

Relationship between Time Management in Courses with Online Interactive Textbooks and Students' Performance

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Abstract—The study aims to explore the relationship between time management in courses with online interactive textbooks and students' performance. The study was done in two computer science courses - a second-year course on discrete mathematics for computer science and a first-year programming course. Each course used a required online interactive textbook on the course topic. Students had reading assignments that consisted of reading specified sections from the textbook and doing interactive activities from these sections. In discrete mathematics course reading assignments on a topic were due before the class period in which the topic was discussed. In the other course reading assignments were due after the material was discussed in class. For each student, we measured whether they tended to finish reading assignments early or late. We studied the relationship between this tendency of students and their academic performance in the courses. We found that students who tended to do their reading assignments early performed statically significantly better than students who tended to do their reading assignments late in discrete mathematics course where reading assignments were due before topics were discussed in class. In the other course, there was no statistically significant difference in performance among these groups of students.

Keywords—student performance; online interactive textbooks; time management

I. INTRODUCTION

Our goal in this study is to explore the relationship between the time of completion of the assigned reading in courses with online interactive textbooks and students' performance. The study was done in two computer science courses - a second-year course on discrete mathematics for computer science and a first-year programming course. Each course used a required online interactive textbook on the course topic. The textbooks have animations and interactive participation activities for students incorporated in the text. The textbooks provide tools for the instructor to download student activity reports. The reports allow determining the time when activities from each section of the textbook were completed by each student. We used the reports to find out for each student whether they had a tendency to do the assigned textbook participation activities early or late. We study the relationship between this tendency and student academic performance during the semester.

In discrete mathematics course, students were asked to read sections from the textbook on a specific topic and to do all participation activities from these sections before the topic was discussed in class. In the programming course, students were asked to do reading assignments after the material was presented in class.

II. RELATED WORK

A lot of studies have been done on time management and its role in students' academic performance ([8], [11], [15], [16] and [18]). One of the questions studied was if there is a relationship between students' time management and their academic performance. The research has shown that time management is related to students' academic performance and that successful students are good time managers [8]. Moreover, the study [11] tests to see if procrastination would influence the successfulness of online learning students. The study found a negative relationship between students' procrastination and their performance, and this relationship was mediated by the level of student's participation in online discussion forums. It appears that high procrastinators are less successful online students than low procrastinators. The paper pointed that it was due to the learner's level of participation in discussion forums during the learning process. In [10], the study revealed that the majority of students who participated in the research had a view that reading habits had an effect on the students' performance. The research showed that there was a direct relationship between students' reading habits and their academic performance. In another study [6], the authors argued that previous researchers treated the problem as student-centered and ignored the role played by the instructor. However, in their research they suggested that more attention should be placed on the direct role faculty might have in continuing students' reading noncompliance. They found that how faculty integrated reading assignments with the course did affect how the students took responsibility for the reading.

Furthermore, several studies had been done on online interactive textbooks (zyBooks [14]) which we used in our

study and their impact on improvement of students' performance ([1], [2], [3], and [17]). In [3], The authors conducted the study to find out if using interactive textbook in introductory programming courses at three universities would help to improve students' performance. They found that replacing the traditional textbook by an interactive textbook, with most other course features staying the same, resulted in significant improvements in students' exam scores [3]. Another study [1] investigated the question on how much course points should be assigned to textbook activities to ensure student's completion of the activities. The study found that few points are sufficient to lead to high completion rate of about 90%. The authors suggested awarding 5 to 10 points to encourage students to complete the assigned reading [1]. More researches, like [2], compared the text quantity effect on amount learned. The study concluded that using less text with focus on teaching core topics affected student learning positively. None of the researchers investigated the relationship between the tendency of students to complete assignments from an interactive textbook early or late and their academic performance, which is the focus of our study.

III. DATA COLLECTION

We collected data in two face-to-face computer science courses: Discrete mathematics for computer science and Computer science I (programming in Java). Both courses used required online interactive textbooks (zyBooks [14]) on the topic of the course. Each of the courses had required reading assignments from the textbook that contributed 10% to the final grade in the course. In the rest of the section we describe the courses, how student data was collected, and how students were divided in groups based on how early or late they tended to do the reading assignments.

A. Discrete Mathematics for Computer Science Course

Discrete Mathematics for Computer Science course covers mathematical concepts that are used in computer science courses. In this course, the students had advance reading assignments - they were asked to read sections from the online interactive textbook on a specific topic and to do all participation activities from these sections before the topic was discussed in class. Lecture time was used to address questions on the reading; after that students worked in groups applying what they learned. Homework in the course consisted of paper homework assignments and programming assignments that were given after the topic was discussed in class. The final grade in the course was determined based on reading assignments grades (10%), paper homework grades (25%), programming assignments grades (15%), attendance (5%), and exams (45%). There were 43 students in the course.

B. Computer Science I Course

Computer science I (programming in Java) course is the first course on programming for the majors. The course was taught in a traditional lecture format. The teacher explained the

material and discussed it with the students in class first. After that, students had reading assignments and programming assignments on the material covered in class. Reading assignments contained sections from the interactive online textbook and all participation activities from the sections. The final grade in the course was determined based on reading assignments grades (10%), programming assignments grades (40%), attendance (10%), and exams (40%). There were 20 students in the course.

