The Positive Impact of Dropping the Lowest Test Score on Academic Performance and Stress Levels in MathBased Graduate Courses

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Abstract

There is no doubt that exam season in colleges and graduate schools can be a time of high stress. The average student has about three weeks to prepare for an exam, and the pressure can be intense. This can lead to lower grades on the final exams for some students, which can have a negative impact on their GPAs. Math classes at the college level tend to be characterized by a high level of anxiety among students. These pressures can cause some students to forgo studying entirely, which results in low scores on final exams. In addition to providing exam preparation tips, lecturers can relieve student stress by incorporating opportunities for formative assessment, exam reviews, and dropping the lowest test score into the exam schedule. In the current study, we tested the strategy of dropping the student's lowest test score and its benefits in math-based graduate courses at an engineering college. The study investigated whether this strategy could decrease the amount of stress experienced by students during exam periods and enhance overall academic performance. Overall, the study results suggest that the strategy of dropping the lowest test score does have a positive impact on both the academic performance of students and their stress levels during exam periods. These results can be used by instructors to design more effective strategies to improve academic outcomes among their students.

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Introduction

Suicide is one of the most common causes of death among students in colleges and universities in the US[1]. The American College Health Association's National College Health Assessment noted that 13.3% of college students seriously considered and 2% actually attempted to commit suicide [2]. Stress and anxiety have been shown to strongly correlate with suicide attempts [3]. The American College Health Association has also reported that more than 34% of students said the stress of exams have led to poor academic performance. Hence, creating lowanxiety classroom environment is axiomatic to their mental health and beneficial for better academic outcomes.

In math-heavy classes, anxiety tends to be high [4]. Both children and adults with math anxiety may have poor math skills, not necessarily the other way around [5][6]. That being the case, adults with math anxiety are less likely to choose careers related to science, technology, engineering, and mathematics. Sokolowski and Ansari studied when and how math anxiety first appears, what is happening in the brain when people are feeling anxious about math, and how to best help people with math anxiety [4].

In order to lower anxiety about exams, students recommend exam reviews. Mealy and Host[7] identified three types of students reporting high levels of anxiety during exams: those who lack adequate study skills, those who can study but are easily distracted during an exam, and students who mistakenly believe they know how to study but still do poorly on the exam and blame the instructor or "unfair" exam. Seventy-five percent of these students with high anxiety, from all three types, want instructors to conduct some kind of exam review before the test, e.g., a practice exam for them to understand what to expect. They report being less anxious after attending these review sessions.

When the final course grade is heavily weighted on the final grade, it creates enormous anxiety. Some students are more successful as writers and others perform better as test takers. Students consider it to be 'unfair' when their final grade of the semester depends on if they were lucky enough to have that final exam in the format that is their strong suit [8].

A second method is to provide formative exams. A review by Gavin et al. collected research studies from around the world that have deliberately focused on how students conceive of, experience, understand, and evaluate assessments [9]. Including more opportunities to progressively learn through formative assessment engages, motivates, and enables students to do better in their learning. Structuring the exam schedule to allow students to progressively learn from exams helps them succeed on the final exam.

A third method for lowering test anxiety is dropping the lowest test score. McDermott conducted a study with three sections in an intermediate macroeconomic theory course [10]. Three assessment policies in terms of their impact on the cumulative final exam score were compared as follows: (a) three in-class exams each worth 20% of the grade, was compared with (b) three in-class exams with the lowest exam score dropped and the other two exams each worth 30% of

the grade; and with (c) three in-class exams (each worth 20%), plus the option an endof-course exam whose score is permitted to replace the lowest score on the other three exams. The study too found that, allowing students to drop their lowest exam score actually led to better performance on the cumulative final exam. Aitken [8] found that dropping the lowest exam score makes it possible for students to do poorly on one assessment and still do well in the course; and provided procedures for successfully carrying out strategies for incorporating student voice in assessment and their implications, such as student-constructed tests, studentconstructed rubrics, peer and self-assessment. In preparation for this study, to follow Aitken's recommendations for incorporating student voices [8], we sought input from engineering students. Majority of them indicated a preference for two exams instead of one cumulative exam. Additionally, an overwhelming majority preferred to drop the lowest test score over averaging the scores on those two exams.

The current study aimed to explore which exam structure would result in the highest final test score outcome. We tested three hypotheses. First, we hypothesized that dropping lowest test scores would contribute to improved academic outcomes. We further hypothesized that dropping each student's lowest test score would make the first exam (s) more like a practice (formative) exam and as this policy might motivate students to study. Third, we hypothesized that exam reviews would foster better final exam outcomes.

