The Effects of Transitioning an Undergraduate Mechanical Engineering Course from Shorter and More Frequent Class Periods to Longer and Fewer In-Class Sessions

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By Jeffrey Rigney, Matthew Miller, Daniel Arnold, and David Flaherty

Abstract

Class frequency and duration are fundamental parameters within engineering education across nearly all pedagogical methods. Optimizing these factors enables programs to achieve a higher level of learning in the classroom while providing for more efficient time management.

The objective of this paper is to document the perceived effect on students and instructors when transitioning from a traditional 40 lesson course with 55 minutes duration, to one comprised of 30 lessons at 75 minutes in length. This analysis limits research to a mechanical engineering curriculum at the United States Military Academy at West Point, NY. Major assessment performance under the new structure was compared with historical results to provide objective qualitative comparison. Anonymous student feedback was also collected at the midpoint and end of each course. Survey questions centered on perceived information absorption and synthesis, impact on problem solving opportunities, and the effect of variation in classroom contact time. Changes in course syllabi to accommodate the 75 minute structure generally resulted in no net gain or loss of new material to the original curriculum, though outliers did occur and are discussed in more detail. Class size averaged 18 students over four different courses, ranging from Helicopter Aeronautics to Vehicle Dynamics. Course size averaged 34 students with a total of 135 students enrolled across all courses.

The change in course structure demonstrates potential opportunity for both greater depth and application of learning in the classroom as well as increased schedule flexibility. Conversely, the heightened implications of students missing class and the administrative feasibility of such a shift can be problematic. Instructor assessment of student learning and student feedback through end-of-course evaluations will be presented in this paper, as well as recommendations for future instructors wishing to apply similar changes.

Introduction

Most universities offer courses that fall into one of the three following formats: first, a course that meets 3-times a week for 50-55 minutes (MWF); second, a course that meets twice a week for 75-80 minutes (TR); or lastly a course that meets once a week. The United States Military Academy does not offer courses that directly fall into these common formats, but rather into two categories: a 40 lesson course with 55 minute duration lectures that occur on “Day 1” or a 30 lesson course with 75 minute lectures that occur on “Day 2.” In general, the 40 lesson course meets 3-times a week while the 30 lesson course meets twice a week. However, this arrangement does not align with a traditional MWF or TR schedule. Due to overarching changes to the university’s academic schedule, the Mechanical Engineering Division required a significant number of mechanical engineering courses to convert from a 55 minute course to the longer 75 minute course that met less frequently.

The need to change raised some important questions: what is the optimal class duration and frequency for undergraduate mechanical engineering courses? Will students spend more or less time preparing for each individual lesson? What are the student perceptions and preferences for class time and frequency? Although most college instructors cannot choose whether their course is offered MWF or TR but rather are dictated by scheduling constraints between students, classrooms, and instructor availability, the goal of this paper is to help inform instructors of the potential implications of an extended class structure on student performance, student perceptions of the course material, and individual out-of-class time spent on the course.

There is literature that explores the relationship of student performance with class length and frequency, but most of this literature discusses high school block scheduling implications or non-engineering undergraduate courses. The evidence is mixed on whether student performance (grades) increase with shorter more frequent classes [1], [2], [5], [6] versus longer with fewer meeting times [3]. There is further research discussing no difference between shorter or longer classes [4]. The mixed results of the literature review led the authors to conduct their own research in the subject with focusing on undergraduate mechanical engineering courses.

Methodology

Restructuring select courses from 40 lessons to 30 yields a net increase of 50 total minutes in classroom time at the expense of ten less meetings. Of primary concern in reorganizing course syllabi was the ability to maintain the same course content while leveraging extended class periods for problem solving, practical demonstrations, and discussion as necessary for the particular lesson. The primary mechanism for ensuring course consistency was the course and subordinate lesson objectives, as approved by the department program director. In all cases, these objectives were not altered, either to increase or reduce content.

