Chapter 2
Flipping STEM Learning:
Impact on Students' Process of Learning and Faculty Instructional Activities

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ABSTRACT

The call for reform in education, based on the recognition of an increased role of technology, as well as the rapid advancement of technology types and uses, requires major changes to traditional methods of teaching. The purpose of this chapter is to present the results of the use of a flipped classroom approach in a higher education STEM course. The chapter includes information on the development and structure of the flipped classroom, the role of video lectures and active learning in supporting flipped instruction, the value of prior experience as a concomitant variable, and the benefits and limitations of the approach. Examination of findings supports this new method of instruction and learning; however, some student hesitance to move beyond traditional instruction suggests a need to implement the approach as a continuum, beginning with segments, then moving to a blended technique, with final transition into a totally flipped classroom. This process supports instructor development and student buy-in while allowing for formative assessment of resources and increasing of student efficacy.

INTRODUCTION

The need for educational reform is well recognized (Tucker, 2012), and plans for change are in place all over the nation, at all levels and all sites—Pre-K-12 schools, institutions of higher education, states' department of education, and federal offices that support education (United States Department of Education, 2010). These plans for reform include not just what we teach but how we teach. The ultimate goal of this systemic change in education is twofold:

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to improve our nation's economic growth and to cultivate the collaboration skills necessary for international problem-solving (United States Department of Education, 2010).

As we strive to reach this goal, we must also deal with the changing context. Because of rapid gains in both the amount of information and sources for information transmittal, today's students come to learning with a very different skillset than did students who attended school just a decade ago. In addition, there is a very different recognition of what skills need to be acquired for future success in society. On a micro-level, students' future skills must include knowing how to problem-solve, how to successfully work both alone and on collaborative teams, how to think independently yet access diverse external resources, and how to adjust to an ever changing environment (Keengwe, Onchwari, & Onchwari, 2009; Salomon, 2002). On a macro-level, all students must be able to support and add to a highly knowledgeable workforce, heavily based in Science, Technology, Engineering, and Math (STEM).

The call for change in education, based on the recognition of this increase in the role of technology and the rapid advancement of technology types and uses, requires major modifications to traditional methods of teaching and the expected outcomes. Students must not only learn, but also learn how to learn. Increased engagement of students is paramount; in helping students learn how to learn, students must actively construct, and want to construct a flexible knowledge base. Research tells us that increased engagement can be promoted through instructional strategies using visual stimulation, experiential/authentic learning, technology integration, and community-based learning (Brown, Hansen-Brown, & Conte, 2011; Newman, Clure, Deyoe, & Connor, 2013; Newman & Gullie, 2009). Adaptations of these techniques as well as new instructional strategies, particularly in STEM classrooms, are needed; especially strategies that cultivate a student-centered learning environment that promotes proficiency and expertise in subject matter, dissuades the passive learning of teacher-centered direct instruction, and develops the ability to continue lifelong learning of both content and application (Newman et al., 2013). The flipped classroom approach, when integrated with increased hands-on application, is one instructional method currently being explored as a means of meeting the demand for twenty-first century classrooms to provide active and engaging knowledge construction.

The purpose of this chapter is to present the results of the use of a flipped classroom approach in a higher education STEM course. The chapter includes information on the structure of the flipped classroom, the role of video lectures in supporting flipped instruction, and the benefits and limitations of the approach.

BACKGROUND

Research suggests that the growth in technology-related jobs will grow from 50 to 77% over the next decade, making it crucial for educators to prepare students for these jobs (Tucker, 2012). This need calls for an integrated approach to content and technology that will foster knowledge, application, and the ability to continue learning. Brown and colleagues (2011) note that emphasizing a productive interconnected learning environment promoting content and technology skills not only supports, but enhances students' learning, particularly when that setting involves a flexible, but personalized collaborative scenario. This type of student-centered, technology-based, active learning relies on students wanting to take control of their learning; this includes setting their own goals, monitoring their own progress, and facilitating their own and others' critical thinking and problem solving skills (Zimmerman, 1995). Many secondary schools have adopted technology as a way to support and cultivate students' interests and to