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Analysis of Trends in Student Time on Task Across a Program: Do Apparent ”Peaks and Valleys” Smooth Out When All Program Coursework is Considered?

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Analysis of Trends in Student Time on Task Across a Program: Do Apparent "Peaks and Valleys" Smooth Out When All Program Coursework is Considered

Abstract

An objective in educating civil engineering students and preparing graduates to enter professional practice is the inculcation of effective work habits and time management practices. This objective includes working in advance of deadlines on assignments so that students can devote blocks of uninterrupted time to their work and seek assistance if needed. Anonymous student surveys regarding time spent on related work outside of class typically show that students alternate between two extremes: very little time spent on coursework outside of class when no assignments are due, and many hours spent outside of class right before a homework assignment is due or an examination is imminent. This paper seeks to understand, visualize, describe, and address the fluctuations observed in student self-reported investment of time toward undergraduate-level coursework. Is there reason for instructors to be concerned and seek mechanisms that might encourage students to engage with the material more regularly within each course, or are student efforts naturally balanced across competing demands of multiple courses? The authors hypothesize that the "peaks and valleys" observed on course specific time surveys do not fully contextualize student engagement and time management practices. Rather, it is suspected that, on a macro-level, student engagement actually remains constant or increases gradually throughout the semester when considering student time investments across all courses. The authors believe that students alternate their attention and out-of-class efforts among their courses, spending significant time and effort on one course's assignments prior to major deadlines and then shifting their focus to other courses in turn as required. This would actually indicate students are using sustained, single-tasking study habits, which is a time-management strategy generally lauded in literature and management books as opposed to multi-tasking. To test this hypothesis, lesson-by-lesson anonymous surveys of student out-of-class time investment in civil engineering coursework ("course-level time assessments") are analyzed to show student engagement in each class over time. Students' total lesson-by-lesson engagement is then analyzed collectively across all civil engineering courses undertaken in the same semester to reveal a "program-level time assessment." Engagement trends in individual courses versus the program holistically are discussed. Results provide insight as to whether additional out-of-class assignments might provide utility in promoting positive time management strategies and more sustained engagement with course material. Conclusions are important beyond the classroom as time management skills are vital in all industries. This study will benefit both graduate and undergraduate engineering educators seeking to harmonize student effort across multiple courses within a program.

Introduction

The importance of time management and time allocation is a topic covered extensively in literature and media with importance to all disciplines. Time is the only true non-renewable resource in all fields: no matter how it is used, once it passes there is no opportunity to recycle or reuse [1]. In higher education, students must apply their own executive function skills to utilize their time as effectively and efficiently as possible across many competing demands: schoolwork, extra-curriculars, employment, sleep, and time with friends and family. Educators are provided contact time with students to instruct and answer questions but not necessarily to ensure that material is truly learned – such mastery requires student engagement and responsibility. Exams, homework, quizzes, and projects all serve to provide additional practice time and opportunities to evaluate student achievement. To perform well in a course, each of these requires out-of-class time commitment. Literature even suggests that the majority of student learning takes place through such activities outside the classroom [2].

A significant amount of literature comments on allocation of time by college students toward assignments and the negative effects of procrastination and cramming. Observations include "put off until right before the due date" [3] and "potential negative consequences of procrastination are reduced scholastic performance…" [4]. The change of pace and structure of college courses relative to secondary school also makes "procrastinating and then cramming untenable" for students who relied on this strategy in high school [5]. Educators routinely seek to improve student retention of material and performance within an individual course by increasing the frequency of assignments across a term or semester. Data indicate that increased homework frequency may correlate with improved student achievement and higher levels of out-of-class time are correlated with higher levels of student achievement [6]. Conversely, study strategies that approximate cramming have limited benefits in higher education [5].

Educators within the Department of Civil and Mechanical Engineering of the United States Military Academy at West Point have collected data on student self-reported time use as a routine part of coursework for over 37 years [7] . At the institutional level, efforts to measure student time use appear at least as far back as 1966 [8]. When course data are plotted in isolation without concern to other courses taken simultaneously, it appears that student effort is purely in response to evaluation events: exams, homework, quizzes, etcetera. Student reporting of time use varies dramatically with peaks manifesting on key deadlines and valleys occurring generally in between; an example of this is shown in Figure 1 and echoes results of previous research [3]. These results and the perception that increasing the frequency of out-of-class studying may improve student achievement have led educators to implement changes within their courses to "flatten the peaks" and "level the data" for student time use within a course.