Using lesson objectives as the guiding parameter, lesson restructuring followed a generally consistent pattern. First, any lessons under the 40 class format that were “drop periods” (used to provide students with compensatory time) were eliminated from the schedule. Additionally, lessons used as working group sessions for larger projects and laboratories were rolled into adjacent lessons that presented new material. It should be noted that this action reduced working group session time from 55 minutes to a shortened period as allowed by the class it was combined with, typically 30 minutes. Next, this same process was repeated with any classes dedicated to material review in preparation for major assessments, to include the final examination. The next step in restructuring was to combine complementary lessons in a fashion that did not overwhelm students with new material. While the previous actions were relatively simple to execute across all course subjects, this particular step relied heavily on instructor knowledge of the curriculum and individual lesson plans. Not surprisingly, decisions made at this juncture appear to be the most identified for potential changes during end of course faculty reviews. Instructors with little or no familiarity of course progression found themselves using limited data to inform these decisions, such as the total number of lesson objectives for a given class, rather than experiential insight. Finally, for a select number of courses examined, extraneous material not related to the course and lesson objectives was removed. This included lectures on tangent subjects from outside contributors in the field, student presentations on related exploratory topics, and similar events.

The net result of a restructure using this format produced a course with essentially the same lesson layout with the exception of 3-5 "combined" lessons, which contained additional lesson objectives due to consolidation. For most lessons, however, the content did not change, but the time to explore the material of that lesson greatly increased.

Results and Discussion

Time Survey Data

Time survey data is collected each and every class period as a way for instructors to gauge how much time the students are spending on an individual class. Students put in an estimate of how much time they spent outside of class preparing for class, working on homework, or studying for tests. The instructor then compares the time spent with the academic guidelines put out by the Dean to ensure that the workload does not exceed the expectations for the number of credit hours for the course. This metric also provides additional insight for instructors regarding performance with respect to effort put forth in the course. It is important to note that time survey data is input manually and anonymously at the beginning of every lesson. The value is input in units of minutes, and generally reflects the preparation time for the lesson that the student is about to participate in.

Instructors collected time survey feedback from four mechanical engineering courses that transitioned to the new 30 lesson format over the fall (two courses) and spring (two courses) semesters of the 2019 academic year. Because the spring semester is currently on-going, data presented from these courses only includes that pertaining to the first half, or 15 lessons. Similar time survey data for the previous ten years under the 40 lesson format was obtained. To maintain a fair comparison, only the data from the first half of the spring courses is included. In order to best compare time spent on the course, this data is presented as both the average amount of time a student spent per lesson in preparation (Figures 1 and 2), as well as the total amount of time spent throughout the semester (Figures 3 and 4).

Instructors hypothesized that there would be an increase in student time spent per lesson in order to compensate for less frequent contact in the classroom. Figure 1 presents time survey for all four classes from the 2009 academic year to the current year (2019). From this graph, it appears that a marginal increase in average time occurred across all four courses under the new 30 lesson structure. However, these increases are not outside of the standard deviation of the previous decade’s worth of data, and do not lead to any definitive conclusions. In an attempt to provide a more direct means of comparing the two different lesson formats, Figure 2 compares the current semester average preparation time with the average across the last ten years. Here the increase is more apparent. More data points under the 30 lesson format will be useful in determining if this uptick in average time is a result of the restructure or simply an outlier.