Methods

The current quasi-experimental study took place at the New York Institute of Technology, College of Engineering and Computing Sciences in the fall semester of 2018, and spring and fall semesters of 2019, with 19, 25, and 24 graduate-level students enrolled in course Fluid Mechanics, respectively. All three sections were taught by the same instructor. For each course section, the content was delivered the same way, but the exam structures were designed differently. Both midterm and final exams were comprised of 10 open-response questions and were cumulative across the semester. The exam reviews were conducted in the following fashion:

In the first section, (further denoted as 1M1F), only one midterm and one final exam were given. There were no exam reviews. There were no exam scores dropped. In the second section, (2M1F), two midterms (with an exam review after the first midterm) with the lowest score dropped, one final exam, were provided. In the third section, (2M2F), two midterms (with an exam review after the first midterm), two final exams (with an exam review after the first final), and the lowest scores dropped in both midterm and final exams, were provided.

For all three sections, the solutions to the exam problems were provided after the exam. For sections two and three, during the next class session after each exam, we conducted exam reviews. In exams following exam reviews, different math problems were given but similar, in the level of difficulty. The three sections are summarized in Table 1. To avoid pure memorization of algorithms including the values used in the problems given [11], the problems in all exams were also different between all three sections.

Table 1. First, only one midterm and one final exams were given (1M1F). In second section, two midterm and one final exams were given (2M1F). In third section, two midterm and two final exams were given (2M2F). The solutions to the problems in the first exams were provided afterwards for a review session in the following class.

		Section:	**1M1F**	**2M1F**	**2M2F**
		Term:	**Fall 2018**	**Spring 2019**	**Fall 2019**
		# Students:	**19**	**25**	**24**
Midterm	Week 1	Class 1	Exam	Exam 1	Exam 1
		Class 2		Review	Review
	Week 2	Class 1		Exam 2	Exam 2
Final	Week 1	Class 1	Exam	Exam	Exam 1
		Class 2			Review
	Week 2	Class 1			Exam 2

Data analysis: The authors used SPSS to analyze the score distributions and converted the scores to normalized scores. We identified condition 1 (1M1F) as the baseline for comparison.

Results

Midterm exam results

Using the 1M1F section as a baseline, the average midterm exam scores were comparatively higher by 11% for Section 3 (2M2F) and 12% for the Section 2 (2M1F), (Table 2, Figure 1).

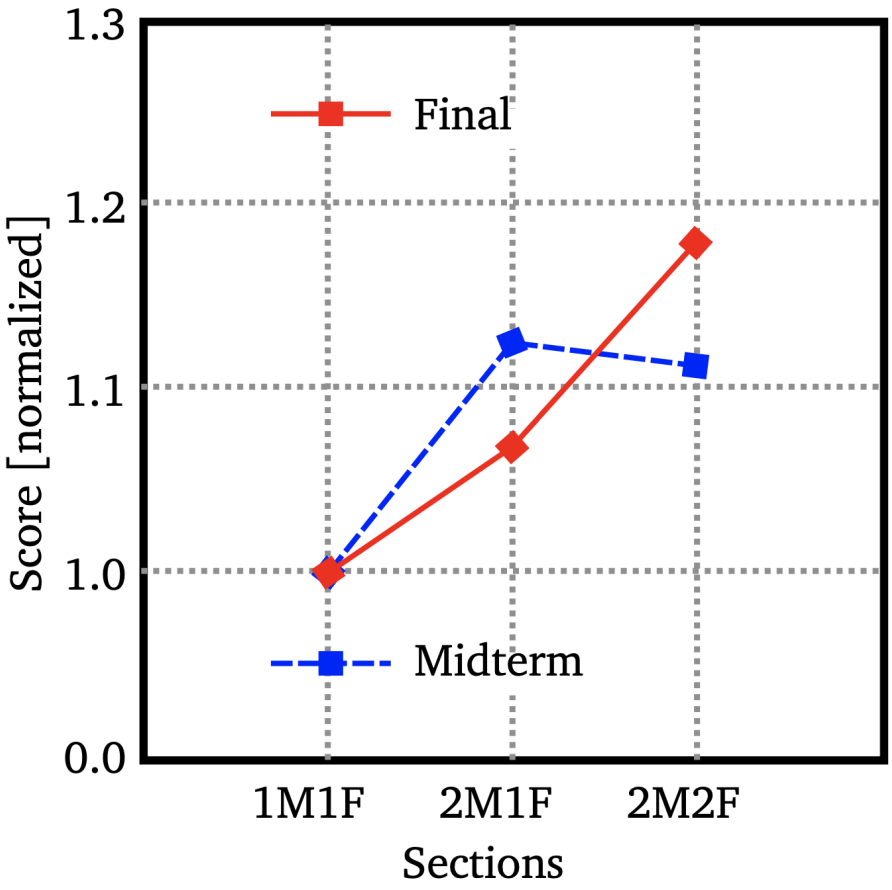

Figure1. The increase of grades in the 2M1F and 2M2F sections compared to the section where only of each exams were given, i.e., 1M1F.

Final exam results

Compared with section 1 (1MIF), final exam results were higher for Section 2 (2M1F) by 7% and Section 3 (18%).

