

# STUDENT USAGE AND BEHAVIORAL PATTERNS WITH ONLINE INTERACTIVE TEXTBOOK MATERIALS

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## Abstract

Traditional textbook usage is experiencing a significant declining trend in the past few years, whereas online interactive textbook material has a high acquisition and high activity completion rate by students. Interactive textbook materials use less text, and instead use more activities: animations, learning questions, and interactive tools. Each of our online web-based interactive textbooks, known as zyBooks, has approximately 1,000 activities along with text readings.

We analyzed online interactive material usage of two different topics used at two major public universities. 282 students were in an introduction to programming course (CS1), and 299 in a discrete math course (DM1). The CS1 interactive material included an integrated homework system for coding activities. Both courses required the online interactive material and awarded points for completing assigned reading activities.

Of the 583 students total, 99.8% acquired the online interactive material. In contrast, surveys in classes using traditional textbooks (even e-book versions) had only about a 70% acquisition rate. Furthermore, students completed 92% of the assigned activities in the interactive material, whereas traditional textbook usage is typically much lower [Ho2004].

Our analyses showed that students accessed the interactive material 4.5 times per week, averaging 20 minutes per access. CS1 students spent 31% of interactive textbook usage time with activities in the interactive textbook, and DM1 students spent 17%, with the remaining percentage of time assumedly spent reading text and viewing figures. The proportional difference may be due to the CS1 interactive textbook including a homework system of coding activities.

Students valued the interactive textbook as an exam preparation aid. During midterm exam preparation, DM1 students voluntarily revisited and re-completed 33% of assigned reading on average, and CS1 students re-completed 23% on average. During final exam preparation, DM1 students revisited and re-completed 30% of assigned reading on average, and CS1 students, who were given numerous other review materials including two practice exams, re-completed 6% on average. The low re-completion for CS1 final exam preparation was expected because students were given practice exams from which to study.

Overall, using interactive textbook material appears to have reversed the trend of students not acquiring and thus not learning from required textbooks outside of lectures. Instead, interactive textbooks have nearly 100% acquisition rates and activity completion rates in the 90% range. Students spend significant amount of time using the material as part of their studies. Further, students felt they learned more with interactive materials than traditional materials.

Keywords: Textbooks, online learning, web-based learning, interactive learning, student usage, student-centered

## 1 INTRODUCTION

Online interactive textbook materials are growing in popularity, and have high acquisition and completion rates by students, whereas traditional textbooks (even in e-book form) are experiencing a significant declining trend. Our interactive textbooks, zyBooks, use less text, instead using approximately 1,000

activities, including animations, learning questions, and interactive tools [ZB2015]. Further, interactive textbooks record student interactions with the activities.

This paper analyzes student usage and behavioral patterns with our online interactive textbook materials, including how a student spends her/his time in the materials, how often and for how long students access the materials, and how the accesses vary throughout the semester.

## 2 BACKGROUND

Interactive textbook materials have been developed by academic organizations [DSA2015] [Le2015] [OLI2015] and companies [Bo2015] [FD2015] [WP2015] [ZB2015]. For Dummies eLearning includes multiple choice questions at the end of sections [FD2015]. The Open Learning Initiative has developed an interactive textbook that includes multiple choice questions and interactive activities that are recorded [OLI2015]. Zyante's interactive textbooks (zyBooks) include recorded animations, learning questions, and interactive tools, and use a less text approach to learning [ZB2015].

Interactive textbooks have also been shown to improve student performance over traditional textbooks [Ed2014] [Ed2015]. Edgcomb conducted a cross-semester analysis with 1,945 students across 3 universities and 4 courses, comparing student outcomes of a course after switching to an interactive textbook from a static textbook [Ed2015]. The course offerings were the same semester of the year, had the same instructor, were taught within 2 years of each other, and did not include other major changes. The average student's class score increased by 14.3% by switching to an interactive textbook, including a 13.6% in exam scores and 7.4% increase in project scores.

Numerous papers have analyzed student performance and usage patterns in a MOOC (massively open online class) [Bi2013] [Br2013] [Da2013] [De2013] [Gu2014]. Breslow analyzed student performance and behavior with a MOOC, Circuits and Electronics course on MITx, via recorded user clicks and course performance. The course included 8 resources: homework, lab, discussion, lecture video, textbook, lecture question, Wiki, and tutorial. The analysis found that students voluntarily spent more time with the textbook during the exams than the other course resources [Br2013]. DeBoer analyzed student course performance in Circuits and Electronics course on MITx, finding that a student's background (ex: country student lived in) was a strong predictor for a student's course performance [De2013].

Many studies on student usage of textbooks have been performed, typically focusing on student surveys [Ba2015] [Gu2011] [Gu2012]. Gurung developed a survey with over 20 questions, including questions on the quality of figures, tables, and other elements [Gu2011]. However, this paper analyzes student activity recorded during the normal usage for a class, giving objective insights into student behavior and usage patterns of interactive textbooks.