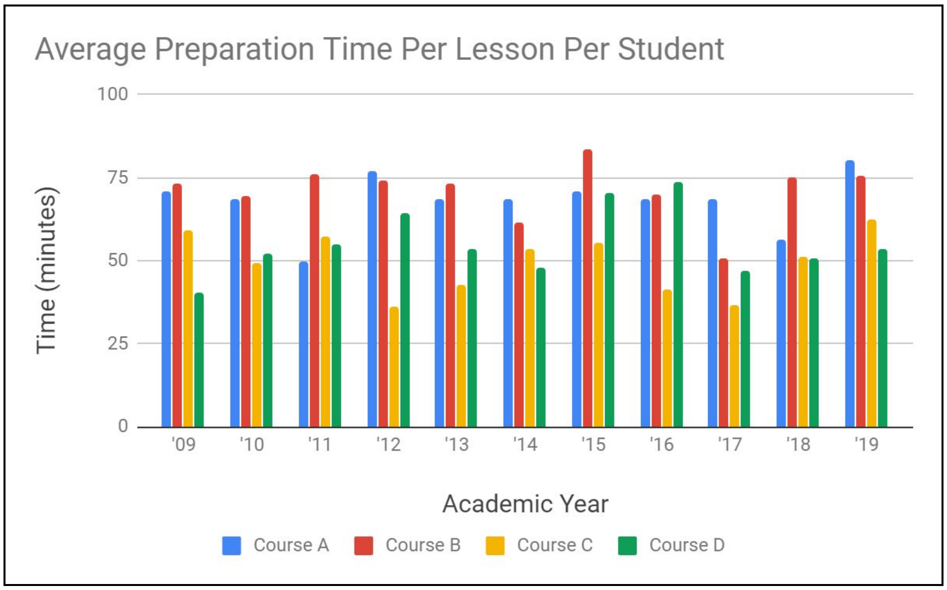

Figure 1. Average Class Preparation Time Across Four Courses

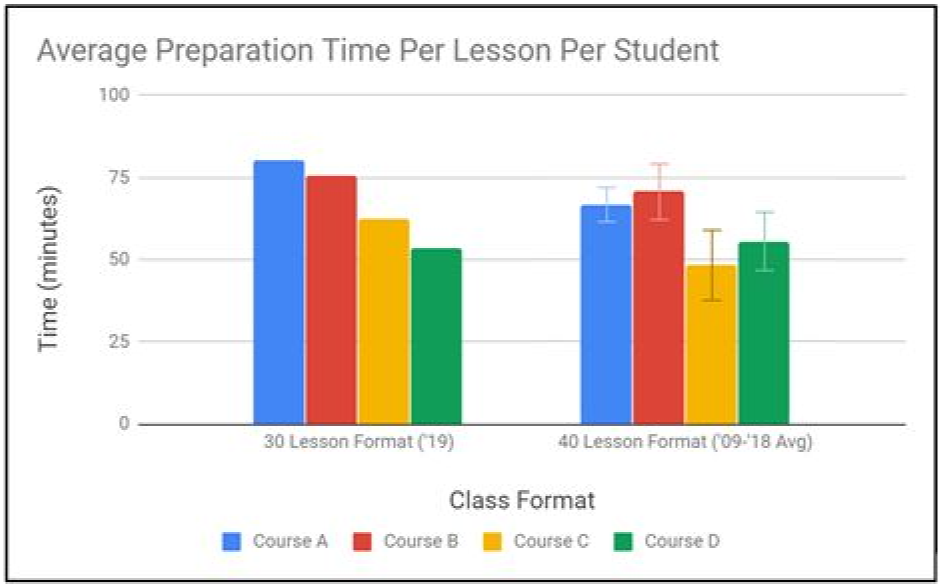

Figure 2. Average Class Preparation Lesson Format Comparison

Figures 3 and 4 present the total time spent by course in a similar fashion as the previous figures. Note that the smaller magnitude of courses "C" and "D" are due to including only the first half of the current semester. Contrasting with the increase in average time per lesson, these plots depicts a general decrease in overall time spent on course material outside of the classroom. Similar to the previous results, the shift in these courses tend to fall within the standard deviation of the previous decade's data, with the noteworthy exception of course "D," which experienced a statistically significant decrease. As previously mentioned, more years of gathering this type of data will allow for a more accurate comparison.

