Impact of Educational Technology-Based Learning Environment on Students' Achievement Goals, Motivational Constructs, and Engagement

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ABSTRACT

Passive learning environment to teach programming concepts, especially in large lecture classes hinders students' motivation, performance and may adversely affect their achievement goals. The study presents the use of two instructional strategies teamwork and reflective thinking using educational technologies introduced in a class of 120 first year engineering students. This study also presents the impact of educational technologies based learning environment on students' motivation, achievement goals, and engagement.

CCS CONCEPTS

•Social and professional topics~Computational science and engineering education

KEYWORDS

Educational technologies; Programming course; Active learning

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1. PROGRAM CONTEXT AND STATUS

I am a third-year doctoral student at the School of Engineering Education at Purdue University with a research focus in both engineering and computer science education. For my dissertation research, I am conducting a quantitative investigation to study the impact of educational technologies based learning environment on an introductory programming course student. I have collected the data for my dissertation. I plan to defend my dissertation in August 2020. I plan to submit papers based on my dissertation to renowned computer science education platforms. I would like to use the expertise of researchers at ICER'2019 DC to refine my data analysis strategies and to discuss possible future directions. As a member of the iOS development team of CourseMIRROR application, and I envision getting feedback on improving CourseMIRROR application.

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2. BACKGROUND AND MOTIVATION

Actively involving students in the learning process is crucial for improving students' understanding of fundamental STEM concepts and computer science education. However, most introductory engineering and computer science classes at the undergraduate level are taught in large lectures that typically result in traditional lecture-based instruction, which hinders students' learning by placing them in mostly passive roles. Literature suggests the use of various educational technologies and instructional strategies to increase the active involvement and enrollment of students. In this study, I propose to combine these technologies and two of these instructional strategies together, which could enhance students' learning outcomes in large engineering and computer science classes. The First-Year Engineering Program at large Midwestern University is designed with a team-based learning component. I for my study believes that we can combine this team based learning component with students' reflective thinking, where students are prompted to reflect on their learning experiences. These two approaches individually have been effective to enhance students' learning outcomes, but limited research exists that investigates the impact these two approaches together, specifically with the design and implementation of educational technologies component.

3. RESEARCH QUESTIONS

In this study, by using educational learning technologies, I wish to explore the relationships between students' academic performance and instructional strategies in a First-Year engineering course. The main topics taught in the course are the

application of computer programming by using MATLAB, and the development of mathematical models to solve engineering problems in a collaborative teamwork manner. In addition, I am proposing to investigate how students' achievement goals, engagement, and motivation change because of these experiences. Specifically, I am planning to address the following research questions:

1. How do students' team membership behaviors and reflection quality change over time?
2. How do students' reflection quality and team membership behaviors relate to their academic performances?
3. How do students' achievement goals, motivation, and engagement change because of these learning experiences?
4. How do students' achievement goals, motivation, and engagement relate to their academic performances?

4. EDUCATIONAL TECHNOLOGIES

I used two educational applications 1) CourseMIRROR (Mobile In-situ Reflections and Review with Optimized Rubrics) mobile learning system, and 2) CATME (Comprehensive Assessment of Team Member Effectiveness). I used these educational technologies for a variety of reasons such as to create an engaging learning environment for students, promoting students thinking about each delivered lecture and write the reflections, evaluate their own and peers team effectiveness after each team based project's milestone, and also to collect data effectively.

CourseMIRROR was used to collect students' reflections after each lecture during one academic semester. CourseMIRROR prompts and scaffolds students to write insightful reflections on complex concepts and problems at the end of each lecture [1], [2]. It uses Natural Language Processing (NLP) algorithms to generate coherent summaries of reflections for each lecture by clustering them based on the common themes. Available to both instructors and students, these summaries allow instructors to identify and attend to the difficulties and misunderstandings that students encountered from the lecture. Further, students can see the larger picture of difficulties encountered by their peers.

I also used CATME to form and manage student teams [3], [4]. The embedded peer evaluation feature of CATME allows team members to rate each teammate by using 5-level behaviorally anchored rating scales as well as self-evaluation of their performance. The peer evaluation system also provides feedback to students and to the instructor about how each team member is performing.

5. DATA COLLECTION

I have collected the data from 120 First-year engineering students. The dataset included: 3430 student reflections in 26 lectures; team membership evaluation collected after each milestone (four times); pre and post surveys of students' achievement goals, motivational constructs (self-efficacy, and task value), and engagement scales (behavioral, emotional, social, and cognitive aspects); students' background information (race and gender); and students' individual exam scores in three exams.

6. PROPOSED ANALYSIS

I will conduct repeated measures ANOVA on reflection quality score and on team membership data to determine the changes over time. I will also use stepwise hierarchical regression analysis to explore the relationship between reflection quality, team membership, and academic performance. Further, I will conduct simultaneous hierarchical regression analysis to determine the unique contribution of each construct to predict exam scores. For achievement goals, motivational constructs, and engagement scales, I plan to use multivariate repeated measures ANOVA to determine the changes in students' achievement goals, motivational constructs, and engagement scale after creating a learning environment combined with mobile technologies and instructional strategies in a first-year engineering class. As the engagement scale is not validated for undergraduate students but is extensively used in math and science classrooms, I plan to validate the instrument before progressing with the data analysis.

7. IMPLICATIONS OF THE STUDY

I will discuss the findings of these results with particular emphasis on challenges associated with such a learning environment. Further, I will discuss the study findings to indicate both the positive and negative effects of such integration of educational technologies and instructional strategies. Further, the study implications will advance the literature of computer science and engineering education by suggesting how educational technologies can be the way to incorporate instructional strategies in the classroom. Also, how this integration can help to set up a constructive social environment which may improve students learning and performance, and enhance self-regulated learning skills.

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