Time Limited Exams: Student Perceptions and Comparison of Their Grades versus Time in Engineering Mechanics: Statics

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Abstract:
Little research has been performed as to whether timed exams serve any purpose beyond the limitation of the class time. The use of time limited exams is broad and includes college entrance exams, graduate school entrance exams, professional and licensing exams and typical coursework exams. Entrance and professional exams are achievement tests and also considered "power" tests. Should all tests assume this quality? In engineering fields where professional exams are frequently required post-graduation, time limited exams may be considered a stepping stone.

Previous research has mainly focused on students with disabilities. However, students without disabilities may also suffer from exam anxiety. Exam anxiety may be due to a variety of psychometric factors. In order to better understand factors associated with exams, students were given a survey to determine their perceptions. The survey included questions on perception of time and self-evaluation of emotion. The survey questions were correlated with exam grades and the amount of time the students spent on the exam.

Introduction:
Time-limited exams are a part of most classes, particularly due to time constraints of classroom scheduling. Fifty-minute classes have a maximum exam time of fifty minutes due to those limitations. Some research does not support additional exam time increasing student scores (Armitage 1999). Additionally, having an unlimited amount of time to complete an exam may reduce anxiety, but cause students to second guess themselves and change answers (Brye et al 2005). Anxiety has been shown to be a negative predictor of exam performance and likewise a motivation to learn is a positive predictor of exam performance.

For students in engineering programs, there are expectations of other time limited exams like the Fundamentals of Engineering exam (FE) and the Professional Engineering exam (PE). The FE is limited to 5 hours and 20 minutes (NCEES 2017a) while the PE is limited to 8 hours (NCEES 2017b). True achievement tests are noted as "power" tests, where time is not as important as determining complete student knowledge and skill. A speed test, however, is considered easy with a very compressed time limit. Completion rates are also important to a determination of time limited. If all examinees can attempt 75% of the problems, it is not considered a speed test (Parr et al 1996). Using this basic definition, the engineering exams reviewed herein and both the FE and PE would be considered power or achievement exams.

When considering an achievement test, the instructor ultimately seeks to determine if the student understands the material. For ABET accreditation, student learning outcomes document if a program meets educational objectives. The coursework and the exams will correspond to the student learning outcomes. In a statics course, the instructor seeks to determine if the student is

able to apply the fundamentals of engineering which will be applied in later courses and as a basis for engineering design coursework.

For large class sizes, there can be a tendency to move towards objective testing; e.g. multiple-choice exams, for ease of grading (Tobias and Raphael 1996). Although some research has been performed on timed tests and the effect on grades, the previous studies have focused on multiple-choice exams (Tam 2014). One researcher performed a mixed study of multiple-choice and general problem solving which included open book and open notes (Verleger 2016). However, open book, open note tests do not necessarily have the same level of anxiety as a closed book exam.

At Oklahoma State University, enrollment in statics reaches approximately 700 students per year. The course is offered in three formats: a traditional on-campus offering (70% of the students are enrolled in this portion of the course), an on-campus honors section (enrollment of approximately 15%), and an online offering (15% enrollment) that parallels the others.

For engineering problems, typical homework and exam problems are similar to real world problems and are multi-step solutions which are subjective and likewise more difficult to grade. For this statics course, the examinations have been normalized to extremely similar questions from year to year with only the graphic and numerical values changing. This consistency in problem type allows the instructor to create a rubric which is efficient for grading and limits the subjective nature of grading multi-step numerical solutions.

A question which has arisen is, do student grades represent the time to attempt the exam? During the fall 2017 semester, the exams from this statics course were examined to determine this correlation. The time remaining in the exam period was noted to determine the correlation between the exam score and the speed in which it was completed. Further, students in the statics course were surveyed to determine if they experienced test anxiety.

Three midterm exams, sixty minutes in length, were administered over the course of the semester, each consisting of four numerical problems. These exams were given outside of class, in the evening. There were no classes before or after to provide any additional stresses. The breakdown of time per problem is fifteen minutes. The final exam, one hour fifty minutes in length, contains two additional problems, resulting in an allotment of 18.3 minutes per problem. The exams are closed book with NCEES calculator policy enforced.

Part One: time remaining versus test score

The first segment of this study focused solely on the correlation between the exam time remaining when the exam was submitted and exam score. Exam scores were pulled for the two hundred and ninety-six students that remained in the class for the full semester, however, only those where the time remaining was documented are included in part one. The remaining exams were not taken in the three on-campus exam rooms and were administered at testing centers due to student disability accommodations or online course enrollment.