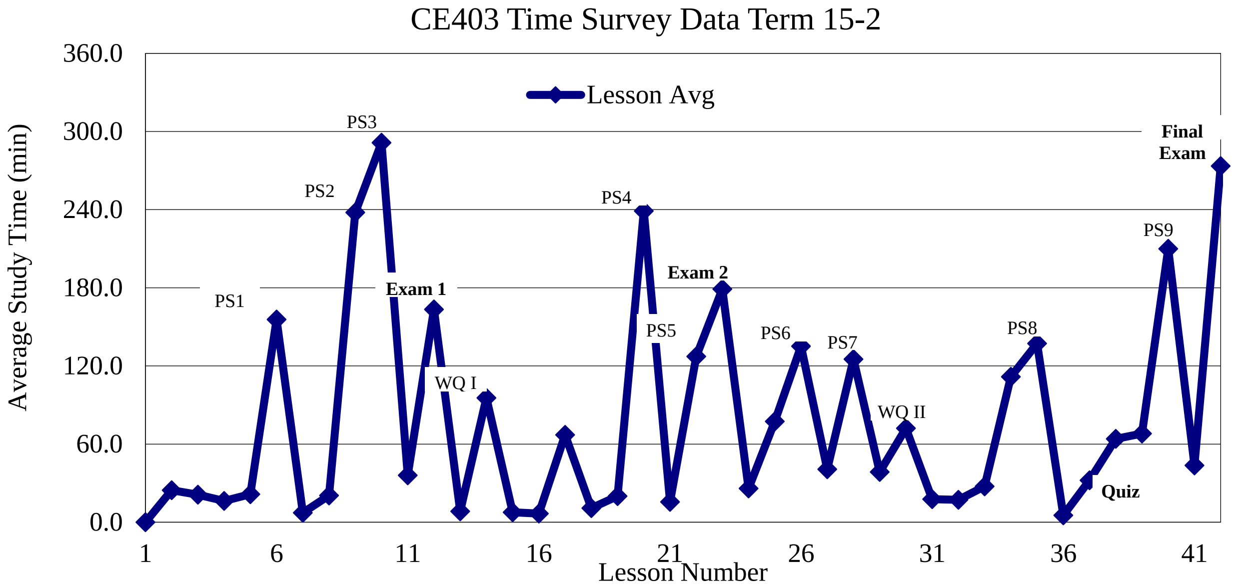


Figure 1: Time Survey Data for CE403, Structural Analysis. Major graded events are labeled as they occur throughout the term.

However, the authors hypothesize that attempting to flatten the peaks in one course may be the equivalent of "planning in a vacuum" since student time application across other commitments and courses are not simultaneously considered. This study aggregates self-reported time use data across multiple courses usually taken at the same time by students enrolled within the civil engineering major to determine if out-of-class time is generally constant and/or gradually increases, implying that students spend less time studying at the beginning of the semester but invest more time as the semester progresses and graded events tend to increase in value (such as a course design project or comprehensive final exam). Wherever possible, a more holistic assessment of student time investment should be used to determine if students are, in fact, allocating time relatively uniformly across their academic pursuits while individual course efforts rise and fall.

Literature Review

From as early as six or seven years old, students are at least encouraged, and eventually required, to complete work outside of the classroom to succeed. Many studies have been conducted to assess the effectiveness of out-of-class work. Generally, these studies establish that student performance increases as student out-of-class working time increases [3] [9]. Within the Code of Federal Regulations (CFR), the United States Department of Education stipulates that one hour of classroom or direct faculty instruction should require approximately two hours minimum of out-of-class student work [10]. This benchmark is to create uniformity across educational institutions on the definition of a credit hour but is also beneficial to provide a metric for out-of-class requirements. Research conducted using student survey data in Germany from 1986-2006 found improvements in student performance that correlate with increased time spent on out-of-class studying that span multiple different academic disciplines and demographics [11].

Different study habits and levels of executive function among students translate to many different approaches to tackling coursework, including both homework and exam preparation. When undergraduate psychology students were tasked with memorizing and recalling word pairs but given the choice to either mass or space their practice at retention, the students generally chose to space their practice. When data were analyzed deeper and difficultly of the word pairs taken into account, students generally massed practice on the easier items and spaced out practice on more difficult ones [12]. This specific study cautioned about interpreting the effectiveness of either practice due to study design because its applicability and utility lies in understanding preference for study time use.

Students in an entry level construction management course were surveyed to assess study techniques (what they used to study), how much studying they did prior to major exams, and their perception of the grade they would receive on that exam. This study pointed to concerns with students' ability to self-regulate or apply the correct amount of effort in the correct place to achieve the desired outcome. Over a third of these students estimated their grade to be over one letter grade (10%) higher than the actual grade. This points to potential gaps in study techniques and awareness of their own mastery level [13].