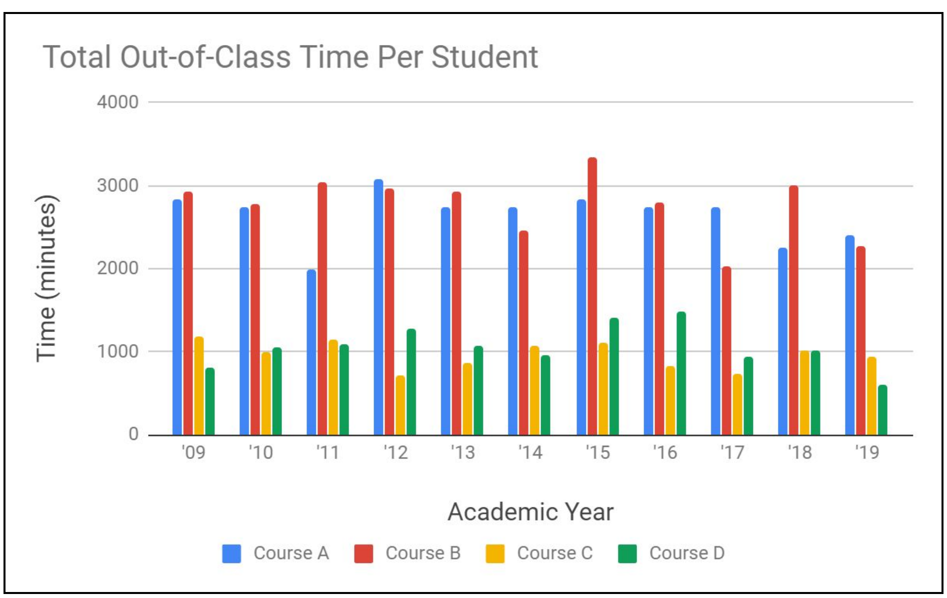

Figure 3. Total Class Preparation Time Across Four Courses

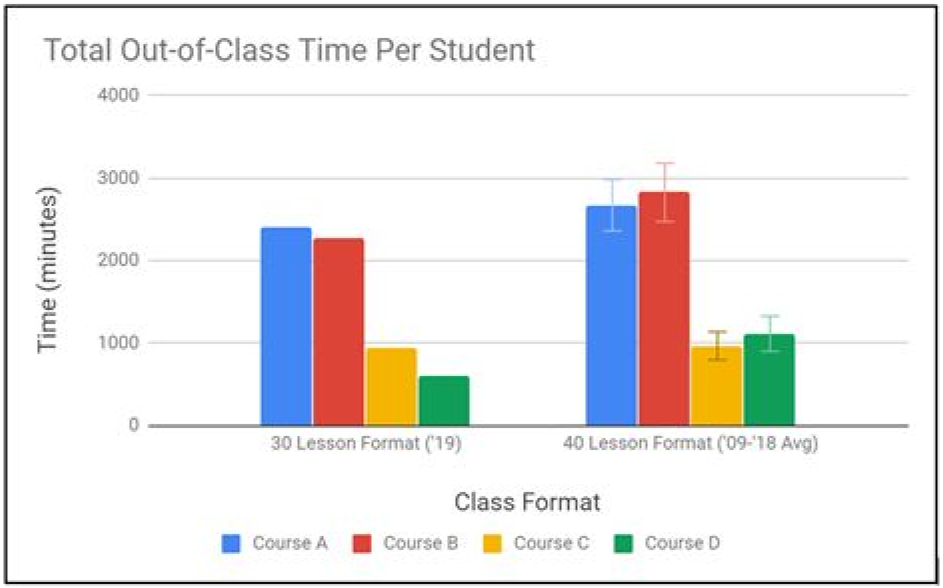

Figure 4. Total Class Preparation Lesson Format Comparison

From the preceding graphs, one can see that while there was an increase in the minutes spent per lesson in all four courses, the overall result was still a decrease in total time spent on the class. As such, there may be some marginal efficiency gained with respect to student time by switching to the 30 lesson format.

Assessment Data

The time survey data alone is not sufficient to evaluate student learning. If, as indicated, the total amount of time out of the classroom is reduced and students are able to maintain a similar level of performance, then it is possible that some efficiency is gained under the new format with respect to student time. However, this efficiency should only be considered if student learning is maintained or improved in the process. Currently, the best metric for communicating student learning is their performance on major individual assessments within the courses. At the engineering department under consideration, a standard set of course assessments consists of three tests and a final examination. While test content changes each semester and the grading varies based on course instructor, final examinations are closely guarded and held constant in order to obtain consistent data across academic years and observe trends.

