Transforming the classroom and helping others to adopt teaching innovations

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Poor retention rates of undergraduates in Science, Technology, Engineering, and Mathematics (STEM) fields have been a concern for educators and have spurred broad calls to reform introductory undergraduate STEM courses (AAAS, 2010; Holdren & Lander, 2012). In the US, nearly half of all students who enter a bachelor's program seeking a STEM degree either switch into a non-STEM field or leave college altogether (Chen, 2013), and the majority of students who leave STEM fields do so within the first two years of their program (Watkins & Mazur, 2013). Furthermore, students who are women, underrepresented minorities, first-generation, from low socioeconomic backgrounds, etc. leave STEM majors at a higher rate than their classmates (Chen, 2013). Instructional practices commonly used in first-year STEM courses, such as lecturing on material straight from the book, are a prominent reason why students leave (Seymour & Hewitt, 2000).

Student-centered instructional techniques, such as using clicker questions with peer discussion or small group activities, have been shown to increase student learning (Freeman *et al.*, 2014), decrease dropout rate (Freeman *et al.*, 2014), and decrease the achievement gap for first generation and other underrepresented students (Eddy & Hogan, 2014). To determine how often student-centered instructional techniques are being used at the University of Maine, we observed over 300 STEM classes using the Classroom Observation Protocol for Undergraduate STEM or COPUS (Smith *et al.*, 2013). When using COPUS, observers indicate which of the possible 25 different student and instructor behaviors occur during two-minute intervals throughout the duration of the class session. For example, observers indicate if the instructors are lecturing, asking questions, etc. At the same time, observers indicate if students are listening, discussing questions, etc. COPUS was adapted from the Teaching Dimensions Observation Protocol (Hora & Ferrare, 2014). Some of the advantages of this protocol over other protocols (AAAS, 2013) include a lack of judgment of instructor quality, a high level of inter-rater reliability with limited training, and a high level of resolution of instructional practices that can be aligned to research on how people learn (Lund *et al.*, 2015).

These data show a range of teaching practices at the University of Maine, which has changed the way we offer professional development to faculty. Notably, there was a continuum from 2% to 98% of the codes devoted to lecturing (Smith *et al.*, 2014). These results are important in light of other work arguing that common categorizations of STEM instruction as either traditional lecturing or using student-centered instruction, for example, lack sufficient detail and may actually be undermining efforts to provide effective professional development (Henderson & Dancy, 2008; Hora & Ferrare, 2014). Because of the observation results, we now explicitly honor the diversity of teaching practices in all of our faculty professional development offerings at the University of Maine. We are also supporting a suite of professional development activities including workshops that provide a low-investment on-ramp for faculty to get involved and Faculty Learning Communities (FLCs) (Richlin & Cox, 2004) where faculty meet monthly to discuss and support changes in teaching practices. Furthermore, student-centered classroom activities designed during the FLCs have been shown to improve student learning and provide faculty a supportive environment to try new instructional techniques. These results reinforce the benefits of providing long term professional development and the importance of developing a community where faculty members are providing peer coaching to each other.

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