In another study, two groups of students at the Citadel received homework in two formats: with either weekly or daily deadlines. Both groups received approximately the same number of problems across the semester; the variance was in the frequency of due dates. Educators collected self-reported out-of-class time survey data from both groups. The group with daily deadlines spent on average approximately 50% more time on course work out-of-class between each lecture than the students with weekly deadlines [3]. Visual representations of out-of-class time, reproduced in Figure 2 below, show reduced variance in the average time value for students who turned in daily assignments than those who turned in weekly assignments. This suggests that students are only spacing their practice when the educator's deadline requires it. The two large peaks in each visual representation correspond to exams, demonstrating that homework frequency is immaterial to student's decisions to mass practice prior to an exam [3].

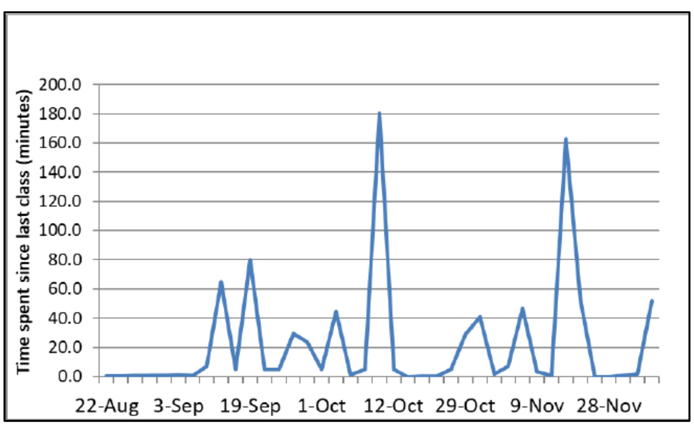


Figure 2a: Time survey data with homework assigned weekly, reproduced from [3]

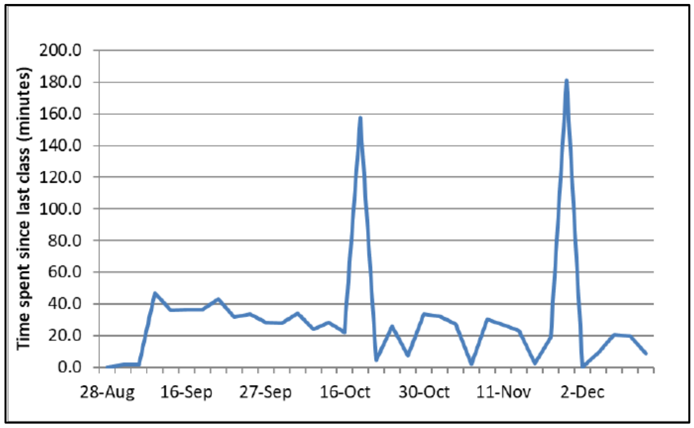


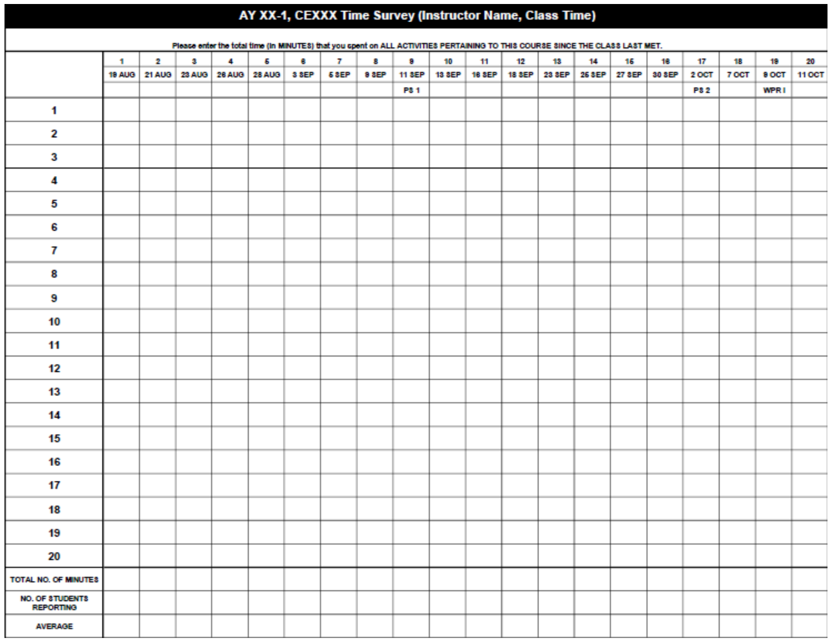
Figure 2b: Time survey data with homework assigned daily, reproduced from [3]

Other research teams have completed studies to assess student time use over years or decades. Various methods, including student time logs, Higher Education Research Institute Surveys, and surveys of engineering department heads were used to understand student use of out-of-class time and contrast it with expectations [14]. This study found discrepancies among the different data collection tools and recommended this data be used to assess changes to curriculum and observe trends.