The results of the first exam are given in Table 1. This exam is considered to be the easiest of the three midterms due to the content being covered or highlighted in the prerequisite physics course and had an overall exam average of 83.8%. A handful of students (<4%) turned the exam in with 25 minutes or more remaining, approximately 9.5% submitted exams with 20-24 minutes remaining, and the majority, 554%, submitted with 5-19 minutes remaining in the exam. Approximately one-third of the students submitted exams with little time remaining, 14.3% submitting with 1-4 minutes remaining and 17.4% had zero time remaining. When compared to the corresponding exam scores, it is noted that the majority of students submitting the exam early received much higher grades as compared to little grade difference in those that submitted with 1-4 minutes remaining or no time remaining.

Time Remaining	Students (n)	Average	Standard Dev.
>30	2	93.50	9.19
25-29	8	82.88	16.30
20-24	28	85.32	13.40
15-19	55	85.78	11.82
10-14	54	84.46	13.75
5-9	54	83.81	14.63
1-4	42	83.10	12.82
0	51	80.04	14.09
	294	83.81	13.49

Table 1: Exam 1 score versus time remaining

The results of the second exam are given in Table 2. This exam covers topics that students find historically more challenging and time intensive problems. The overall exam average for the second exam was a 79.7%. A small percentage of students (<4%) turned the exam in with 20 minutes or more remaining and 4.1%, turned it in with 15-19 minutes remaining. The submissions increased over the next three increments of four minutes each, at 12.5%, 19%, and 22%. However, 40% of the class did not submit the exam early.

Time Remaining	Students (n)	Average	Standard Dev.
>30	0	N/A	N/A
25-29	1	93.00	N/A
20-24	8	83.50	21.05
15-19	12	80.25	19.29
10-14	37	80.05	18.38
5-9	56	80.32	14.04
1-4	65	77.29	14.00
0	116	80.51	15.01
	295	79.69	15.50

Table 2: Exam 2 score versus time remaining

The results of the third mid-term exam are given in Table 3. This exam had the lowest overall average of the three exams reported from the 296 students, 76.4%. Approximately 5.5% turned the exam in with 20 minutes or more remaining. The next two increments of four minutes each saw submittals of 10.9% and 11.6%, respectively. The remaining three increments saw more significant submittals of 18.8%, 26.3%, and 27.0%. When comparing the corresponding exam scores, the number of D's and F's rise over these increments as well.

Time Remaining	Students (n)	Average	Standard Dev.
>30	1	71.05	N/A
25-29	1	96.00	N/A
20-24	14	70.93	24.33
15-19	32	79.56	18.73
10-14	34	81.62	13.85
5-9	55	77.42	15.28
1-4	77	74.66	16.96
0	79	74.32	16.56
	293	76.36	16.94

Table 3: Exam 3 score versus time remaining

Although the student perception survey was administered before the final exam, the final exam results are included here to compare with the midterm exams where the average time per problem was less, 15 minutes per problem compared to 18.3 minutes during the final exam. Results of the final exam are given in Table 4. This exam had an overall average of 81.7%. The final exam data more closely resembles the data of the first exam (shown in Table 1). Nearly half of the students (47.9%) submitted their exams with more than 20 minutes remaining with only 12.5% using the full allotted time (zero time remaining).

Time Remaining	Students (n)	Average	Standard Dev.
>60	2	84.33	13.67
50-59	13	78.05	23.49
40-49	33	86.24	8.57
30-39	45	81.35	15.55
20-29	45	82.86	11.94
10-19	65	83.04	11.83
1-9	49	82.19	11.34
0	36	75.48	12.84
	288	81.70	13.13

Table 4: Final exam score versus time remaining

Part Two: student perceptions of timed exams

During the week following the third midterm, students were administered a 5-point Likert scale survey during their recitation to gage their perceptions on timed exams. The questions range from general statements to more pointed questions directed toward the three midterm exams in statics. The total respondents (250 students) are less than those considered previously (296 students) due to class attendance versus exam attendance. A Likert scale analysis is shown in Table 5 and reflects the responses to each of the eleven questions with 5=strongly agree, 4=agree, 3=neutral, 2=disagree, and 1=strongly disagree. Figures 1-11 chart the responses to the individual questions but show the relationships between exam average and average time remaining in the exam. These averages, exam and time, are of the three midterm exams.

