Changing the Teaching Culture in Introductory STEM Courses at a Large Research University

By Geoffrey L. Herman, Jennifer C. Greene, Laura D. Hahn, Jose P. Mestre, Jonathan H. Tomkin, and Matthew West

We describe a major transformation in teaching large introductory courses in the sciences and engineering at the University of Illinois at Urbana-Champaign, impacting over 17,000 students yearly. The transformation was emergent, not prescribed, and occurred through two programs that included both engineering and science departments. Working collaboratively in Communities of Practice (CoPs), made up of a small number of faculty and teaching professionals formed within departments, faculty adopted and implemented evidence-based instructional practices with the goal of sustaining them over time. To make the reform process understandable to research faculty, we adopted the adage of "teach like you do research," meaning not only using iterative, evidence-based decision making but also engaging in a scholarly, collaborative community that pushes each individual member toward excellence. Another essential feature of the reform was embedding faculty members within the CoPs who had both knowledge of and a track record of implementing evidence-based reforms in their courses to serve as resources to the CoP. We describe the course-reform process and lessons learned and provide evidence for the success of our efforts.

Despite mounting documentation that evidence-based instructional practices (EBIPs) are more effective for teaching STEM (science, technology, engineering, and mathematics) gateway courses than traditional lecture approaches (Freeman et al., 2014), significantly changing traditional teaching practices at research universities remains a daunting task (Beach, Henderson, & Finkelstein, 2012). Reforms made to gateway STEM courses are typically based on instructors' biases and hunches about good practices, rather than on research evidence, perhaps because STEM faculty knowledge of EBIPs is neither expected nor rewarded (Handelsman et al., 2004). Even when faculty reform a course by adopting some EBIPs, it is typically initiated and "owned" by the instructor teaching the course at the time, and progress is lost when a new instructor takes over the course.

We report here on two related, successful efforts to implement EBIPs in large gateway undergraduate STEM courses in 14 departments at the University of Illinois, using a Community of Practice (CoP) model to address such barriers to change.

Institutional change in postsecondary STEM education

Recent literature on changing instructional practices in STEM highlights the ineffectiveness of "top-down" mandates and of isolated faculty development workshops that disseminate "best practices" (Henderson, Beach, & Finkelstein, 2011). These approaches are likely ineffective because they fail to address the implicit beliefs that drive instructional decisions (Hasweh, 1996; Luft & Roehrig, 2007; Tsai, 2002). Recent studies have suggested that we can address these mindsets by focusing on affecting faculty's beliefs and motivation, as well as the broader institutional culture (Beach et al., 2012; Brownell & Tanner, 2012; Finelli & Millunchick, 2013; Finelli, Richardson, & Daly, 2013; Henderson & Dancy, 2007; Siddiqui & Adams, 2013).

The CoP model offers a way to encourage both individual and collective change. CoPs provide a highly collaborative organizational structure that is intended to last and thereby promote long-term situated learning (Lave & Wenger, 1991; Wenger, 1998; Wenger, McDermott, & Snyder, 2002). Such collaborative cultures can lead to the forging of new beliefs and identities (Keys & Bryan, 2001) as well as curriculum reform (Finelli & Millunchick, 2013; Villachia, Marker, Plumlee, Huglin, & Chegash, 2013).

We therefore focused on forming CoPs around each of our targeted gateway courses to create sustainable, evidence-based instructional change. Two notions guided our reform efforts. First, building on the strong culture at the University of Illinois of STEM research collaborations, we encouraged faculty to "teach like you