The data source for this paper was course specific time survey data. The time survey in the Department of Civil and Mechanical Engineering at the United States Military Academy "is used to obtain input from students on the amount of out-of-class time they spend in preparation for each lesson. It is administered to every student, in every class, in every course offered by the civil engineering faculty [7]." The time survey informs instructors, course directors, and program directors with a "reasonable accuracy" as to how much time students are committing to out-of-class preparation. Limitations to this data do exist and are covered later in this paper, but the principal application of time survey results are comparative: if the various biases in data are systematic and consistent across courses and time, the data can be used to inform decisions [7].

Methodology

Data on student out-of-class time use has been a part of the programming of courses at the Department of Civil and Mechanical Engineering of the United States Military Academy at West Point since at least the late 1980s [7]. The collection mechanisms vary slightly across courses and across eras. The collection mechanism used during the time period chosen for this study was an anonymous blank table that circulates among the classroom during the first few minutes of each lesson and resembles the one shown in Figure 3. Students are prompted to "Enter the total time in minutes that you spent on ALL ACTIVITIES PERTAINING TO THIS COURSE SINCE THE CLASS LAST MET." Respondents (students) can choose any row they desire to place their response in. The total number of minutes is summed and divided by the number of students reporting for that lesson to get an average time of out-of-class preparation for each lesson.



AY XX-1, CEXXX Time Survey (Instructor Name, Class Time)

Please enter the total time (in MINUTES) that you spent on ALL ACTIVITIES PERTAINING TO THIS COURSE SINCE THE CLASS LAST MET.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	19 AUG	21 AUG	23 AUG	26 AUG	28 AUG	3 SEP	5 SEP	9 SEP	11 SEP	13 SEP	16 SEP	18 SEP	23 SEP	25 SEP	27 SEP	30 SEP	2 OCT	7 OCT	9 OCT	11 OCT
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Figure 3: Example Time Survey Collection Form

For this study, the researchers selected four courses typically taken during the same semester and same year by a Civil Engineering major cohort. The names and course abbreviations can be found in Table 1. These courses were chosen because they all are usually taken by students in the sixth of eight undergraduate semesters, i.e., spring of their junior year. The spring of 2015, 2016, and 2017 were selected as a sample of the entire dataset for analysis. These are abbreviated throughout the paper as “academic year 1X-2”, or “AY 1X-2.”

Table 1: Courses and Course Codes Chosen for Study

Course Code	Course	Enrollment (N =)		
		AY15-2	AY16-2	AY17-2
CE450	Construction Management	76	72	80
CE403	Structural Analysis	49	35	45
CE371	Geotechnical Engineering	38	35	46
CE380	Hydrology/Hydraulic Design	45	36	43

As with any data, it is valuable to acknowledge that this dataset may include some confounding factors. First, this data is all self-reported. Self-reported time data is prone to error, both under and over the actual value. This could be deliberate on the part of the respondent (responding with an impossibly high value such as 1,000,000 minutes) [8] or it could be unintentional due to the inherently subjective nature of time perception or lack of official time keeping tool/method [13] [15]. Faculty do remove reported out-of-class time values that are either impossible or nonsensical such as 1,000,000 minutes or π^e prior to collating the data at the end of each term.

The mechanism of data collection, a preformatted piece of cardstock that is passed around at the start of class, is a compromise on the educator’s part to acquire data in a time expedient manner that is easily spot-checked at the end of each class to ensure full compliance but leaves room for student anchoring bias or wargaming. Anchoring bias could manifest in this format if students look at previously entered responses for a given lesson and develop their own responses based on previous responses. Anchoring bias is impossible to control for in this scenario as the student could choose to report a value similar to the values already reported or choose to “wargame” a higher or lower value in an attempt to manipulate the educator’s understanding of out-of-class time application.

The researchers assess that, while imperfect, this data still provides a useful snapshot into out-of-class preparation time. Anchoring bias and the subjective nature of time perception are both valid concerns that could mislead a research team if the objective were to determine exactly how many minutes were applied by students for each lesson: however, our work seeks to look at and conduct comparative analysis of prevailing trends instead of the finite values reported.

An additional confounding factor is that the courses selected are not fully comprehensive of what a student would have for their entire academic load during the semester. These four courses consist of approximately two-thirds of what a civil engineering student would take in total for semester as shown in Figure 4. The other courses do not collect data in the same way as the Department of Civil and Mechanical Engineering, which prevents a fully comprehensive look at student time usage across a semester. Individual scheduling constraints also preclude some students from taking the course with their class cohort: semester abroad experiences or high school Advanced Placement (AP) credit among other factors could require a student to take some of these classes in a nontraditional term. This scheduling factor means that not all students are experiencing all four courses at once. Nevertheless, anecdotally, this would only apply to less than 10% of a cohort.