Student Perceptions of Timed Exams	Total Responses	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)
Q1. Timed exams are difficult.	250	9%	41%	35%	13%	2%
Q2. Timed exams are more difficult than other types of exams.	250	17%	47%	17%	17%	2%
Q3. I feel anxiety or stress when I prepare for exams	250	22%	48%	13%	13%	4%
Q4. I feel anxiety or stress when I take exams	248	22%	51%	13%	12%	2%
Q5. I feel more anxiety or stress when an exam is timed	250	28%	43%	17%	9%	3%
Q6. I would feel less stress if an exam was not timed	248	30%	41%	16%	10%	3%
Based on the three hourly exams...						
Q7. I would be able to complete the exam in the time allotted if the number of problems were reduced	250	19%	38%	28%	12%	3%
Q8. I could have completed additional problems in the time that was allowed	249	6%	22%	18%	35%	18%
If these exams had unlimited time…						
Q9. it would reduce my stress	250	22%	46%	20%	9%	2%
Q10. I would have performed more work	250	29%	41%	20%	9%	2%
Q11. I would have performed better	250	26%	34%	28%	10%	2%

Table 5: Student perceptions of timed exams

Question 1 asks students if timed exams are difficult. Over 50% of those surveyed agree or strongly agree that timed exams in general are difficult. These students had the lowest exam averages and, unsurprisingly, submitted their exams with less time remaining on average than those that were neutral or disagreed. Figure 1 reflects the breakdown of question 1.

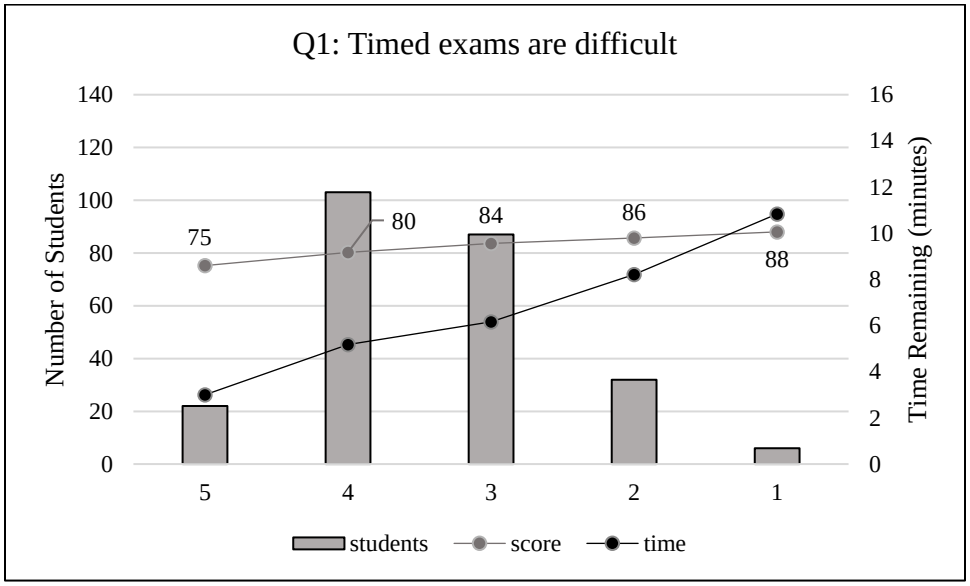

Figure 1

Question 2 asks students if timed exams are more difficult than other types of exams. Of those surveyed, 64% agree or strongly agree that timed exams are more difficult than other types of exams. Little change occurs between question 1 and question 2 in those that disagree and strongly disagree. However, students that were neutral in question 1 do agree or strongly agree that timed exams are more difficult than other types of exams even if they don't find them notably difficult. The students that agreed and strongly agreed to question 2 don't have a significantly lower exam average compared to the other students as the averages were fairly constant over the categories. However, the students did utilize more time during exams than the other groups. Figure 2 reflects the breakdown of question 2.