Table 2. The increase in cumulative final grades in the 2M1F and 2M2F sections compared to the section where only of each exams were given, i.e., 1M1F.

	1M1F	2M1F	2M2F
Midterm exam	0%	12%	11%
Final exam	0%	7%	18%

In the current study, 50-60% students decided to take the second exams. Hence, since not all students decide to take the

second exams, the lecturer is not expected to double their work load.

Discussion

In this study, we explored three different test schedule exams for improving final exam scores in math classes. We found that the best exam structure for achieving the highest final exam score was section 3, with two midterms and two finals and two exam reviews. In the format where there are two midterms and one final, dropping each student lowest mid-term score assisted the section in achieving a higher average midterm exam score. However, in the format with two midterms and one final, students achieved also higher average final exam score compared to the section 1 with only one midterm and one final exam.

By structuring the exam schedule with two mid-terms and two finals, students who score poorly on one exam can still achieve a high score on the final exam. A student's entire semester grade should not depend so heavily on their performance on the final. Everybody has bad days, and they should not be punished if they happen to have an off day during high stakes final exams. Additionally, every student learns/tests differently. Some students get lots of information through reading, while others learn better by listening to lectures and doing practice problems. This is why it is important to offer multiple exams to ensure that everyone is able to reach their full potential and achieve their best possible grade. For example, one student might fail a test because they have misunderstood an important concept, while another student might fail a test because they simply didn't do enough practice problems or properly prepare for the test. An effort should be made to distinguish between the two types. These different types of students should not be penalized equally for failing the same test, as they both have different learning styles and should be evaluated based on their own individual performance. Having multiple exams is even more important for international students because many of them do not speak the local language fluently and are unfamiliar with the school system in their host country.

Many students get frustrated when they cannot understand the questions being asked on an exam or have trouble with the language barriers. Multiple exams help level the playing field for students who have limited language proficiency because they will be given more opportunities to demonstrate their mastery of the material by giving additional practice tests and review lectures before the exam. In order to make the overall grading system more fair for all students, it is also important to drop the lowest grade in a student's final exam in order to incentivize them to study harder. This will help prevent the failing students from receiving a lower overall grade than the student (s) who scored higher on the final exam even though all of the students passed the required exams that contributed to the overall score. Again, this is also especially important for international students because they may not fully understand how the grading system works and may end up with a lower overall grade than they intended simply because they failed the exam that was required to earn a higher score on their final course grade.

Over the past several decades, educational leaders have adopted and adapted a variety of learning technologies. With each passing year, those learning technologies expanded at an exponential rate and placed increasing demands on students, teachers, principals and school districts to maintain the innovations [12]. Embracing innovative learning

technologies in the classroom is not a new phenomenon as educational leaders have consistently strived to acquire or implement new tools to increase academic achievement [13]. However, many lecturers are still resistant to the push from their educational leaders to implement new innovative technologies. While, generally, it is accepted that teaching should be based on what we know about how the brain learns, until recently, however, we have had a few clues regarding how the brain retains information. Recently, education research is more focused on our understanding of the learning process, and we have a much more solid foundation on which to base educational decisions [14].

Conclusions

Our results are corroborated by MacDermott, who conducted a similar study with three sections of intermediate macroeconomic theory [10]. Allowing students to drop their lowest exam score led to better performance on the final exam. Others report significant costs that might offset the benefits of a grade-dropping policy [15]. For example, lecturers might object that their time in class is limited and they cannot cover the required material if they dedicate some of it to additional exams. Though, the students who are satisfied with the outcome from their first exam taken, logically, do not need to attend the second one [16]. Moreover, some lecturers could be discouraged from letting their students improve their score, as a common perception is that better average class grade, even if resulting from implementation of innovative teaching techniques, might indicate grade inflation, i.e., grading leniency [17].

Author contributions

Conceptualization (M.T., L.M., T.P.), Data Curation (M.T., L.M., T.P.), Formal Analysis (M.T., L.M., T.P.), Investigation (M.T., L.M., T.P.), Methodology (M.T., L.M., T.P.), Project Administration (M.T.), Resources (M.T., L.M., T.P.), Software (M.T., L.M., T.P.), Supervision (M.T., L.M., T.P.), Validation (M.T., L.M., T.P.), Visualization (M.T., L.M., T.P.), Writing – Original Draft Preparation (M.T., L.M., T.P.), Writing – Review & Editing (M.T., L.M., T.P.).

Competing interests

The authors confirm that there are no known conflicts of interest associated with this publication and there has been no financial support for this work that could have influenced its outcome.

Ethical approval statement

The study did not include human or animal subjects. Ethics approval was not required for this study.

Consent

No consent was required. Before the data was analyzed, all personally identifiable information was removed, which resulted in anonymized data that cannot be associated with any one individual. Additionally, the anonymization has not distorted scientific meaning of the study.

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