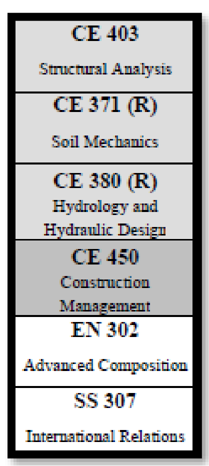

Figure 4: Example course plan for a Civil Engineering major in the class of 2016 during semester six, spring of junior year.

Scheduling and the lack of a fully comprehensive dataset presents challenges to interpreting these data. However, similar to previous discussion, the authors believe that these confounding factors do not overly restrict the ability to make broad generalized conclusions about trends within the data such as students spending more time preparing for one class than another. At the same time, these confounding factors do lead the authors to believe it would be inappropriate to attempt to draw conclusions of the quality of the time spent on task. Inaccuracies resulting from rounding, unawareness of time's passage, or differing perceptions of time are some of the various ways a student could have a lack of compliance with the survey's stated question. The authors believe these data are best utilized to identify trends for general program analysis.

Lastly, Table 2 shows much higher enrollment each semester in CE450, Construction Management, than the other Civil Engineering courses. Each student at the United States Military Academy must take a minimum of three engineering courses to graduate, regardless of major, and CE450 is one of the courses offered to non-civil engineering majors to help fulfill that requirement. Therefore, the student population of CE450 is both civil engineering majors and non-civil engineering majors.

Table 2: Population and number of sections by course and term

		CE450	CE403	CE371	CE380	Total
AY15-2	Students	76	49	38	45	208
	Sections	4	3	3	3	
AY16-2	Students	72	35	35	36	178
	Sections	4	3	2	2	
AY17-2	Students	80	45	46	43	214
	Sections	4	3	2	2	
Total Students		228	129	119	124	**600**

After collection, the data were formatted by lesson (each course contains 40 lessons, or days a class would meet), by course, and by term. This allowed the calculation of the average time spent per course and an average total time spent studying for these four courses per term, as well as time allocated across each lesson by course. Each course met approximately every other day. This is important to note as each lesson's preparation could have been spent over two total days, or even more if across weekends or breaks. References to a "Lesson 41" refer to the final exam.

Findings and Results

The authors hypothesized that student time allocation out of class would be generally distributed across courses, i.e., that students would allocate time to the requirements with impending due dates and, once complete, shift focus to other courses. Additionally, we hypothesized that total out-of-class time would be generally increasing across a semester. This was logical to the team: coursework generally requires more engagement as the term progresses.

Instead, the authors were surprised to discover that student engagement bounces between extremes holistically just as well as when analyzed at the individual course level. Figure 5 below captures this for the first spring semester in the selected dataset. It is apparent that lessons 8-11 are rather demanding for students across all courses. Students report spending approximately 780 total minutes (13 hours) in preparation for lesson 8 across these four courses. However, once this period passes, out-of-class time drops. Again, what is not reflected here is student out-of-class engagement in non-Civil Engineering courses. As stated above, students may have as few as two or as many as four additional courses that the authors do not have data for, and it is certain that some out-of-class time is being spent preparing for these courses too. When this data was overlaid with due dates for assignments as done in Figure 1, it is apparent that students respond strongly to graded events by applying time and effort- this was echoed in a survey of the literature [3].