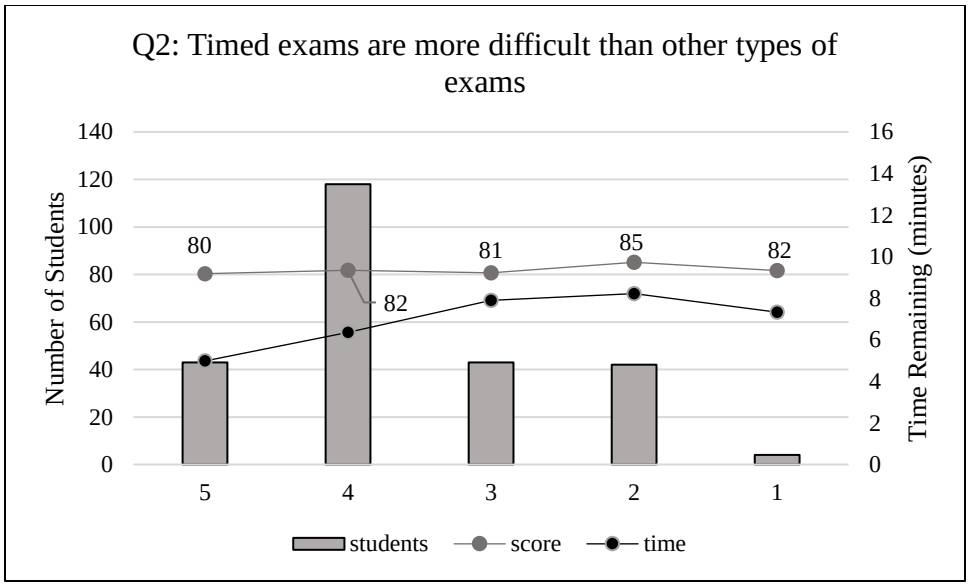

Figure 2

Question 3 focuses on exam preparation and if anxiety or stress is felt during that time. When responding to question 3, 70% of students agreed or strongly agreed to feeling anxious or stressed. Only 17% of students disagreed or strongly disagreed. When looking at the time utilized during exams, no clear correlation exists. However, the students who feel stress while preparing for exams have considerably lower exam averages, 77% and 82%, to those who do not feel stress, 87% and 86%. Figure 3 reflects the breakdown of question 3.

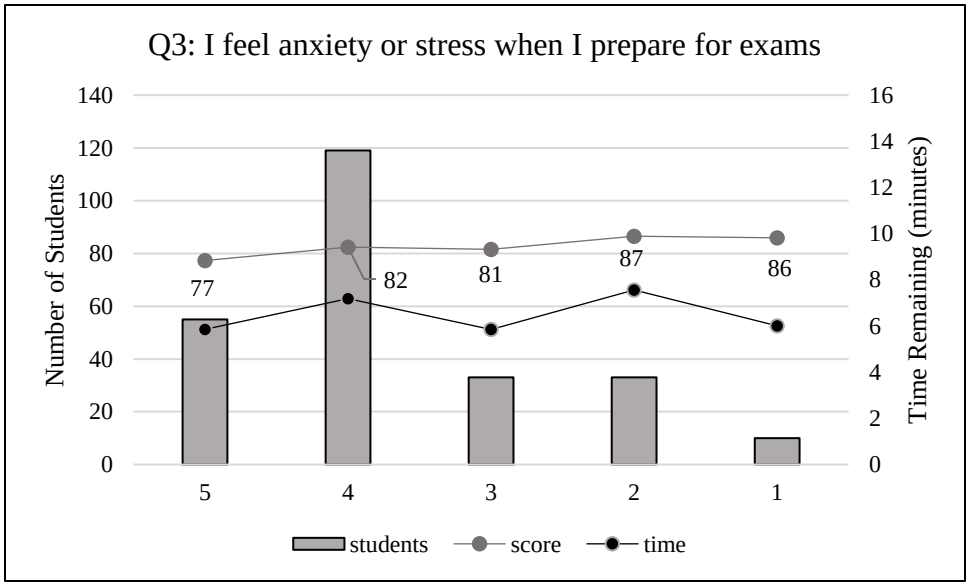

Figure 3

Question 4 is related to anxiety and stress and how these are tied to exam taking in general. A large percentage of students, 72%, either agreed or strongly agreed. These students also had the lowest exam averages at 76% and 83%, respectively. The exam averages continued to increase as students felt less anxiety and stress. The students that strongly agreed used more time to

complete the exam but the other categories varied. Figure 4 reflects the breakdown of question 4.

