate instructor knowledge and practices in science disciplines. In an effort to encourage and support additional research in this area, an inter-disciplinary team of researchers has conducted a review and analysis of literature about studies of knowledge for teaching across STEM disciplines. In this report, we share findings from our review and highlight key challenges and opportunities in this research area. We discuss how major categories of knowledge for teaching that appear in multiple disciplines (e.g., pedagogical content knowledge) are defined in those different disciplines. We also discuss research on types of knowledge that can apply across disciplines (e.g., pedagogical knowledge) and knowledge types that currently appear only in descriptions of knowledge used to teach mathematics (e.g., specialized content knowledge, horizon content knowledge).

We seek feedback on our representations of the knowledge for teaching across STEM content areas and on our suggestions for next steps to advance research on undergraduate instructors' knowledge and practices.

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