

Impact of a Free Textbook on an Introductory Programming Course

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Abstract—Rising textbook costs has made students reluctant to purchase them. According to the review of Bureau of Labor Statistics (BLS) data, textbook prices has risen 88% since 2006 and the rate of its increase has been greater than tuition. Even parents do not have the ability to pay for the textbook for years. The high cost of textbooks has led many students to forego the purchase of textbooks and has led to underachievement in many cases. Anecdotally, the authors have determined that many students are not purchasing the textbook for a programming fundamentals course. In this paper, we present our findings in implementing a free textbook and its impact on students.

Index Terms— free textbook, introductory programming

INTRODUCTION

One of the reasons students don't purchase textbooks is because of the rising cost. According to the BLS (Bureau of Labor Statistics), from the years 2006 to 2016, the cost of textbooks has risen 88% [7]. This shows that the rising cost of textbooks far outpaces inflation for all items which was 21% for those years and it also outpaces tuition fee which rose by 41%. The results have been quite alarming. A study involving 400 students indicated that about 42% of students did not purchase course materials because of cost reasons [5]. Anecdotally, instructors are reporting that students are underperforming in classes because the lack of textbooks [8].

In this paper, we describe our work in implementing a free online textbook for an introductory programming course. We replaced an expensive regular textbook with a free online version written by the authors at Georgia Gwinnett College (GGC). GGC provides an ideal setting to implement such a free textbook because of the diversity and economic circumstances of our students. In 2016, GGC had 12,052 students enrolled, and out of those students, 7190 students received the Pell Grant which is based on financial need [6]. In this paper, we report the impact of the free textbook on students and the lessons learned.

RELATED WORK

Efforts such as OpenStax [3] and the Open Textbook library have been providing free textbook for students. These resources are widely used and beneficial to students but did

not quite fit our need. The problem is that a free textbook is not enough. A set of assignments and projects that can be used as assessment material must be accompanied by the free textbook. In addition, there is a need for slides and other teaching material as well. In fact, the key difference between most open textbooks and regular textbooks are the teaching resources available. Most regular textbooks have teaching material and assessment material that are supplied with the textbook whereas open texts seldom provide them.

The state of Georgia has recognized that a free open source textbook is beneficial for student success and have started the Affordable Learning Georgia (ALG) [1] grant initiative that provides faculty with grants to create an open textbook and create supporting teaching material as well. This study was funded by an ALG grant.



FIGURE 1
Online Textbook

IMPLEMENTATION

Programming Fundamentals (ITEC 2140) is a Java based introductory programming course for Information Technology (ITEC) major students at GGC. All ITEC majors are required to take it and it is a prerequisite for many upper level ITEC classes. Many instructors teaching ITEC 2140 have reported that many students are not purchasing the textbook. The textbook used for ITEC 2140 was bulky and hard to carry by students. Many instructors suspected that the cause of the high failure rate is because students were overwhelmed by the amount of content covered in the course and gave up on reading the textbook.

In the Summer 2019 semester, the authors have decided to write an open textbook for ITEC 2140. Each instructor wrote one chapter of the textbook and each chapter addressed a goal of the course. Since Fall 2019, the open text has been adopted as the official course textbook. Here are the course goals of ITEC 2140:

- Understand the evolution of computer languages (from machine code to object-oriented).
- Understand the concept of the coding process and code manipulation.
- Analyze real world problems and design algorithmic and programming solutions.
- Understand the general ideas of classes and objects as elements of a programming environment.
- Know general ideas about conditional expressions, functions, and control structures.
- Prepare, execute and debug program code within an interactive programming environment.
- Demonstrate a consistent and readable programming style.

The online open textbook was organized into seven chapters. We used open source tools such as AsciiDoctor(<http://asciidoc.org/>) to write the textbook and published it as an HTML document on a virtual private server (VPS). Figure 1, shows a screenshot of the layout of the textbook. The target audience of the open textbook is first year Information Technology students. No prior programming experience was assumed and emphasis was given in code understanding by using PythonTutor [4] to step through code line-by-line in most code examples. The language we chose was Java as it is one of the most widely used programming languages in IT.

Currently, the book has seven chapters that are organized into the following (update chapters):

- Getting Started
- Data Types, Variables, and Expressions
- Conditions
- Loops
- Methods
- Arrays and ArrayList
- Object Oriented Programming

Our textbook comes with a curriculum, specific course goals, and teaching materials such as slides and assignments as we found those lacking in most open textbooks. We have created a common course shell on our institution’s learning management system (LMS) to share the curriculum with our colleagues. In the course shell, we have included material that an instructor new to the course may need in order to teach the programming fundamentals course. The main goal was to enhance the accessibility to learning resources for both students and faculty.

In the Fall 2019 semester, we had eleven sections of ITEC 2140 (Programming Fundamentals) course at GGC. We had about 250 students in total and we have given them a survey

before and after using the open textbook. The goal was to observe if there were any meaningful changes in four aspects, namely: self-esteem, textbook usage, learning style and study habits. The students were given a set of questions and asked to indicate agreement with each question using the Likert scale where 1 indicates Strongly Disagree to 5 indicates

Strongly Agree. This survey items had a reliability test and

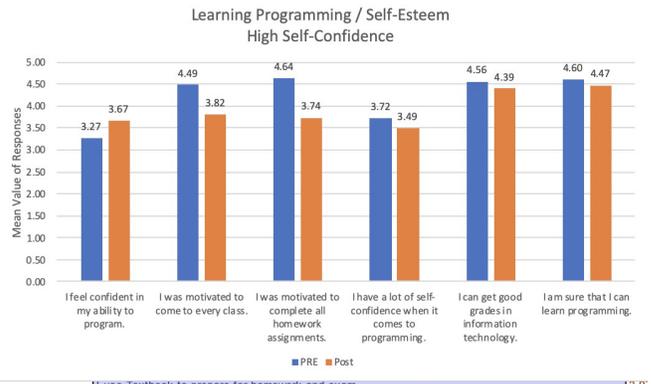


FIGURE 2
Self Esteem of Students

the value was 0.862 which is acceptable internal consistency reliability.