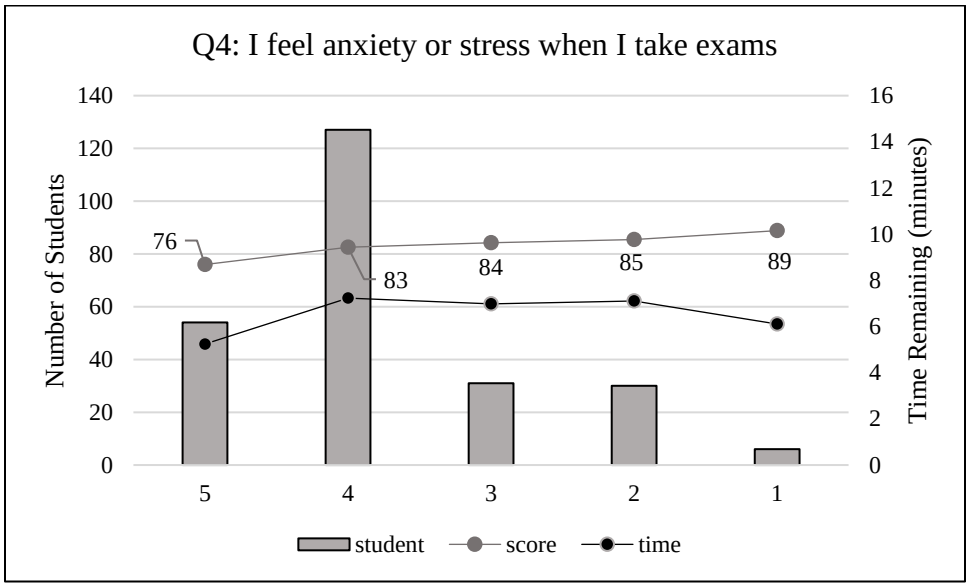

Figure 4

In question 4, students were asked about general exam anxiety and stress. Question 5 separates general exams from timed exams by asking if a student feels more anxiety and stress if an exam is timed over taking an exam in general. Although similar looking to question 4 when charted, fewer students agreed that they felt anxiety or stress when they take exams but that difference was split over strongly agreed and neutral. These responses indicate the link between stress and anxiety with exam taking but that they are not as strongly tied to timed exams specifically. The exam averages were lowest with those that strongly agreed and the students that strongly agreed and agreed had less time remaining when they submitted their exam than those that were neutral, disagreed or strongly disagreed. Figure 5 reflects the breakdown of question 5.

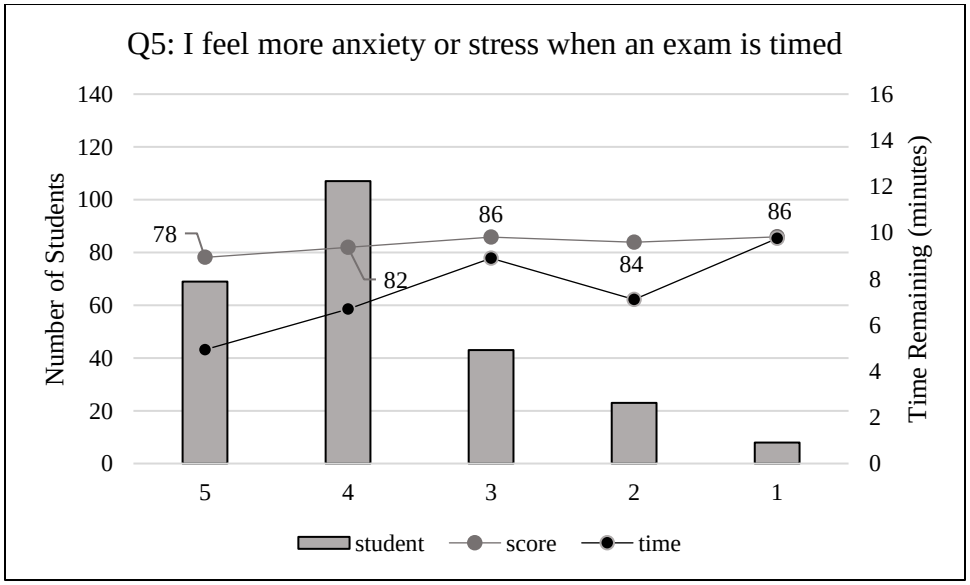

Figure 5

The last question pertaining to exams in general is question 6. This question parallels question 5 and thus yielded similar results. Students were asked if they would feel less stress if an exam was not timed and 71% agreed or strongly agreed. The time remaining during the exam also reflects that the students strongly agreeing or agreeing are using the most amount of time. These students are also linked to the lower exam averages. Figure 6 reflects the breakdown of question 6.

