Flipped Learning for Educational Content Delivery: Application to Programming with Python

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ABSTRACT

Modern technology has undeniably increased the ease of access to technical knowledge for students. It has also affected the learning process, creating an environment in which students no longer need to rely solely on their instructors to aid their learning or learn from online resources, but also learn from their peers. Studies have shown that Flipped Learning, a concept in which the traditional lectured classroom is inverted so the students themselves become peer instructors (Lee, et al. 2011)) has become a successful learning methodology. This paper describes a study that aims to evaluate how different technologies influence and support the Flipped Learning methodology when applied in the context of programming with Python. The purpose of this study is to test, within the context of Flipped Learning, the effectiveness of the use of different technologies used to facilitate a peer instruction environment as an effective method of delivering educational content in a classroom. This experiment will attempt to understand students' ability to learn programming concepts in a peer supported environment using different supportive technologies

Keywords:
Flipped Learning, education delivery, programming concepts, peer instruction

INTRODUCTION

With the variety of technologically supported educational systems available, there is an increase in the different channels through which information and knowledge can be transmitted: forums, videos, and online content (Luo, et al. 2013). The traditional classroom lecture has evolved beyond a mere one-way communication channel to one in which the students themselves have access to an immeasurable number of resources, given their ease of access to technology. At the other end of the spectrum, students can learn entire programs online. We are interested in studying means by which technology supports classroom learning. Flipped Learning is a concept in which the traditional lectured classroom is inverted so the students themselves become peer instructors. There is a growing body of research interested in demonstrating the effectiveness of Flipped Learning. In the context of programming, a study by Lee, Porter, Simon, and Zingaro (2011) has demonstrated an improvement in learning basic concepts when Flipped Learning was applied in the classroom. In this paper, we want to find out whether technology usage has an impact on learning in the same context. To do so, we first start by relating existing studies on e-learning and Flipped Learning. We then present a methodology to implement Flipped Learning in an introductory course on programming principles with Python, based on the work of Lee et al. (2011). We introduce and describe three tools that can be used to support Flipped Learning. We present our methodology for testing and our hypothesis.

LITERATURE REVIEW

Given the involvement of technology in the education of students, e-learning became a popular learning mechanism in the early 2000s when electronic media and communication technologies were identified as potential aids to a student’s learning experience. Garrison (2003) stated:

“The essential feature of e-learning extends beyond its access to information and builds on its communicative and interactive features. The goal of qualitative e-learning is to blend diversity and cohesiveness into a dynamic and intellectually challenging ‘learning ecology’” (p.53)

Multu’s and Szafir’s (2005) paper evaluated Flipped Learning — a concept whereby students learn subject content outside of the classroom and use traditional lecture time to conduct and participate in activities that enhance their learning in groups. Flipped Learning could support a sustainable teaching model without requiring an instructor as well as encouraging collaborative learning. Also known as an inverted classroom, Burge, Helnik, and Gannod (2008) investigated the use of the Flipped Learning model to teach a software engineering course to university students. Results from the initial pilot study indicated that students were able to accomplish the learning objectives of the class within the semester.
In the book *Flip Your Classroom: Reach Every Student in Every Class Every Day* (2012) authors Bergmann and Sams found that the provision of content outside the classroom allowed students to absorb material on their own time and at their own pace and thereby encouraged individualization wherein the teacher’s role is to oversee and assist a student’s progress. They also found that the Flipped Learning model (which includes a peer instruction component), despite its shortcomings, increased student-to-student collaboration and, if permitted, groups be organized based on common needs and students to solve problems in collaboration with their peers with the instructor being present to answer student inquiries. According to Lee, Porter and Simon (2013) “PI [Peer Instruction] supports a student-centered learning environment ... that is, instructor explanation is augmented and/or replaced with carefully crafted questions designed to engage students in learning.” They found that peer instruction decreases the fail rate by 67% when compared with standard instruction and were a great contribution to the students’ sense of self-worth.

Since its introduction, the Flipped Learning model has been used across a number of high schools with significant decreases in student failure rates, and students who formerly performed at a lower level were now more enthusiastic about participating in classroom activities (E.J. Jones, 2013). Given the widespread and growing acceptance of the Flipped Learning model, a number of methodologies (such as video casting, screen recording, posting lecture slides) and education platforms (such as Piazza, Classroom Salon, Panapto, etc.) concerned with content delivery have been developed and established. All of the individuals using the Flipped Learning methodology in their classrooms have identified that while there is no single standardized method of “flipping a classroom,” a community of instructors and their methodologies are freely available on community support sites. However, while there are a variety of tools that aid the Flipped Learning model, the common features and functionality that contribute to a successful Flipped Learning software have yet to be identified.

Lee, Porter, Simon, and Zingaro’s (2011) paper “Peer Instruction: Do Students Really Learn from Peer Discussion in Computing?” identified the positive reactions to the implementation of peer instruction in a programming course environment. Having taught programming concepts previously to middle school students in a pseudo-Flipped Learning program called InSPIRE (Fernandes & Thowfeek (2012)) using an established teaching framework, the author was motivated to expand the idea of having students learn independently and from their peers into Flipped Learning. It can be considered a further development on the subject of changing the learning process using technology. Using a number of different tools to support learning of Python programming concepts, the purpose of this study is twofold: (1) to test the applicability of peer instruction in a classroom at our university as an effective learning methodology for students, and (2) to test the effectiveness of the use of different technologies that can facilitate a Flipped Learning environment.