## 3 PARTICIPANTS

We analyzed interactive textbook usage of two different topics used at two major public research universities. 282 students were in an introduction to programming course (CS1), and 299 in a discrete math course (DM1). The CS1 interactive material included an integrated homework system of coding activities. Both courses required the interactive textbook and awarded course points for completing assigned reading activities.

## 4 STUDENT USAGE AND BEHAVIORAL PATTERNS

This section analyzes typical usage patterns by students.

Across CS1 and DM1, 99.8% of students acquired the interactive textbook, and students completed 92% of the assigned activities.

An activity is recorded each time a student checks an answer, watches an animation, or interacts with an interactive activity. For each student, a *session* was defined by delimiting when there were 20+ minutes between any activity.

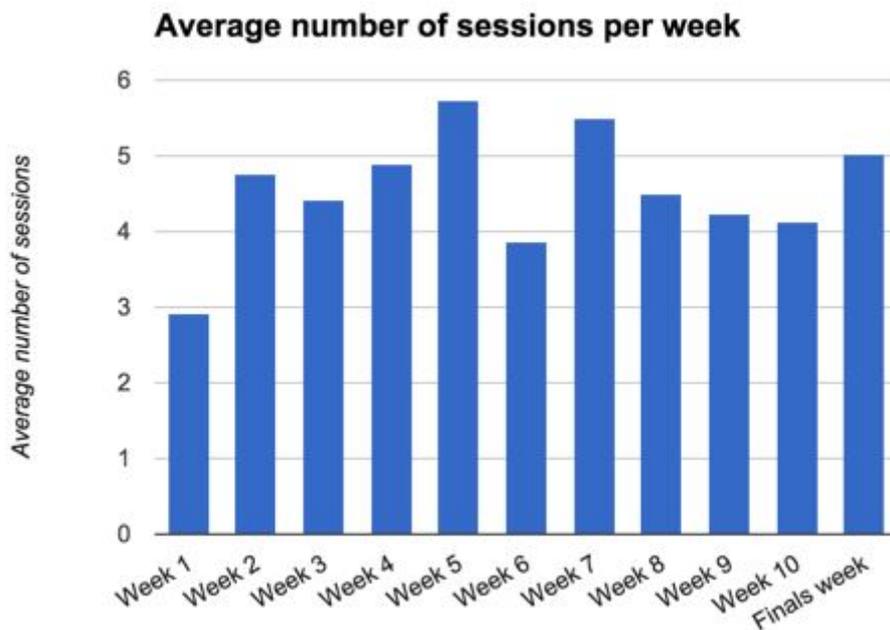
Time spent on an activity was computed by subtracting the time when the last part of an activity was completed from the time from the first part of an activity was completed.

#### 4.1 Sessions per week

Frequent accesses to learning material helps increase the amount learned. The number of interactive textbook sessions per week indicates the frequency that a student works on the interactive textbook. **Figure 1** shows the average number of sessions per week across CS1 and DM1 students. The average week had 4.5 sessions per student, indicating that students regularly accessed the textbook.

Further, students increased the number of sessions in Week 5, which was midterm exam week, indicating that students used the interactive textbook to prepare for the midterm exam. Also, number of sessions increased during final exam week.

**Figure 1:** Students regularly used the interactive textbook throughout the quarter, with usage spikes before exams.



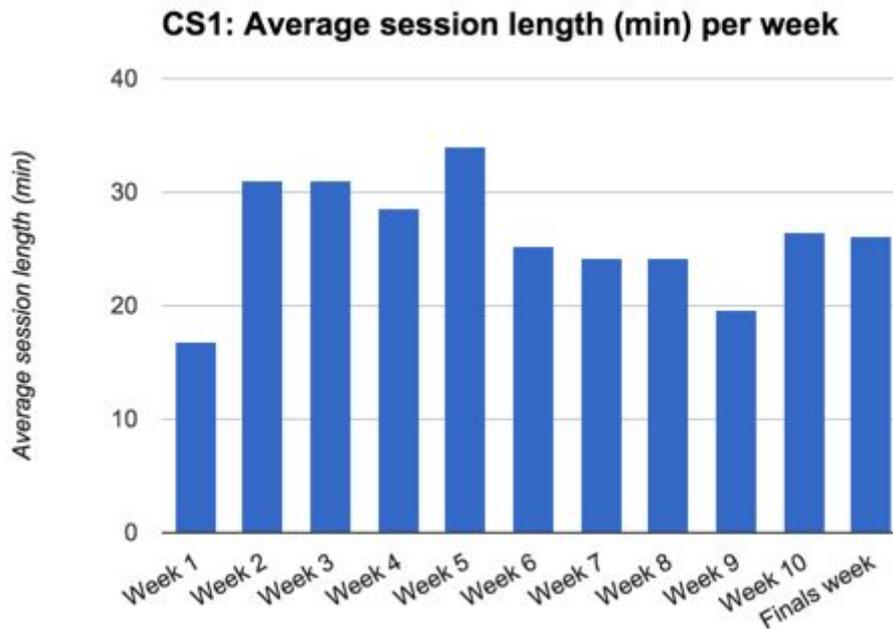
During midterm exam preparation, DM1 students voluntarily revisited and re-completed 33% of assigned reading activities on average, and CS1 students re-completed 23% on average. During final exam preparation, DM1 students revisited and re-completed 30% of assigned reading on average, and CS1 students, who were given numerous other review materials including two practice exams, re-completed 6% on average. The low re-completion for CS1 final exam was expected since students were given practice exams from which to study, which are likely perceived as being most useful for preparing.

