Chapter 20
Online Simulator Use in the Preparing Chemical Engineers

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ABSTRACT

Active learning strategies (including simulations) have been promoted by engineering education reformers as an effort to move traditional STEM teaching toward more constructivist practices. In this study chemical engineering students were studied during the implementation of simulators to promote critical thinking. While many have studied achievement and perceptions of students to measure engineering tools and their development, this study specifically examined students' outcomes connecting the tool to specific teaching and learning strategies. A case study was conducted using pre- and post-test, survey questionnaire, individual interviews, and classroom observations. Results showed the use of simulator was associated with increases in students' scores but the novelty of innovation was not the single explanation for increased scores or favored technology usage. Interviews and other qualitative data suggested that outcomes may closely tie teaching strategies to the effectiveness of the tool rather than the focus on the tool itself. Implications for teaching and future research are discussed.

INTRODUCTION

Technology tool development has a great potential to change traditional engineering classroom environments in higher education. In fact, there are many engineers, educators, and reformer calling for dramatic changes as a direct result of tools and the tech-savvy students showing up to engineering classes. Researchers are defining this population as 'digital natives' because of how savvy this generation is with technology (Prensky, 2001; Tapscott, 2008). These definitions do not yet clearly define which tools matter for university learning. The current digital generation regularly uses computers, the Internet, cell phones, Facebook and other digital tools as the essential part of

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their lives. To better educate engineering students, engineering faculty are encouraged to implement diverse teaching methods and technology in their instructions.

Engineering teaching pedagogies that have been promoted among science educators for engaging science students include active learning, collaborative learning, cooperative problem-solving, and inquiry based learning. Though there is little agreement among engineers what differentiates these pedagogies from one another, many studies have demonstrated this cadre of approaches is more effective than traditional lecture methods (Prince, 2004; Felder, 2006). Yet, in 2001 the National Center for Education Statistics reported that 87.7% of engineering faculty used lectures as their preferred instructional method while only 5% indicated the use of methods other than lecture like seminars, lab or field work, and other methods (Wirt, Choy, & Gruner, 2001). The benefits and desirability of incorporating more effective teaching methods would appear to be obvious, raising the question why the traditional lecture format remains the norm and how instructors who use more technologically advanced and inquiry oriented approaches might bring other more didactic engineering professors.

There are a variety of factors that keep engineering instructors from wandering from traditional practices. These reservations include concerns regarding evidence for effectiveness, student assessment and performance, institutional technical support, and concerns for content coverage when compared to a traditional lecture format (Felder & Brent, 1999; 2001). The National Research Council (1996, 2005, & 2010) argued one of the challenges is informing faculty about research on effective teaching emphasizing the need to create a community of scholars who can be resources for interested faculty. The need to for such a scholarly network is echoed in reports from Project Kaleidoscope (2002) and from the National Academies (2003). Researchers report that engineering instructors clinging to traditional lecture approaches are critical of modernizing university classrooms on three fronts. The first front of resistance is comfort and familiarity. The lecture format is one that most professors experienced when they were students, and it's the one they have employed in their own classes ever since (Van Dijk & Jochems, 2002). The second front is that of faculty time. Faculty are critical of spending too much on modernizing teaching as their time is divided between creative/research activities, teaching, and service (Splitt, 2003; Prince, 2007). By the current widespread course evaluations used at most universities it is possible to be regarded as a good or excellent teacher while employing the standard lecture approach. It clearly requires a significant investment of time and effort to redesign a course which abandons one method and replaces it with more effective ones. Rewards, recognition and advancement potentially resulting from investing time in teaching are often smaller than investment on research and creative activity.

The third front of resistance reported is the readily available teaching materials which support traditional teaching (e.g., textbooks). Traditional teaching materials do not provide teaching resources necessary to transform engineering instruction. There are many additional teaching materials available on the web, developed by funding agencies, and distributed online and through agencies like the National Science Digital Library (NSDL), but it is left to the teacher to find them, determine how they might be fit into an effective teaching approach. Since most engineering instructors are trained as engineers not educators, even changing nomenclature implicit in these resources can be daunting.

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It has been argued that the difference between what students know and what teachers know with regard to computers, the Internet, and other

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