C. Zyante's zyBooks(The Online Interactive Textbooks)

Zyante's zyBooks are online textbooks that include interactive tools, frequent animations and a set of interactive questions. ZyBooks textbooks record students' activities, and have student and instructor dashboards for monitoring activities. The textbooks provide tools for the instructor to download student activity reports [14]. The reports allow determining the time intervals when participation activities from each section of the textbook were completed by each student (each section had several participation activities). We used the reports to find out for each student whether they had a tendency to do the assigned textbook participation activities early or late. We used 12-hour time intervals to classify when activities were completed by a student. We say that activities were completed in interval 1 if they were finished 12 hours or less before the due time. Activities were completed in interval 2 if they were finished from 12 to 24 hours before the due time. Activities were completed in interval 3 if they were finished from 24 to 36 hours before the due time. Interval 4 is from 36 to 48 hours before the deadline. And so on. We recorded the time intervals when each student completed the participation tasks from all assigned textbook sections. For example, student finishing participation activities from section 1.1 of the textbook in the 10th interval means this student did it five days before the due time. We used the time intervals to calculate which students tended to do the reading assignment early and which students tended to do it late. How we divided students in groups is explained next.

D. Division into Groups

First, we used time intervals average to classify the students into groups. For each student, we calculated the average of time intervals when the student completed the participation activities, and used the averages to determine whether students were completing reading assignments early or late on average. Later, we decided to use time intervals medians instead of averages to better handle outliers. Using the medians allowed us to minimize the effect of outliers. For instance, a student does all the reading assignments early except for one time. This would be an outlier possibly caused by some event in student's life not related to study. Having such an outlier would affect the average but it would not change the median. Therefore, the groups obtained using the median should better reflect the tendencies of students to do reading early or late. The difference between using time intervals average and time intervals median

for dividing students into groups was substantial and is shown in the Data Analysis section.

We classified the students into three groups according to the time intervals' average/median of them completing the assigned reading as follows.

- Group G1: A group of students who had average/median of time intervals being greater than or equal to 4 (the students who did the reading assignments 48 hours or more in advance). We say that these is a group of students who tend to do the reading assignments early.
- Group G2: A group of students who had average/median of time intervals being between 1 and 4 (students who did the reading assignments more than 12 hours and less than 48 hours in advance). We call this group a moderate group.
- Group G3: A group of students who had average/median of time intervals being less than or equal to 1 (the students who did the reading assignments 12 hours or less in advance). This is a group of students who tend to do the reading assignments late.

As we mentioned earlier, we considered two sets of groups: groups obtained using the averages and groups obtained using the medians. For each set of groups, we applied one-tailed two-sample t tests ([4], [5], [7]) on the grades of students in different grade categories to see if there is a statistical significant difference between the grades in compared groups or not. We used Excel to do the tests ([9], [12], [13]). We used $\alpha = 0.05$ to determine statistical significance.

IV. DATA ANALYSIS FOR A SECOND-YEAR COURSE ON DISCRETE MATHEMATICS FOR COMPUTER SCIENCE

In the discrete mathematics course, the difference between using time intervals average and time intervals median for dividing students into groups was substantial. When we used the average to classify the students into three groups, group G1 had 7 students, group G2 had 29 students, and group G3 had 7 students. When we used the median to classify the students into three groups, group G1 had 8 students, group G2 had 13 students, and group G3 had 22 students.

For each grade category (attendance, homework, programming assignments, exams, and overall course grade), we applied the one-tailed two-sample t test on the grades of students in the groups to see if there is a statistical significant difference between the grades in compared groups or not. We did the following comparisons of student grades among the groups: group G1 versus group G3, group G2 versus G3, group G1 versus G2, and groups G1 and G2 combined versus G3. Table I shows the results (p-values). If $p < .05$ the difference is statistically significant; otherwise, the difference is not statistically significant. For each comparison among the groups (e.g., G1 vs G2), column with label "Av" shows results of comparison when groups were obtained using the averages, and

column "Md" shows results when groups were obtained using the medians.

The results show that there is a statistically significant difference in the homework and overall course grades between groups G1 and G3 regardless of whether averages or medians were used when dividing students in groups. Students who had a tendency to do their reading assignment early performed statistically significantly better (at $p < 0.05$) than students who had a tendency to do the reading assignments late. When the medians were used, there is also a statistically significant difference in programming assignment grades between groups G1 and G3.

There is no statistically significant difference in any of the grade categories between groups G2 and G3 when the averages were used. However, the grades are statistically significantly different in these groups in all grade categories, except for exams, when medians were used for dividing students into groups.