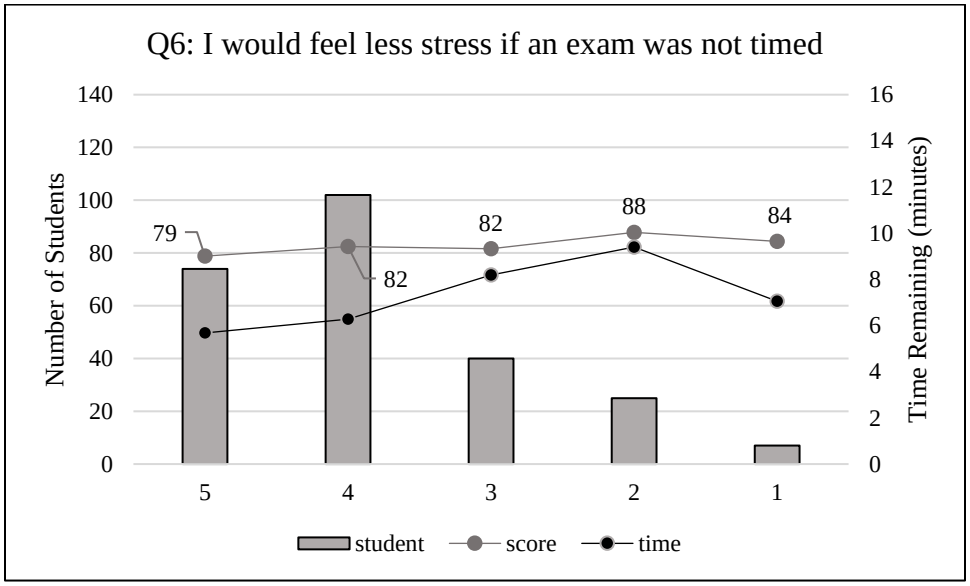

Figure 6

Questions 7 and 8 reference the three statics midterm exams specifically. Question 7 asks the students if they felt that they would be able to complete the exam if the number of problems was reduced. The students that agreed or strongly agreed were 57% of those surveyed. These students reflected little to no time remaining when submitting their exams. However, the 19% that strongly agreed did not reflect the lowest exam score but, in fact, had the highest percentage of all the categories. Figure 7 reflects the breakdown of question 7.

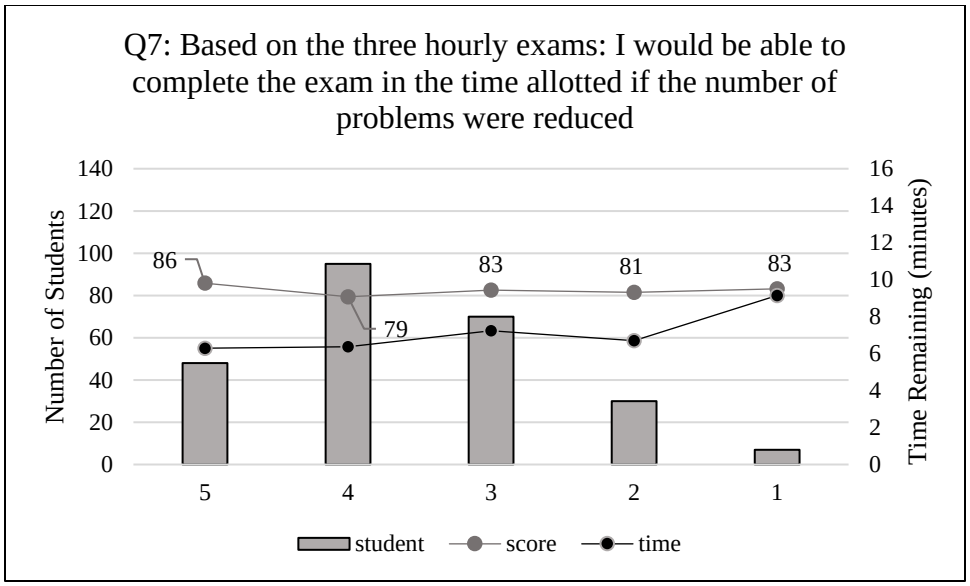

Figure 7

Question 8 reaches out to those students that would typically finish the exam early by asking if they felt that they could have completed more problems within the given exam timeframe. The responses from question 8 had showed many students agreeing or strongly agreeing that they could complete more problems in the time that was allowed. The students that agreed had the highest exam average and the most time remaining when they submitted their exams. But, not unexpectedly, the students that disagreed or strongly disagreed had the lowest average exam score and the least amount of time remaining. Figure 8 reflects the breakdown of question 8.

