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Understanding and Promoting Earnest Completion in Online Textbooks

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Abstract

Digital textbooks are becoming more common in college-level computer, engineering, and science courses. For various reasons, some students quickly click on reading activities to earn completion points, without earnestly attempting the activities. We analyzed student earnestness in digital computer science and engineering textbooks across a semester. We found that student earnestness declines significantly as the semester progresses. We also found that earnestness levels at a semester's start have a tremendous impact on earnestness throughout the semester, namely that lower average earnestness at a semester's onset leads to a significantly more rapid decline. For example, one course with an initial 90% earnestness score fell to 76% by week 6, whereas another course with an initial 72% score dropped dramatically to just 32% by week 6. This finding emphasizes the importance of instructors ensuring students recognize the utility of the textbook activities from a course's start, and ensure that the activity workload is reasonable too, to start students with high earnestness. We close with recommendations for encouraging earnest completion early in the semester, which is crucial for maintaining earnest completion throughout the course.

Introduction

Earnest engagement with coursework is a critical factor for student success [1],[2]. Engagement is defined as “quantity and quality of the physical and psychological energy that students invest in college experience” [3]. In practice, this might be observed as class attendance, effort on assignments, or asking questions that show connection of the course material to other topics. Higher engagement coincides with better learning outcomes and course grades.

High engagement also encourages deeper learning to take place [4]. "Deep" learning occurs when students focus not only on surface-level content knowledge (e.g., definitions), but understanding and reflecting on how content relates to other ideas, and integrating concepts in real world applications. Students who engage in deep learning retain more information, and earn higher course grades [5],[6],[7],[8],[9],[10],[11].

A number of factors contribute to high or low levels of student engagement. For example, innovative courses that employ interactive forms of learning are associated with increased engagement [12]. Teaching quality [13] and perceived workload [14] also have a direct impact on engagement.

The ability to measure student engagement has historically been limited, usually relying on surveys and self report data. We don’t know how student survey responses align with actual

engagement and effort, because students tend to not want to admit when putting in less effort. In addition, survey response rates are generally higher among more earnest students, resulting in skewed student samples. A measure of engagement that we use in this analysis is *earnestness*, or the amount of assigned material students put reasonable effort toward. With modern digital textbooks, we measure student earnestness throughout the semester by looking at time spent and earnest completion of the book.

In this paper, we measure earnestness over the course of a semester. We predict that earnestness declines over the course of a semester, as students get overwhelmed with school work and lose the initial momentum to put in the effort. We confirm that this is indeed the case, and additionally, the earnestness at the beginning of a semester influences how much earnestness will decline over the semester.

Methods

We obtained anonymized behavioral data from zyBooks, an online textbook publisher. zyBooks authors primarily Computer Science and Engineering content natively for the web, making extensive use of animations and interactive learning questions. Explanations of correct answers provide students with further information, and explanations of incorrect answers break down the common misconceptions that students have about the content. One kind of interactive learning question are short answer questions, which students typically complete for some portion of their course grade. This question type includes a clickable "show answer" button, which reveals the correct answer. Students may then type that answer in, and receive full credit for the question.

We defined earnestness as the number of short answer questions that students earnestly attempted to complete. An earnest attempt is when a student at least attempts to provide a response to the question, whether incorrect or correct, prior to clicking "show answer". A blank answer does not count as an earnest attempt. We then computed the earnestness score, which is the proportion of earnest attempts to total attempts.

Data were collected from courses in Java, Python, and C++. We selected only courses from Fall semester 2020 with between 40 and 150 enrolled students. The analysis included 1,343 C++ students with 56 instructors from 48 courses, 2,417 Java students with 54 instructors from 43 courses, and 1,767 Python students with 32 instructors in 22 courses. About 75% of all courses were 4-year institutions, and about 85% were public institutions. In a recent internal survey, 95% of instructors reported that they assign course credit for completion of the in-book activities. The amount assigned varies between instructors, and we did not do a detailed analysis of points assigned in the courses used in this study.

Results

For each student, we calculated the average earnestness score for each chapter. Figures 1-3 show the average earnestness per chapter for students in Python, Java, and C++, grouped into high initial earnestness students (80+ percent earnestness in the first 3 weeks) and low initial earnestness students (below 80% earnestness in the first 3 weeks).