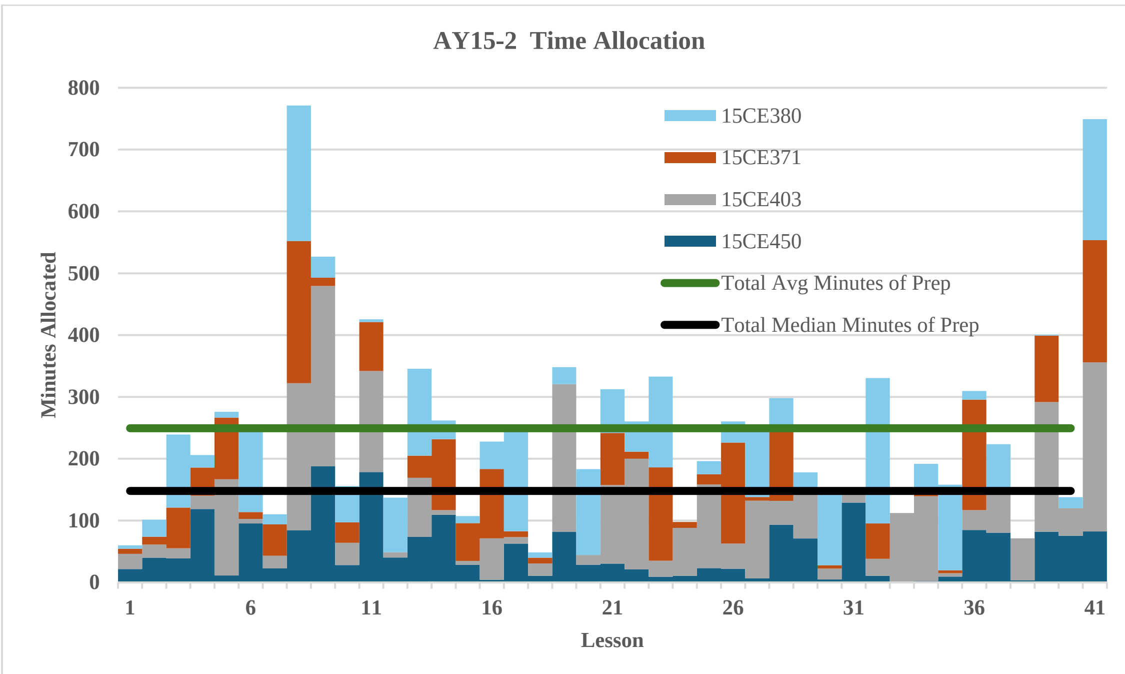

Figure 5: Academic Year 2015, Spring. Time allocation across four Civil Engineering Courses. Average and median values do not include final exam (Lesson 41) preparation.

The findings from Academic Year 2015 are consistent with findings from both Academic Year 2016 and 2017, with their graphs reproduced as Figure 6 and Figure 7 below.

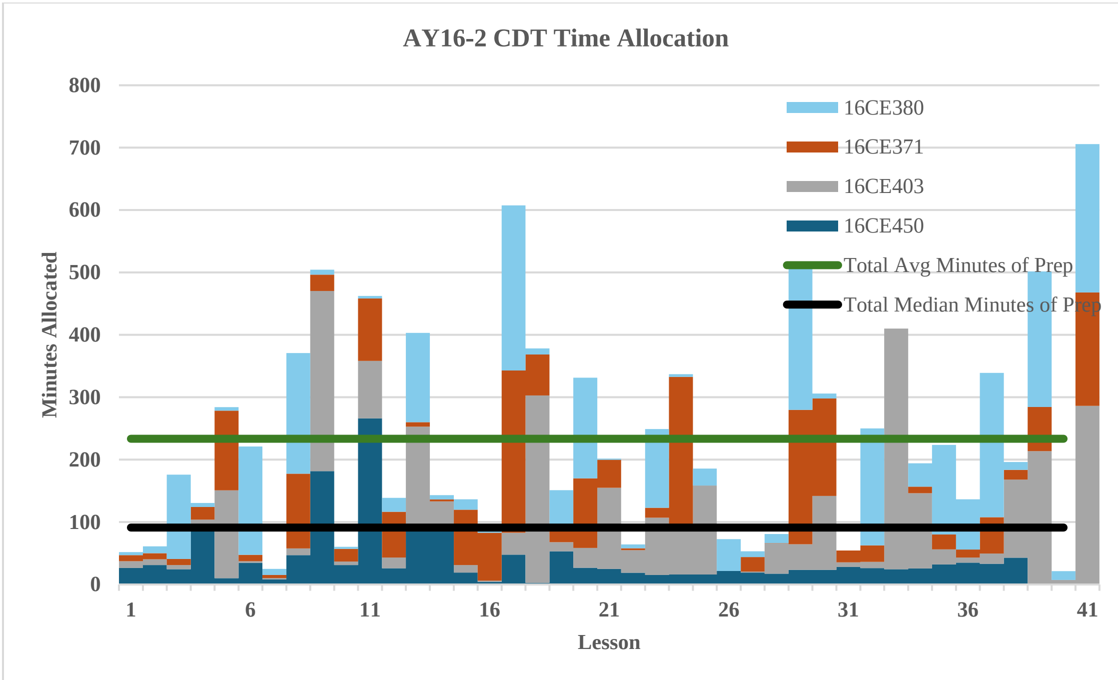

Figure 6: Academic Year 2016, Spring. Time allocation across four Civil Engineering Courses. Average and median values do not include final exam (Lesson 41) preparation.

