

Chapter 11

Teaching Undergraduate STEM Students as Emerging Adults: Developing More Self-Regulated Learners in Online Education

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ABSTRACT

The need to reform science, technology, engineering, or math (STEM) education in the United States has been shown through both industry and educational research. Despite many suggested reform strategies including applied, active learning, most STEM undergraduate education is being delivered in large, lecture-based classrooms. In 2020, the need to deliver STEM undergraduate courses online complicated reform efforts. This chapter is focused on the need to reframe reform efforts to be more focused on designing and delivering STEM online courses to develop emerging adult learners. This would involve moving from the primary mode of pedagogical instruction to andragogical instruction designed to be more inclusive and engaging. This approach would provide opportunities for learners to become more self-regulated in online STEM education with the goal of cultivating self-directed learners that will be retained in STEM programs and ultimately be successful future STEM professionals.

INTRODUCTION

Science, Technology, Engineering, or Math (STEM) education is a topic of discussion in both higher education and industry as there were 8.6 million STEM jobs in the United States in May 2015 (Fayer et al., 2017). As of 2017, the fastest growing STEM occupations required a bachelor's or higher degree (Fayer et al., 2017) while hiring for STEM jobs took employers longer to fill than positions in other fields (Rothwell, 2014). While STEM jobs are available, the educational pipeline in the United States is not keeping up with industry demands. In 2011, it was noted that too few students entering college (12th graders) were proficient and interested in STEM as a college major (Business Higher Education Forum,

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2011). According to The Coalition for Reform of Undergraduate STEM Education (2014), while many students initially selected STEM as their area of interest only 40% of undergraduate students completed a STEM degree. While there are many contributing factors to difficulties associated with filling STEM jobs in the United States, STEM reform in undergraduate education is often mentioned as an essential method for resolving this societal issue.

BACKGROUND

Engagement, active learning, and student perceptions have been studied in the past; however, traditional lecture formats still seem to be the primary delivery format in STEM education. In research by Lane and Harris (2015) about student engagement in large classes, there was higher engagement among students when interactive teaching methods were used compared with more traditional methods of teaching. Meaders et al. (2020) found undergraduate STEM student concerns included that they did not receive help or know where to get help, they did not have enough personal access to their instructors and did not receive immediate feedback. To address student concerns and to improve educational outcomes, STEM reform has focused on increasing student engagement through active learning. In a meta-analysis by Freeman et al. (2014), students in traditional lecture courses were 1.5 times more likely to fail than students in courses with active learning. However, even with this focus on active learning, it seems the lecture format is often the preferred teaching strategy for undergraduate STEM instructors. In a large study of STEM teaching in the United States during 2008, Stains et al. (2018) found that the most common instructional approach was lecturing with students primarily listening.

The suggestions for systemic STEM reform were developed (Coalition for Reform of Undergraduate STEM Education, 2014) prior to the COVID-19 pandemic and stakes are even higher as STEM professionals will play a role in addressing this crisis. Furthermore, the field of undergraduate STEM education is still pursuing reforms that now need to be delivered in an online format. While many colleges deliver some courses online, the need to teach completely online for public health reasons required quick adoption of technology-based learning for all University stakeholders including instructors, students, parents, administrators, and industry leaders. While this transition occurred, there was much discussion among students about the effectiveness of online learning. Perhaps, the most publicized issue was that of college students in the popular media asking for refunds because their courses were being delivered online. Students still earned credit for the courses that were being delivered online while protecting their health and the health of others. This situation brings about the question of “why were the undergraduates complaining about online learning?” Perhaps, many undergraduates lack the ability to learn on their own indicating a lack of self-regulation.

Kizilcec et al. (2016) found students in Massive Open Online Courses (MOOCs) with strong self-regulated learning (SRL) skills, characterized by the ability to plan, manage, and control their online learning process, outperformed those with weaker SRL skills. It is also possible that dissatisfied online learners may only have had experience with face to face, lecture-based learning. In research by Wang et al. (2013), learners experienced with online learning tended to have more effective learning strategies and motivation with online courses. A lack of technological experience within college courses may also be concerning when those students enter the workforce. Many continuing education opportunities and workforce training is provided through online delivery, which requires a certain level of competency in online learning. However, the answer may not be a rapid return to traditional learning because students

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