The high initial earnestness group starts with an average of nearly 100% earnestness, while the low initial earnestness group starts with an average of 70-75%. Over the course of the semester, average earnestness drops each week, with a substantial difference from week 1 to week 6. More interestingly, courses that start with low earnestness exhibit a greater decrease over the course of the semester. The high initial earnestness group dropped by 25 % over seven weeks, whereas the low initial earnestness group dropped by more than 60%. We performed a linear regression on earnestness drop from chapter 1 to chapter 6 onto student's chapter 1 earnestness. Initial earnestness significantly predicts how much earnestness will drop for students in C++ ($F(1,1342) = 52.63$, $p < .0001$), Java ($F(1, 2415) = 10.93$, $p < .001$), and Python ($F(1,1766) = 11.03$, $p < .001$).

We hypothesized that the drop in earnestness across chapters is due to students becoming less engaged with the content as the semester progresses. This could be because they are burnt out, or have work piling up, or other reasons. An alternative hypothesis, however, is that the drop in earnestness is caused by the content becoming increasingly challenging. Maybe students are less likely to be earnest when the content is more difficult. As an additional measure of student engagement, we fit a generalized additive model – a method useful for understanding the smoothed trend of a variable over time – for standardized time spent daily for each student to determine whether students were spending less time in the book as the semester progressed. Figure 2 shows that time spent in the zyBook decreases over time, consistent with our hypothesis of decreasing engagement.