Table 1 presents the assessment scores for students in the four courses considered in this paper. Courses “A” and “B” occurred during the fall semester of the 2019 academic year, while courses “C” and “D” occurred during the spring semester. Because the spring semester courses are on-going, only the first test results were available to consideration.

Table 1. Major Assessment Performance Under 40- and 30-Lesson Formats

		Test 1	**Test 2**	**Test 3**	**Final Exam**
Course A	40 Lesson Format (10-yr Average)	83.03	87.28	85.88	87.78
	40 Lesson Format Standard Deviation	3.14	3.43	3.82	4.52
	30 Lesson Format (2019)	84.30	82.90	86.80	90.20
Course B	40 Lesson Format (10-yr Average)	82.11	88.40	83.06	84.26
	40 Lesson Format Standard Deviation	4.75	1.70	3.29	2.59
	30 Lesson Format (2019)	81.80	86.20	77.00	85.35
Course C	40 Lesson Format (10-yr Average)	84.47			
	40 Lesson Format Standard Deviation	4.14			
	30 Lesson Format (2019)	81.25			
Course D	40 Lesson Format (10-yr Average)	84.00			
	40 Lesson Format Standard Deviation	2.82			
	30 Lesson Format (2019)	84.30			

The data shows no meaningful change in assessment performance from the current year (30 lesson) to the previous years' data (40 lesson). Additionally, any marginal change that may be observed falls within the previous decade's standard deviation. Coupled with the time survey data, this indicates that if a small time efficiency has resulted from the shift to the 30 lesson format, it could be considered worthwhile because student performance has not been compromised.

Student Feedback and Preference

While the increase in total contact time and reduction in number of meetings is attractive at first glance, the ability to effectively utilize the full 20 minute increase in an individual lesson can be problematic. Instructors observed that a substantial challenge to this was the student's ability to remain engaged during the longer sessions. Figure 5 depicts anonymous feedback from two of the mechanical engineering electives ("A" and "B"), where greater than 50% of the population perceived at least a moderate (scale of 3) impact of their ability to maintain focus.

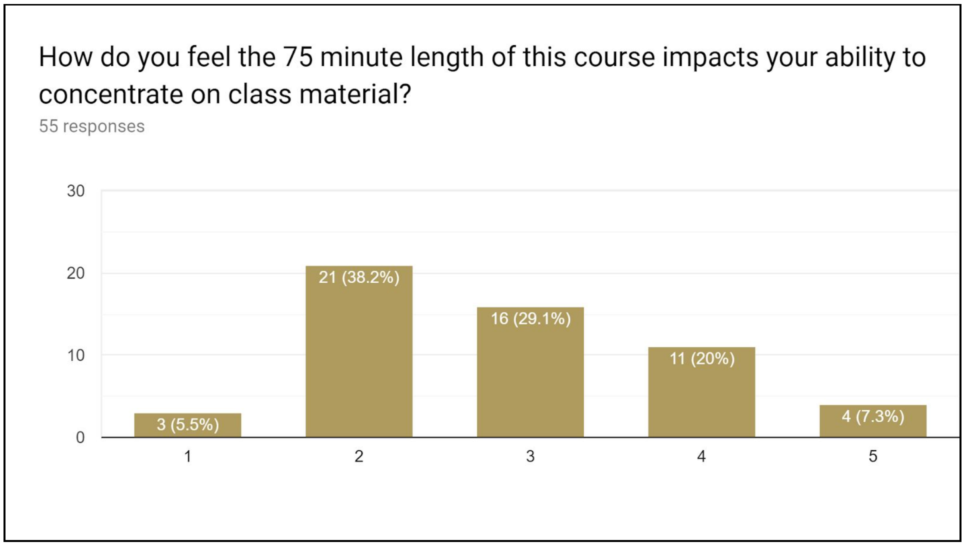

Figure 5. Self-perceived Ability to Concentrate in a 75 minute Class

This likely plays a large role in the generally negative outlook of engineering students on the conversion to the new 30 lesson format. The majority of students that responded to the survey felt that the extended meeting did not result in reaching a deeper understanding of the material (Figure 6), nor did they prefer the longer class structure (Figure 7). It should be noted that this population included third and fourth year students only, whom had, up until this semester, spent their undergraduate time conditioned according the 55 minute style. Similar survey data for subsequent year groups that spend their entire undergraduate time under this new structure would merit comparison to these results.