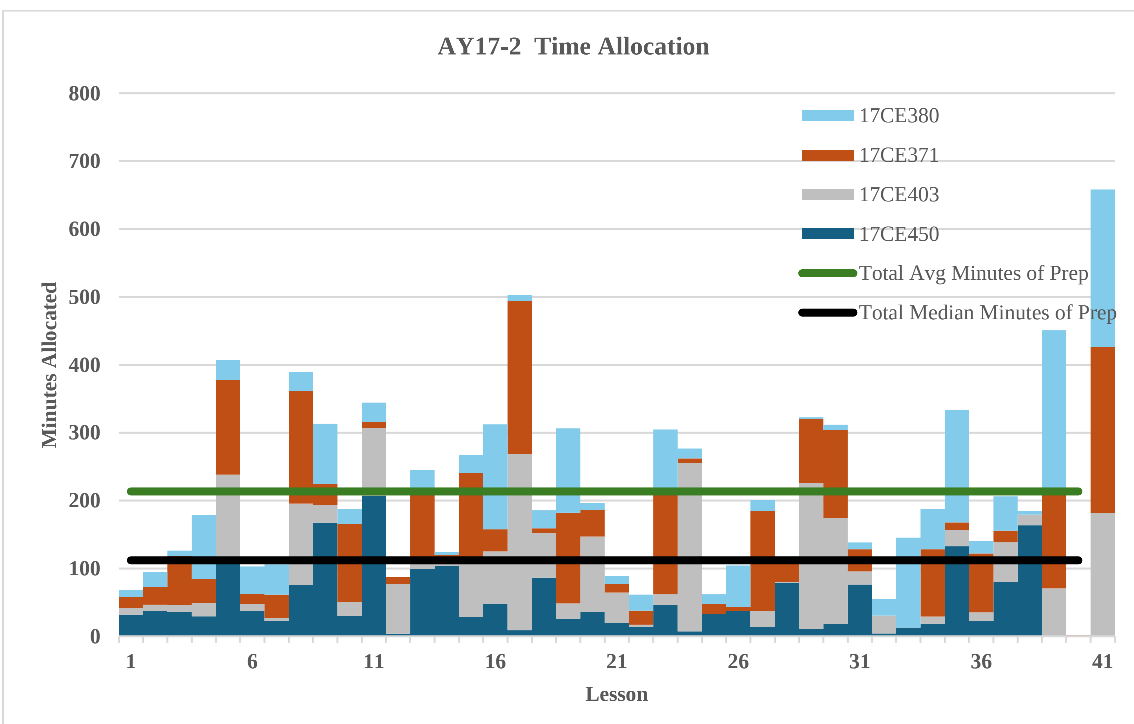

Figure 7: Academic Year 2017, Spring. Time allocation across four Civil Engineering Courses. Average and median values do not include final exam (Lesson 41) preparation.

Over this three-year period, the mean and median total out-of-class time allocation values decreased. These values are summarized in Table 3. The difference between the mean and median can be seen as statistical evidence of very high variance data from lesson to lesson.

Table 3: Total out-of-class time per lesson by academic year

Final Exam Prep *Excluded*		
	Total out-of-class time per lesson	
AY	**Mean [minutes]**	**Median [minutes]**
AY15-2	249	148
AY16-2	233	91
AY17-2	213	112

Each academic year, students report a much higher out of class time commitment preparing for the final exam than for a standard lesson. As this data is an outlier and a final exam cannot be compared to a regular lesson, this data has been removed from all figures and tables unless specifically noted. Table 4 below includes final exam reported preparation in calculations of means and medians by academic year.

Table 4: Total out-of-class time per lesson by academic year, final exam prep data included.

Final Exam Prep *Included*		
	Total out-of-class time per lesson	
AY	**Mean [minutes]**	**Median [minutes]**
AY15-2	262	153
AY16-2	266	97
AY17-2	226	114

Areas for Future work

Although the results of this study were surprising, the investigation of students' time on task prompted many additional questions and opportunities for future research. It may provide additional insight into students' decisions regarding time investment to expand the information collected to include demographic features such as age or prior work experience. This comment is prompted by a study which found that students at the Citadel who had prior work experience in the military or private sector generally showed more evenly distributed time on task throughout the semester [3]. There may be other differences among demographic groups based on major within engineering, gender, student athlete status, etc.

An interesting find from this research that is congruent with previous work is the mean out-of-class time reported across the three-year period decreased. The difference with final exam preparation excluded is over a full half hour drop through the three-year period, or almost a 15% decrease, as Figure 8 and Table 3 illustrate.