#### 4.2 Session lengths

The length of each student's session with the interactive textbook is important for indicating the quality of each session. Short sessions (under 10 minutes) may not be enough time to learn much, and long sessions (over 1 hour) may potentially be an inefficient habit, such as last-minute rushing through large portions of assigned reading. Each section of the interactive material takes around 10 - 15 minutes to complete at a normal working pace for a student.

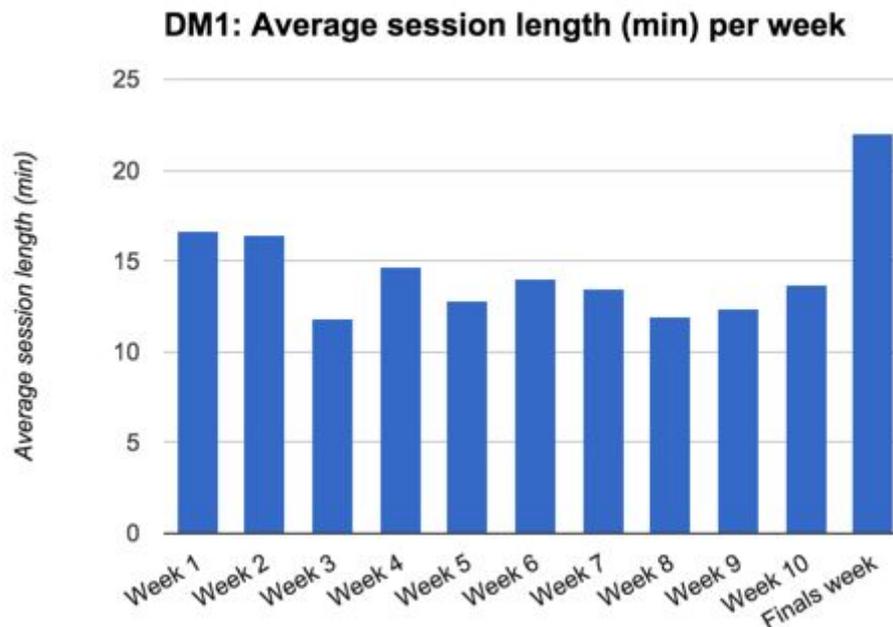
**Figure 2** shows the average session length per week for CS1 students. The CS1 students spent 26 minutes each session on average. There is a notable increase near the midterm exam (week 5) and the final exam (finals week), indicating students found spending more time with the interactive textbook beneficial to exam preparation. Note that CS1 students had access to practice final exams, but still chose to increase session lengths when preparing for the final exam.

**Figure 2:** CS1 students prepared for exams with the interactive textbook, as indicated by the increased session lengths prior to exams.



**Figure 3** shows the average session length per week for DM1 students. DM1 students spent on average 15 minutes each session. Students had notably longer session lengths during finals week. Also, the average session length per week remained notably consistent throughout the quarter.

**Figure 3:** DM1 students especially used the textbook to prepare for the final, as indicated by the longer periods of time during finals week.



CS1 tended to have longer reading assignments, which may be the reason that CS1 students tended to have longer session lengths than DM1 students.

The average session length per week for CS1 and DM1 were consistently above 10 minutes and below 60 minutes, which seems to be consistent with good study habits. One possible explanation is that the

instructors assigned reasonable-sized reading assignments -- we encourage instructors to assign reading before every lecture. Another explanation may be that students may have found the interactive textbook to be beneficial to his/her learning and incorporated the textbook into a regular study regimen.

We also looked at how students spent their time, categorizing as either working on activities or reading text and viewing figures. CS1 students spent 31% of interactive textbook usage time with activities in the interactive textbook. DM1 students spent 17%. The proportional difference may be due to the CS1 interactive textbook including a homework system of coding activities in addition to the learning activities.

## 5 CONCLUSION

Interactive textbook material appears to have increased acquisition and reading completion rates well over traditional textbooks, and re-instated the practice of most students reading textbook material outside of lecture (a practice that had been fading in past decades). 98% of students acquired the interactive textbook and completed 90% of the assigned reading.

Students chose to regularly access the interactive textbook throughout the term, averaging 4.5 accesses per week with an average access length of about 20 minutes, which seems consistent with good study habits.

Future work includes detailed user studies to determine why the usage patterns exist and how they might be improved, and an analysis of the various interactive elements to determine the impact of an interactive activity (e.g., an animation) compared to a static activity (e.g., a multi-part figure).

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