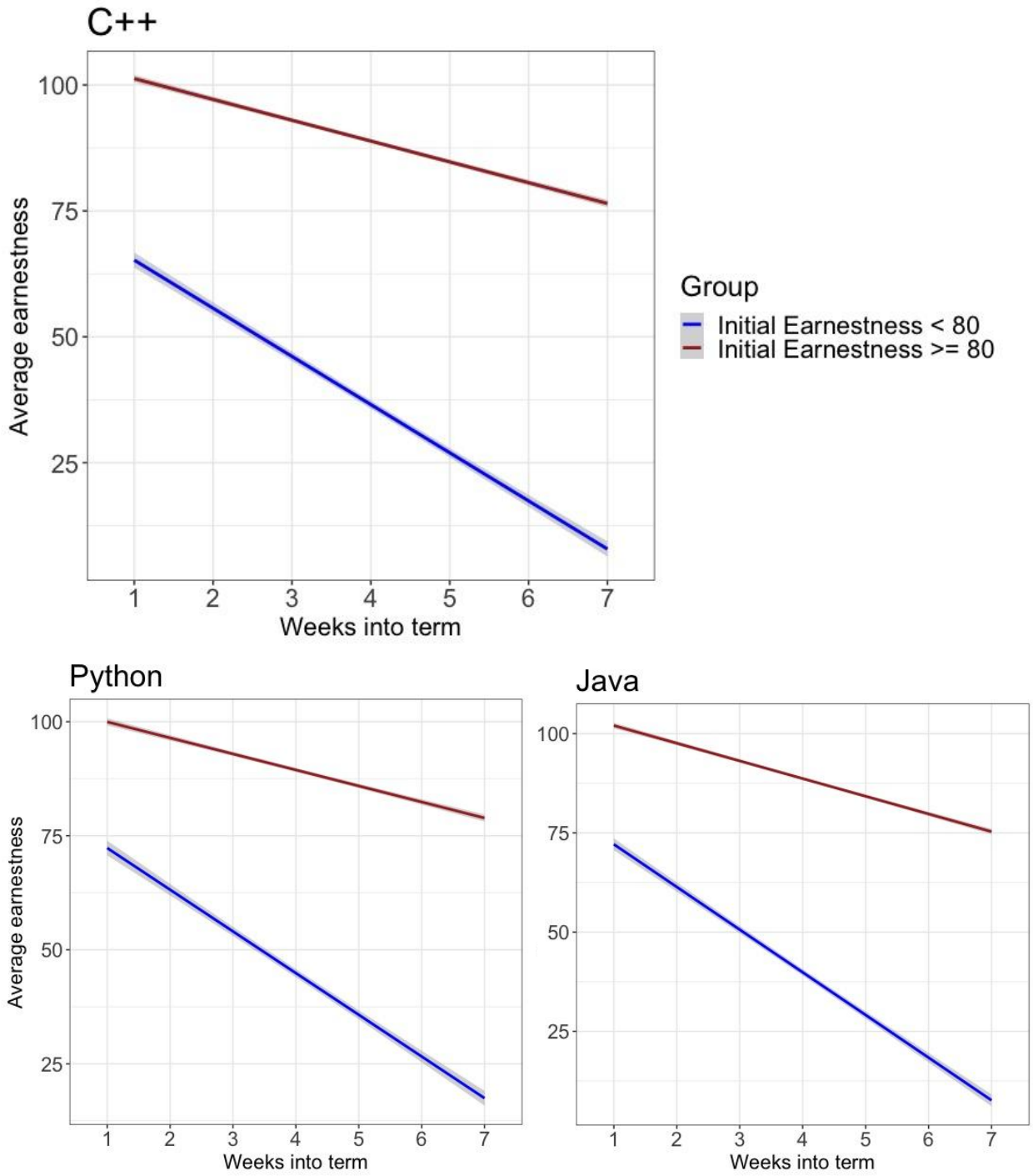

Figure 1: Earnestness change across chapters for C++, Java, and Python students. The blue line represents students who had => 80 percent earnestness in the first three chapters.

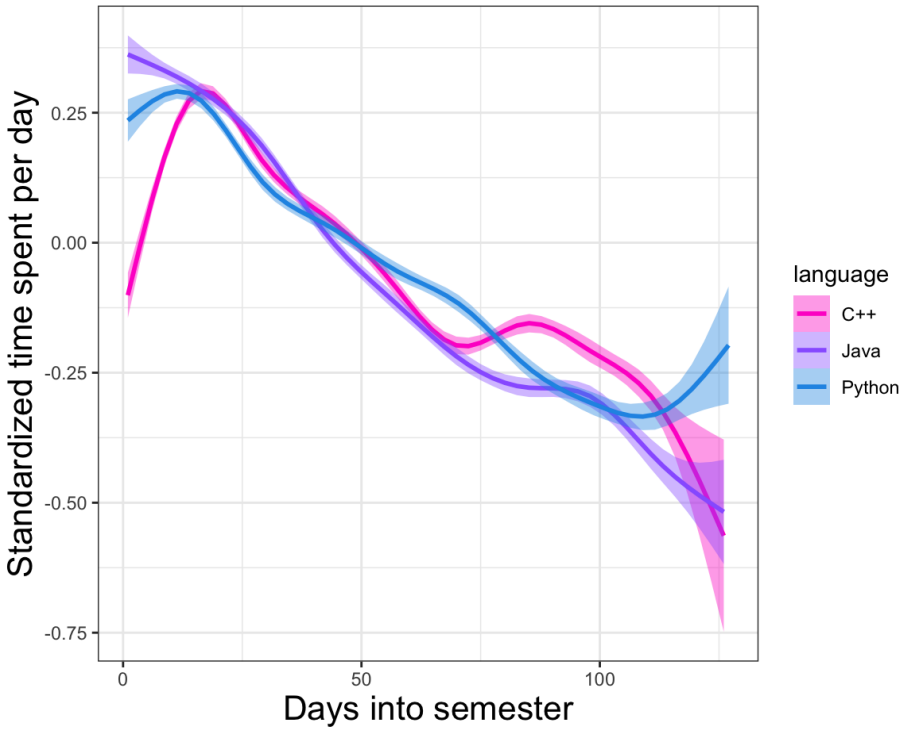

Figure 2: Time spent standardized per student across the semester for C++, Java, and Python.

Discussion

We've shown, unsurprisingly, that engagement declines over the semester. Decline in engagement is prevalent across many domains, even outside of academic settings. When a person starts something new, they're excited, and that excitement wears off as time goes on. The decreased earnestness over the semester might be a result of students getting behind and struggling to catch up (increased pressure and rationalization). Another possibility is that as the content becomes increasingly difficult, the amount of time needed to earnestly complete content increases, which leads to higher incentive to act unearnestly.

These results are for the books created by one particular publisher. Further research is needed to determine whether the same trends are seen in traditional textbooks, books from other publishers, or free downloadable textbooks. We also looked at computer science textbooks only; whether these trends will persist in other disciplines is another future are of research that is of interest.

Interestingly, we also found that the lower earnestness is at the beginning of the semester, the more rapidly it will decline. This suggests that once students begin exhibiting unearnest behavior, rationalization increases and they're more likely to continue with unearnest behavior. This means that establishing an environment that encourages students to earnestly do their work must happen *right away*. Some things that can be important for this endeavor are:

- framing the usefulness of the course content
- fostering an environment where students feel like they fit in
- encouraging students to work together collaboratively
- making content manageable and not overwhelming

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