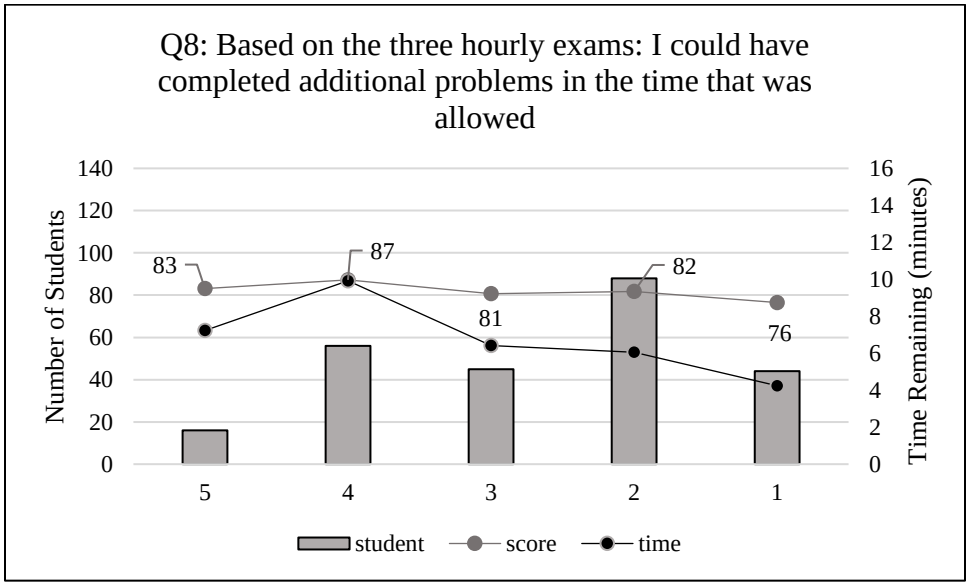

Figure 8

When asked in question 9 if stress would be reduced if the exams had unlimited time, 68% agreed or strongly agreed while only 11% disagreed or strongly disagreed. The trends for exam average and time utilized reflect this sentiment as shown in Figure 9.

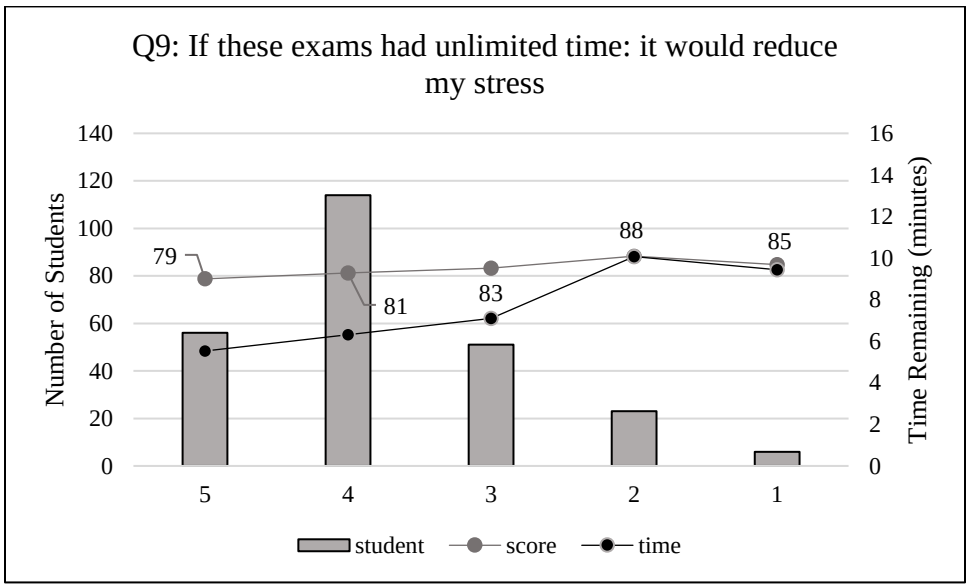

Figure 9

In question 10, students are asked if they would perform more work if unlimited time was provided. The responses yielded similar percentages to question 9's agree and strongly agree and identical percentages to disagree and strongly disagree. The time remaining and the exam averages match what would be expected – the more time remaining, the higher the exam averages. Figure 10 reflects the breakdown of question 10.