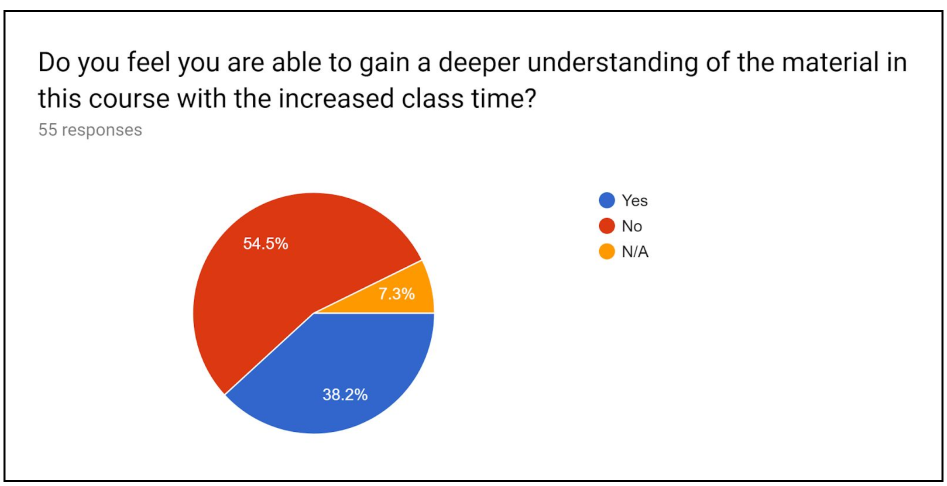

Figure 6. Self-perceived Ability to Gain Deeper Understanding in a 75 minute Class

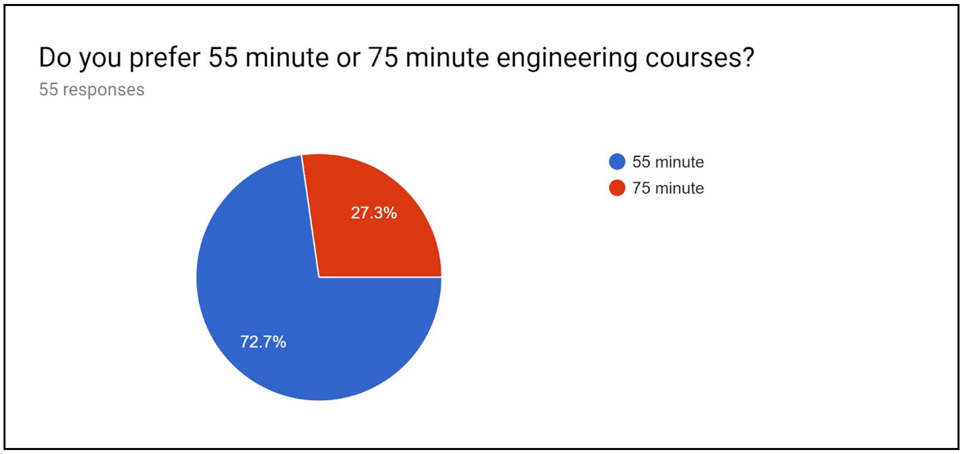

Figure 7. Student Class Structure Preference: 55 minute v. 75 minute

Conclusions

Several conclusions can be deduced from the above results. While students perceive increased difficulty in their ability to concentrate as lesson time grows, academic performance indicates that lesson objectives are still being met at the same relative performance. Additionally, time survey data indicates a potential uptick in average time spent preparing for class per lesson under the new model, but with less overall time required. As such, there is evidence of gained efficiencies in consolidating courses into fewer, longer lessons. The merits of increased class time are not at zero expense. Outside implications not covered in this paper, such as perceived issues related to the heightened consequences of missing classes, also merit closer attention.

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