e-Learning: Teaching Computer Programming Online to First Year Engineering Students

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Abstract

Computer Programming is an important component of a curriculum in engineering. Many engineering programs require students to learn computer programming during the first year in the program. For students, mastering computer programming can be challenging, and the learning experience can be even more difficult if done in an online environment.

This paper introduces the audience to the format of an online computer programming course developed to teach first year engineering students how to solve engineering problems using Matlab. The course involves the use of online videos, the implementation of group projects, and the continuous assessment of learning through homework and reading comprehension activities. The course promoted student-instructor interactions through the implementation of a blog and the participation of students in the online chat room.

This paper discusses the format of the course, student participation, satisfaction, and completion rate, as well as strategies to promote student-student, student-instructor, student-material interactions. Results from a student survey administered at the end of the course are presented, and the challenges faced by students learning computer programming online are discussed.

Introduction

Online courses are becoming more popular among students, with top academic institutions offering full degree programs online. Research on online learning exposed the convenience of online courses and their accessibility to all student groups, including students working full time.

Researchers working on online learning have identified several challenges associated with web-based courses, including the lack of immediate response to students' questions or concerns, and students' feeling of isolation from the instructor and other students enrolled in class.[1-6] Song and colleagues found that a familiarity with online technologies and proper time management contributed to student satisfaction in an online environment.[2] They also indicated that a lack of student understanding of course objectives lead to students' dissatisfaction in a web-based course.[2]

To improve online courses, it is necessary to understand the learners' experience and to address the challenges faced by online learners.[3-6] Although the implementation of blogs and chat rooms have significantly improved students' experience in a web-based course, it is also important to adapt other technological advances to the online environment. It has been recognized that the design of the online course is as important as its implementation, and organizations such as Quality Matters Inc have contributed to the development of standards for online learning.

Online learning has not been as popular in engineering as it has been in other fields of study. However, engineering programs are beginning to recognize the importance of online courses in education.

The main purpose of the study was to understand the challenges faced by students enrolled in an online computer programming course. The paper discusses the format of the course, student satisfaction, and completion rate, as well as strategies to promote student-student, student-instructor, student-material interactions. The results from a student survey administered at the end of the course are presented, and the challenges faced by students learning computer programming online are discussed.

Methodology

Course Format
The online computer programming course was delivered in a series of 10 modules. Students were required to complete one module at the time, with modules completed in sequential order. As indicated in Table 1, the first module contained an introduction to the course, modules 2-5 introduced students to basic arithmetic operations, vectors, and matrix analysis. Modules 6-9 contained more advanced programming, which included conditional if statements, loops, and user-defined functions. In module 10, students were asked to reflect on several ethical cases presented, and were required to post their reflections in a blog.

Table 1. Content of each module

Module	Content of Each Module
1	Introduction to the course
2	Introduction to Matlab; description of windows (platform) available in Matlab.
3	Introduced students to basic built-in functions and to arithmetic operations in Matlab.
4	Introduced students to vectors and matrices.
5	Introduced students to calculations with vectors and matrices
6	Introduced students to script files, input and output commands
7	Introduced students to plotting in Matlab
8	Introduced students to if statements, for and while loops
9	Introduced students to user-defined functions
10	Ethics in Engineering

Each module began with a description of the module's educational objectives and cited sections of the book associated with the module. A module contained instructional videos, reading comprehension activities, one online quiz, and homework. Two projects were assigned and completed in groups.

Assistance was provided on a daily basis through online office hours using a chat room. Help was also provided by email. Each student completed an online midterm exam and an on campus final exam.

The course was internally evaluated and passed the Quality Matters Rubric for online courses.

Survey
Forty-five students enrolled in a freshman engineering program at a large land grant university in the mid-Atlantic region, completed a survey administered at the end of the course. The purpose of the survey was to assess students' perception of the course, interest in computer programming, and problems associated with the course.

Results

Response to Exit Survey:

According to the survey, 60% of the students enrolled in the course were exposed to computer programming for the first time. For 61.4% of the students in class, this was the first online course taken.

According to the survey, the biggest challenge reported by students was associated with group work; indeed, 76% of the students surveyed indicated that working in groups in an online environment was difficult. Students reported problems that included non-participating members, members not available for online meetings, or with teammates submitting work late (see Table 2). Reading comprehension activities and homework were rated as "not difficult nor easy to complete" (64% of responses).

In general, 40% of the students considered the course challenging and 62% of the students indicated that learning computer programming online was difficult for them.