As part of the factor analysis, principal axis factor analysis with varimax rotation was conducted to assess the underlying structure for the attitude survey. Based on the result, self-esteem, textbook usage, learning style, and study habits were categorized.

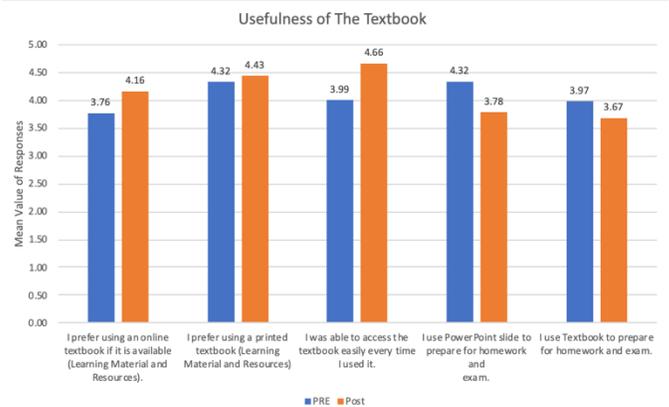


FIGURE 3
Usefulness of the Textbook

A. Self-esteem

We measured the impact of the open textbook on student’s self-esteem regarding programming. Figure 2, indicates that there is a drop in most self-perception questions except in the “I feel confident in my ability to program” question. This is

consistent with the failure rates we find in ITEC 2140 and the difficulty students have with the subject matter. Despite the improved accessibility of the open textbook, we find that self-perception regarding programming does not improved very much.

B. Textbook Usage

Not surprisingly, students indicated that they prefer using an online textbook if it was available and that they were able to access the textbook easily (from 3.99 to 4.66 as shown in Figure 3). Despite the preference for the online textbook and the ease of accessing it, we find that there is a slight decrease in using the textbook for the exam and assignments. This is a somewhat paradoxical result as we expected students to utilize the textbook more often in their course work.

C. Learning Style

According to Figure 4, having access to an online open textbook does not seem to alter the learning style of our students. The data indicates that there is almost no change learning style in our students. This result is expected as having one course transition into an online open textbook would not impact student’s learning style in a meaningful way in one semester.

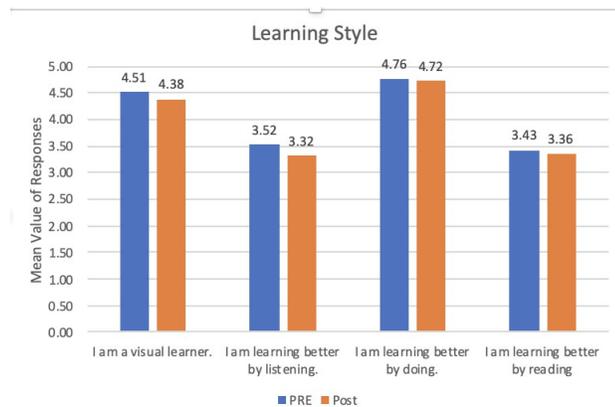


FIGURE 4
Learning Style

D. Study Habits

Figure 5 shows that study habits does change. What was interesting to find was that students reported that they took less notes and watched less educational videos. This can be attributed to the fact that our textbook has links to curated video resources and the ease of accessing the textbook may lessen the need of note taking.

ANALYSIS AND CONCLUSIONS

One of the most important benefits of having an open textbook was that we no longer had problems where the student could

not afford the textbook for financial reasons. The textbook was online and our students could access it as often as they liked. This is supported by data in our survey where students indicated that they were able to access the textbook without any problems. But paradoxically, students indicated that they relied less on the textbook in their course work. This could be attributed to different learning styles or study habits. One of the drawbacks of having an open textbook with common assessment material was the problem of plagiarism. Instructors found that quite a number of students shared solutions. Instructors may need to be more vigilant in choosing different problem sets from a common bank of problems instead of reusing a standard set of problems.

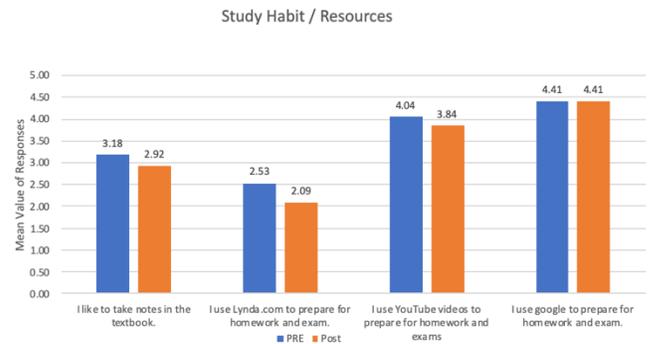


FIGURE 5
Study Habits

FUTURE WORK

One of the problems with a common course shell with a common open textbook is that it can lead to a problem where solutions are posted online for potential plagiarism. Websites like Course Hero [2] can facilitate in this process as students can look up a solution without much effort. Therefore, in addition to a common set of assignments and assessment material that can be relied on, some portion of the assessment should be unique or tailored by the instructor.

We also found that more challenging and/or easier problems and topics should be added to the textbook to challenge the advanced student and encourage students who need more help. It is difficult to consider the wide range in abilities of the students but we believe that an open textbook provides a great way to address such an audience.

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