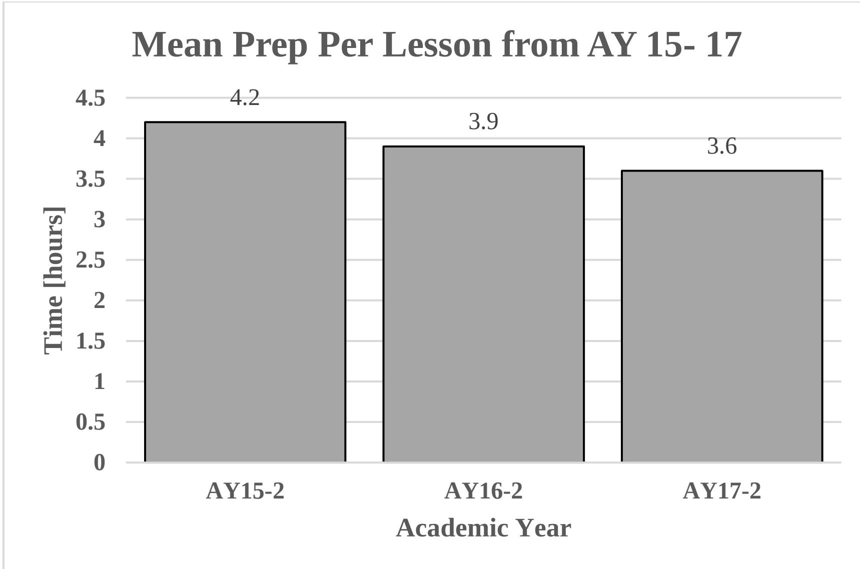

Figure 8: Mean Prep Per Lesson total from AY 15-17, final exam prep excluded (Graphical representation of Table 3)

A long-term study that compared data sets from 1961, 1981, 1988, 2003, and 2004 noted the average time spent studying for full-time college students decreased across the data sets [16]. Even as the authors attempted to correct and adjust for various factors, they annotated that student "are investing much less time in academics as they once did." The mean weekly hours of study time in given years are reproduced in Table 5. This is a gradual decline in time spent studying across multiple decades, and over a 50% decrease over four decades.

Table 5: Mean weekly study time, reproduced from [16]

Year	Mean [hours]
1961	24.43
1981	19.75
1988	12.96
2003	13.28
2004	11.23

The data used in this paper is congruent with the theme of the previously discussed long-term study, even if this study duration is much shorter.

As noted previously, students take some coursework outside of their program, and these courses may not collect or share data about student time on task. Additional coordination of data collection in future semesters could close this data gap and help investigators determine whether the entire time spent on all academic pursuits follows a similar distribution.

Babcock and Marks attempted to discern why the decline in student time spent studying has been occurring, with little success but some possible explanations. The most relevant two possibilities noted are the improvement of education technology as well as the change in economic valuations [16]. Both are vital for educators to understand. Firstly, how efficiency may be gained through better technology, especially now with the rise of artificial intelligence and other practices leading to a decrease in the time required to achieve the same end state. Additionally, the intrinsic value of student time as students perceive it relative to other endeavors may fluctuate over time, a difficulty with time estimation noted in other sources as well [15].

Finally, the results of this study challenged a common assumption that time on task which is distributed as uniformly as possible is, indeed, a benefit to students and that this should be encouraged by teachers. It may be interesting to further explore this assumption by attempting to replicate the work done by Skenes et al: investigating student performance and out-of-class time in different sections of a large-enrollment course: one set organized traditionally and one with many small assignments which force students to study and work in many shorter sessions spread throughout the semester [3]. If the students were evaluated with the same final exam at the end of the semester, it could be possible to discern whether the forced-uniform distribution of time on task had any significant influence on students' performance.

Conclusion

This study disproved the authors' hypothesis, which was that when considered holistically across coursework taken within the Civil Engineering program during a given semester, total student time out-of-class would be approximately equal from lesson to lesson and generally increasing over the duration of a semester. Results of self-reported out-of-class time over three different semesters and four courses that are usually taken together show that total student out-of-class time actually waxes and wanes across the semester in the same fashion as it waxes and wanes across the semester for a single course.

Initially this study hypothesized that students may be using single tasking techniques versus multi-tasking. However, after analysis of these data it is inconclusive whether or not students are choosing one strategy over the other, and whether or not that is a deliberate decision.

A recommendation for educators that are trying to level the peaks and raise the valleys of out-of-class time in their course may be to distribute their graded events at as high a frequency as practical. This conclusion is in concurrence with the literature reviewed above. Students respond to the carrot (or stick) that graded events represent by applying time out-of-class to prepare. That out-of-class preparation leads to increased student performance; therefore, engineering a curriculum that creates maximum opportunities for students to be rewarded for out-of-class preparation (by performing well on frequent, smaller graded events) may actually be more effective. Results show that students are not spending consistent amounts of time on total coursework and just shifting efforts from course to course as the authors previously hypothesized.

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