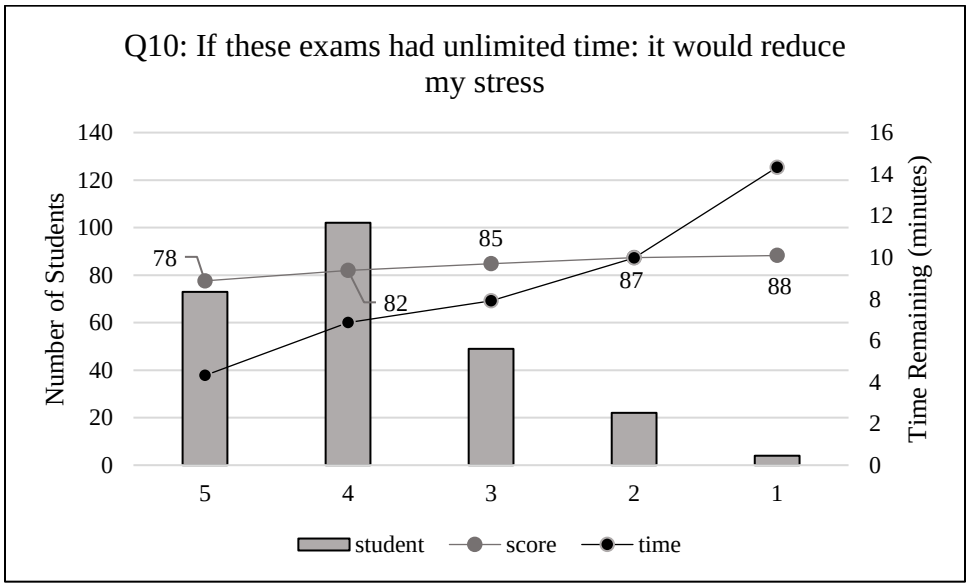

Figure 10

Lastly, question 11 asks the students that if they felt they would have performed better with unlimited time on the exam. Figure 11 reflects the breakdown of question 11. The majority of

students agree or strongly agree. This is also reflected in the amount of time remaining and also the trend in exam averages.

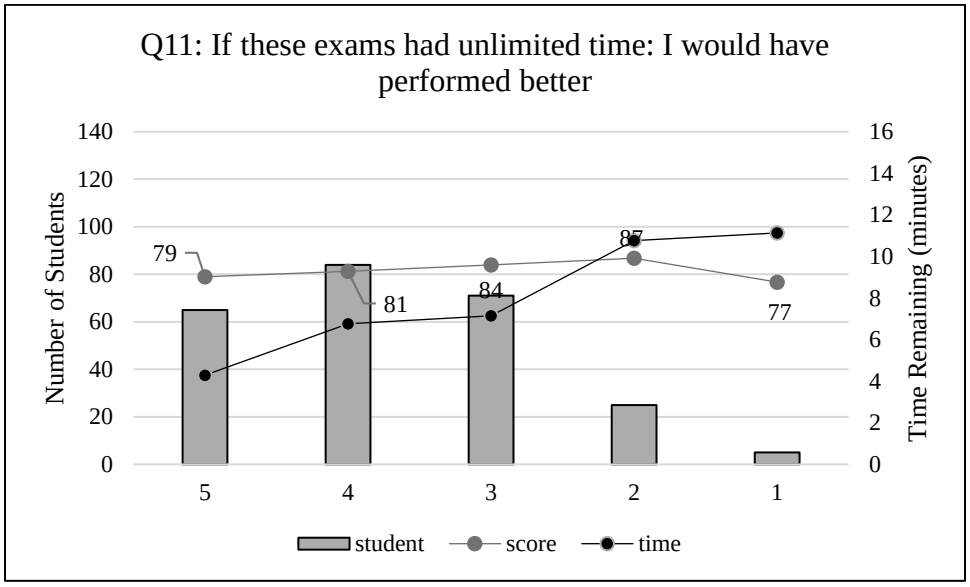

Figure 11

Conclusions:

In the fall 2017 semester, 296 statics students' exam habits were tracked in an attempt to relate exam performance to the utilization of available time. Three hourly midterm exams and one final exam were documented. When analyzing the results, the midterm exams became the main focus and were studied individually as well as averaged into a group. The higher grades varied by exam in terms of time utilization. However, the D & F category remained consistent with the majority of low grades belonging to students who did not submit their exam early.

A follow-up was conducted in the form of a student survey measuring perceptions with a 5 point Likert scale. These figures showed that not only is there a correlation between time and exam score but that student perceptions also align. Typically, students that felt stress and anxiety during timed exams performed worse than those that were unaffected by the fact that the exam was timed. Since the exams were of a very similar content and format to previous exams, the problem complexity and variation was not thought to be a factor. In addition, the students that utilize accommodations through the student disability office were not included in the time remaining calculations since those exams are administered through the university testing center. Although these students are not a large percentage of the class, the results might shift slightly if included.

Although a large class, this data is isolated to the behavior and perception to one semester's set of students. The current student population is statics is being tracked and will be surveyed at the end of the spring 2018 semester. In addition to the 11 questions administered, questions focusing on how timed exams affect motivation are being considered. Other items might include

how grading percentages affect the levels of stress and anxiety, i.e. homework versus exams, and if the amount of exam preparation affected these levels.

The data in this paper does not reflect gender or race. If a follow-on study is performed, race and gender could be considered to see if any particular group is affected at a higher rate.

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