TABLE I. T-TEST RESULTS (P-VALUES) ON STUDENT GRADES IN THE DISCRETE MATHEMATICS COURSE

Course Components	G1 vs. G3		G2 vs. G3		G1 vs. G2		(G1 & G2) vs. G3	
	Av	Md	Av	Md	Av	Md	Av	Md
Attendance	.08	.08	.2	.01	.1	.3	.1	.007
Homework	.001	.02	.07	.009	.03	.4	.02	.001
Programming Assignments	.055	.005	.3	.007	.01	.3	.2	.004
Exams	.3	.3	.3	.3	.4	.3	.3	.2
Overall (Total)	.007	.03	.08	.01	.09	.4	.03	.005

Cells in the table contain p-values. If $p < .05$ the difference is statistically significant; otherwise, the difference is not statistically significant

Av.: Intervals Average Md.: Intervals Median

There is no statistically significant difference between groups G1 and G2 in any of the grade categories regardless of whether averages or medians were used in group definitions.

The results for groups G1 and G3 were similar to results between groups G2 and G3 when the medians were used, so we decided to combine group G1 (which had 8 students) and group G2 (which had 13 students) in one group (G1&G2) which now had 21 students. We compared group (G1&G2) (these are students who tended to do the reading assignments early and students in the moderate group) and group G3 (students who tended to do the reading assignments late). We found that there is statistically significant difference between group (G1&G2) and group G3 in homework, programming assignments, attendance and total grades.

Table I shows that there are more statistically significant results when the medians were used to divide students in groups comparing to the case when the averages were used. In particular, there is no statistical significant difference between G2 and G3 groups when the averages were used, but there is a

statistically significant difference between these groups in all categories except for exams when the medians were used. Using the medians allows us to minimize the effect of outliers and results in more accurate classification of students into groups.

V. DATA ANALYSIS FOR A FIRST-YEAR PROGRAMMING COURSE

In the programming course, the difference between using time intervals average and time intervals median for dividing students into groups was not that big. When we used the average to classify the students into three groups, group G1 had 4 students, group G2 had 11 students, and group G3 had 5 students. When we used the median to classify the students into three groups, group G1 had 5 students, group G2 had 9 students, and group G3 had 6 students.

We applied the one-tailed two-sample t test on the grades of students in the groups to see if there is a statistical significant difference between the compared groups or not. We compared groups G1 versus G3, G2 versus G3, and G1 versus G2. We found that there was no statistically significant difference between the groups in any of the grade categories (attendance, lab assignments, exams, and total grades) regardless of whether averages or medians were used when dividing students into groups.

VI. DISCUSSION OF THE RESULTS

In the discrete mathematics course, students who had a tendency to do their reading assignments early performed statistically significantly better than students who had a tendency to do the reading assignments late. There could be several factors contributing to the result. One of them could be that students who had a tendency to do reading assignments late are high procrastinators. If it is the case then lower course scores are no surprise as other researchers have shown that high procrastinators have lower academic performance scores (e.g., [18]). However, in the programming course there was no statistically significant difference in the performance of students who had a tendency to do the reading assignments early versus late.

We believe that the main contributing factor to the results that also explains the difference in the findings in the two courses is the way reading assignments were used in the courses. In discrete mathematics course, students were asked to read sections from the textbook on a particular topic and to do all participation activities from these sections before the topic was presented in class. Then, students' questions on the material were addressed in class and students worked in groups applying what they learned. Students who did the reading late (right before the due time) were likely pressed for time and could have spent less time on the reading comparing to students who did the reading well in advance. Students who had a tendency to do reading assignments early were likely less

pressed for time and possibly spent more time and read the material more thoroughly and thus were more ready for the class discussion and group work. Therefore, they benefited more from class work and learned more during class periods comparing to students who were less prepared. Homework assignments were directly related to the material discussed in class; therefore, students who benefited more from class work were more likely to have higher homework scores. In the programming course, students were asked to do reading assignments after the material was presented in class. Readings were not that essential for lectures preparedness. Therefore, the reading completion time tendencies did not have that much of an effect on student learning during lectures, which could explain the lack of statistically significant differences in grades between student groups.

The lack of a statistically significant difference in exam scores between the groups could be due to the following factors: 1) different students have different anxiety levels for exams that could affect their performance, and 2) exams are not so directly related to class work comparing to homework assignments because students learn the material for the exam not only in class but also from feedback on homework, study groups, review sessions, etc.

The study suggests that when the reading assignments are essential for students to be better prepared for class work in the course, students who tend to do reading assignments early perform statistically significantly better when students who tend to do the reading assignments late.

VII. CONCLUSION AND FUTURE WORK

We studied the relationship between the tendency of students to complete assignments from an interactive textbook early or late and their academic performance. We found that students who had a tendency to do interactive reading assignments early performed statistically significantly better than students who had a tendency to do the assignments late only in the course where reading assignments were essential for students to be better prepared for class work. In the course where reading was assigned after lectures, there was no statistically significant difference in performance between these groups of students.

In the future we would like to repeat the study while collecting more information from students. We would like to assess the level of procrastination among students using questionnaires so we could check whether students who tend to do their reading assignments late are students who have high procrastination scores or not. Also, we plan to ask students to report how much time they spend on reading assignments to check our hypothesis that students who finish reading assignments late tend to spend less time on them.

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