According to the survey, 88% of them indicated that their expectations for the course were met. At the end of the course, 72% of them reported a good or excellent understanding of Matlab. According to the survey, 84% of the students prefer to take an online course versus a classroom course.

Challenges faced by students

This study identified several issues associated with online learning (see Table 2). Students indicated that the fact they were working full time affected their performance in the course. Group work was also a challenge, with students concerned about non-participating teammates, teammates not meeting deadlines, or teammates unable to meet on a regular basis. For some students, it took time to adapt to receive help via email or in an interactive online discussion.

Table 2. Challenges faced by students

Category	Students' Concerns
Full time job	-Time constraint in an accelerated course while working full time -Time constraints with working 40 hrs a week

Student-teacher interaction	-Hard to get used to emailing and using the chat room to get help from the teacher -Not having instant answer like in a face to face class -Help was hard via email -Hard trying to program without 1 to 1 instruction
Student-student interaction	-Difficult to solve projects without meeting group -Dealing with non-participating group members -Hard to get other students to do their share of the work and to meet because they thought the class was solely "online" - Trying to work in a group effectively online - Hard to manage team and meet deadlines
Student-material interaction	- It was a lot of work but not hard work

Recommended Changes to the Course:

Several students indicated that RCAs should be simpler and that students should be able to advance to the next RCA without a perfect score. One student recommended the inclusion of at least one individual project, instead of two group projects. In terms of group work, there was a recommendation to request mandatory group meetings, which could be part of their final grade for the project.   Students also requested more examples to assist them in the completion of homework and one student indicated that homework should be resubmittable.

Table 3. Recommended changes to the course

Course Component	Recommendations/Comments Made by Students
Reading Comprehension Activities (RCAs)	- make them simpler and easy to follow - don't make 100% to go forward onto the next RCA - make them so you don't have to score perfectly on one to advance to the next one -replace them by programming exercises
Projects	- implement mandatory meeting days to work on project - more time to complete projects - change the deadlines for the deliverables of the project
Homework	-homework should be resubmittable - some were extremely hard - homework was far more difficult than tests, quizzes, projects, and RCAs - give more examples to compare to

Table 4. Strategies to enhance learning in an online course

Interactions	Approach Used and Recommendation
Student-Teacher	-Weekly emails send with reminders on deadlines and online office hours -Send emails to guide students in the solution of projects -Office hours held in a chat room -Recommendation: Use webcam and microphone to enhance the experience
Student-Student	-Blog in which students can post problems, comments, interact with other students in class - Group projects -Recommendation: Students should be able to chat with colleagues online and should be able to know when colleagues are available online
Student-Material	-Include quizzes, homework, projects, reading comprehension activities -Recommendation: Students should be able to track progress made in the course

Table 5. Example of Technology Available for Online Learning

Interactions	Technology
Student-Student	Emails Chat room Blogs
Student-Teacher	Webcam and Microphone Blogs Whiteboard Emails Chat room
Student-Material	Videos Computer-Aided Assessments

Discussion

The fact that online courses are attractive to working students is not new. In this study, students commented on the difficulty of working full time while taking an online course. Others indicated that technical problems, such as the inability to download the software, slow internet connection, or lack of internet connection at home, hampered their ability to complete the assigned work.

Although one of the biggest concerns was the difficulty of working in groups, teammates were assigned by the instructor based on student's weekly availability and their daily schedule. This

study identified a need to make students accountable for their participation in group work, and their contribution to the project should be part of the project grade.

In this course, videos, blogging, whiteboard, and computer-aided assessments were utilized to enhance student learning (see Table 5). Although student-teacher interaction (see Table 4) was promoted via emails and chat room, there is a need for better technology to make the interaction more like a visit to the instructors' office. For instance, the use of webcams and microphone would have enhanced the learner experience. Improvements to the learning platform are needed to promote student-student interaction; students need to know when classmates are present in the online course, should be able to interact with other students online, and should be able to track their progress in the course.

One of the challenges faced in this class was the fact that it was offered during the summer and was completed in 6 weeks. This time constrain placed more pressure on students as they had to learn the material in a limited period of time.

The selection of two projects for the course was found to be appropriate, and the fact that both projects were completed in groups increased student-student interactions and in general, learning.

Conclusions

Learning computer programming online can be a difficult task. Successful web-based learners are those committed to the completion of the course, those that begin their work ahead of time, request help as needed, and don't wait to the last minute to complete the work. In an online course, students are accountable for their own learning. Better technology is needed to maintain student engagement in the course and to promote the social environment normally experienced in the classroom. Quality control is also needed to assure that the content of the online course is similar to what is taught in the classroom.

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