**METHODOLOGY**

The study will use Lee, Porter, Simon, and Zingaro’s (2011) peer instruction model (Lee, Porter, Simon and Zingaro’s, 2011) Figure 1.). This model intends to explore students’ ability to learn from one another in a classroom environment that has been “flipped” — i.e. a classroom in which the students read up on the concept before attending a class and then carry out activities during the classroom session to support the concepts they have learned. In this model, students are given a quiz based on the material they were asked to read before the class session. These quiz questions will be created in collaboration with the course instructor. The questions will reflect the lessons of the classroom as well as establish the objectives of the principle being taught. In our research, we attempt to understand students' ability to learn programming concepts in a peer-supported environment using different supportive technologies. We plan to use this model in three sessions of an introductory course in Principles of Computing during Spring 2014.

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**Figure 1. The Isomorphic Testing Process.**

(Source: Lee, Porter, Simon, and Zingaro’s, 2011)
For three different sessions throughout the semester, students will be given resources on a specific programming concept before a session, then quizzed on the concept using a question with multiple choice answers that they vote on. Without the results of the poll being shown, the students will be separated into groups in which they will be asked to share their thoughts and analysis with the assistance of the instructor(s) when required. The students will then be asked to answer the first quiz question again, giving them the chance to change their previous answer based on their discussion, and then all of the responses will be displayed, with the correct answer indicated. In order to reinforce the concept, the students will be given a second question similar to the first question to vote on and answer again. The data collected and displayed in real time will be used to determine whether students have understood the concepts they have discussed in their group sessions. The polled answers will be checked against the correct answer, and if a majority of the students do not have the correct response, then additional resources or explanations will be provided to clarify the students’ understanding. This process will be carried out at different sessions using different technologies in terms of virtual polling technologies and student response systems. Approximately five minutes before the end of the session, the students will be asked to complete an online questionnaire regarding their experience using the system they interacted with. At the end of all the sessions, the students will be given a final questionnaire that aims to understand their preferences among the systems as well as their experience of the flipped class.

The students will not be subjected to a trial run of the systems because we do not want to influence any biases with regard to their ability to adapt to new technology. That being said, to ensure that the system tools work well, they will be tested on a group of students not taking the Principles of Computing class as a way to keep track of the timing of the different stages.

TECHNOLOGY SUPPORT FOR FLIPPED LEARNING

Content for the course will consist of material produced by the professor based on the material produced by Beth Simon’s resources for Flipped Learning (http://www.peerinstruction4cs.org/). To identify suitable software to use, a number of factors were taken into consideration: minimal cost to both the instructor and the students, the ability of the system to provide a way to check aggregate student responses on both quizzes, the ability to provide a discussion scene in which questions are seen across all groups anonymously (also for tracking and later study by students and instructors), and the ability to allow students to vote with existing technologies or readily available ones (iPad, computer, or smartphone). Consequently, three different student response systems that were identified will be used during the sessions in order to identify the features of the systems that support and/or enhance the learning process: iClicker, Socrative, and LectureTools.

iClicker

iClicker (http://www1.iclicker.com) is a student response system that uses an individual handheld polling device that allows students to respond to a question displayed on screen – recent developments in the technology also enable students to use the iClicker app to respond to a question using their own laptops or iPads. The iClicker comes with software that need not be installed on the instructor’s computer; it enables him to set up a class and determine the responses a clicker can submit. While the iClicker system is a commercial product, our university’s IT department already has several sets of iClicker polling devices that can be used for a session.

Socrative

Socrative (http://www.socrative.com/) is also a student response system that allows student responses to be recorded from laptops, mobiles, and iPads. Instructors can easily set up a quiz question, either in multiple-choice formats, true or false, or short answers. Additionally students can be organized into groups and have quiz “races” in response to questions asked by the instructor. The system also allows students to provide feedback regarding the system and the concepts they learned during the classroom session. As of now, the system is free for students and instructors.

LectureTools

Unlike the previous two systems, LectureTools (http://www.lecturetools.com/) is a system that allows an instructor to upload presentations and allows students to take notes in real time, ask questions, and receive responses from both instructors and other students; student assessments can also be tracked. Responses can be submitted through a smartphone, iPad, or an Internet browser.

Each of the sessions in the study will use a single technology. At the end of the session students will be asked to fill out a questionnaire to identify the features of the session in terms of the learning process. The session questionnaires will measure how well the session and the materials provided were sufficient, and the final questionnaire will attempt to measure the features of the system that the students found useful.
CONCLUSION
The student feedback on the performance of a session can be used to measure the sufficiency of the resources that the students require to sustain a successful flipped classroom. By attempting to identify which features of the technologies used in the study support and enhance the student’s learning process, these features can be collectively used to propose the design of a comprehensive Flipped Learning system. In such a system, the students’ need for an instructor in the learning process is reduced because of their ability to rely on their peers for instructional support.

The study was granted IRB approval on the Jan. 20, 2014 and the first session will be held in February.

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REFERENCES