AC 2012-3264: OPTIONAL FINAL EXAMS AS AN ASSESSMENT TOOL IN ENGINEERING CURRICULA

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Optional Final Exams as an Assessment Tool in Engineering Curricula

Abstract – The idea of a heavily weighted, comprehensive final examination is entrenched in the assessment process of many courses. In this paper, we offer arguments in favor of a policy of making comprehensive final exams optional to students and examine the effects on the assessment process. We do so by implementing an optional final exam policy in the assessment systems of two different engineering courses over the span of several semesters. We analyze the prior performance levels of students who choose to take optional exams and examine the impact that varying incentives have on exam participation rates. We also compare the performance of students who chose to take an optional exam to their performance on mandatory mid-semester exams and evaluate the impact that optional exams had on overall grades in our assessment schemes. Surveys of our participants show that over 80% of students viewed the optional exam policy as a positive change to the assessment scheme and only 3% viewed it negatively.

I. Background and Motivation

Researchers in Science, Technology, Engineering, and Math (STEM) education have been expressing concern over graduation and retention rates for decades. Recently, the issue has found its way into the highest levels of economic and educational policy discussion, as U.S. employers in high tech industries struggle to find qualified employees amidst a shortage of STEM degrees in the workforce. In August of 2011, President Obama’s Jobs and Competitiveness Council called for an additional 10,000 engineering graduates each year to meet these shortages\(^1\). If these goals are to be met, educators in engineering disciplines must strive to improve their graduation rates, as only 40% of students that begin their education in STEM fields go on to complete their degree in that field\(^2\). Such low graduation rates may be discouraging, but for educational researchers they highlight the opportunity for significant gains to be made. However, realizing these gains may require a systematic reevaluation of all parts of the educational process, including methods of classroom assessment.

In their seminal book on the reasons students give for leaving STEM fields, Seymour and Hewitt found that engineering students cited a ‘curriculum overload’ and ‘overwhelming pace’ in courses as being key factors in the decision to switch majors for 45% of students surveyed\(^3\). Workload-related complaints were the second most common reason for engineering students to leave their field and ranked significantly higher for engineers than for science and math majors who cited it only 25% of the time.

In engineering courses, the period of greatest overload often comes in the final weeks of the semester, when students must wrestle with homework assignments, semester-long projects and research papers, and end-of-semester exams all coming due within a short timeframe. It can prove to be a challenge simply for a single class, but for students feeling the cumulative effect of
multiple engineering classes, it can be overwhelming. Students’ less-than-sanguine feelings about this time are readily apparent in colorful nicknames like “Dead Week” and “Hell Week” in common use at many universities. Health researchers have even linked this period to increases in stress and measurable deterioration in health among students [4].

If we are to address students’ feelings of being overwhelmed, it seems clear that some of the first strategies educators should explore are methods of reducing end-of-semester workloads. From our experience as both students and instructors, we believe that design projects and research papers are essential components of the educational process in engineering courses, as they most directly reflect the demands of engineering fields. As such, we wished to look outside of cuts to design and research projects to reduce workloads. Therefore, we chose to question the role of the final exam and investigate its necessity in the assessment process.

The remainder of this paper is organized as follows: In Section II, we lay out some of the common arguments in favor of the necessity of mandatory comprehensive final exams and present our counterarguments. In Section III, we discuss the possible benefits of making these exams optional. In Section IV, we describe a set of pilot studies we carried out to assess the impact that optional final exams would have on assessment schemes in real courses. In Section V, we present and analyze the data from these studies. In Section VI, we discuss the ramifications of our results on our final exam policy. In Section VII, we describe potential future work. Finally, in Section VIII, we present our conclusions on the use of optional comprehensive exams.

II. Are Comprehensive Final Exams Necessary?

In this paper we focus on an exam system widely used in engineering classes: one or more exams are given during the semester with each mid-semester exam focusing on a subsection of the course curriculum. This is followed by a comprehensive final exam at the end of the semester that covers all of the material from the course. Although such systems are by no means universal, they are common enough that many universities have academic schedules and policies built around the idea of large final exams at the end of each semester.

To be clear, when we discuss ‘comprehensive’ final exams, we are specifically talking about an exam that exclusively covers topics that students have already been tested on previously through mid-semester exams or other forms of assessment. If an exam contains a significant amount of material that students have never been tested on, we would not classify it as a purely comprehensive exam and would not suggest that it be made entirely optional. Instead we would suggest that the material that has been tested before be made optional and that the untested material be put on separate mandatory exam that can be made both much shorter and lower-stakes than a comprehensive final would be. Alternatively, this new material might be tested through other non-exam assessment instruments such as homework assignments.

On its face, a comprehensive final exam may serve a few purposes.
1. It gives instructors the chance to measure a student’s current mastery of a topic; a more up-to-date measurement than what they got from a mid-semester exam or other earlier assessment.

2. Making multiple measurements of the same construct allows us to improve the reliability of our test results.

3. Increasing the number of questions you ask students on a given construct should increase the reliability of the assessment.

4. The final exam may give the instructor a chance to ask questions on topics not covered in the mid-semester exams due to exam length constraints.

5. As a comprehensive exam, the instructor may ask students to synthesize material from many different sections in a single test item.

We argue that these points are either flawed in concept or can be achieved without using a final exam.

*More Recent Results Are Not Necessarily More Useful*

Is a measurement of a student’s mastery of a certain topic taken at the time of a final exam a more valid measurement than one taken on an earlier mid-semester exam? To answer this question, we need to think about a student’s knowledge as a temporal function and think of an exam score as a sampling of this function at a given time. Sayre & Heckler propose a “Simple Model” for this cognitive function for students learning about electromagnetism\(^5\). An example plot of their Simple Model is shown in Figure 1. This model represents the acquisition and decay of knowledge between initial instruction and the first assessment.

![Figure 1: The Simple Model of student learning for a course module\(^5\).](image)
In Figure 2, we modify the Simple Model to include the effects of relearning, to reflect the assumption that students will need to review and relearn material they have forgotten between a mid-semester exam and a final exam. We model the 2nd period of learning with a steeper slope as the process of relearning of previously mastered material has been shown to be faster for both memory-recall knowledge \(^6\) and hands-on skills \(^7\). The relative height of the 2nd peak will depend on how much time the student invests in relearning the material. Students who devote a large amount of time to studying for the final exam or who performed poorly on the initial exam will likely exhibit a higher 2nd peak. Students who do not devote much time to studying for the final may exhibit a lower 2nd peak. However, we argue that given adequate time and resources, it is fair to expect that most students could relearn material to at least a similar level as their original mastery.

If we are using well-designed testing instruments in our classroom assessment, we expect that the scores we measure on tests will track with student mastery. Looking at the mastery curve in Figure 2 from the perspective of a classroom educator, it provokes the obvious question: **What point on the curve should we try to sample when determining a student’s grade in the class?**

Our position is that the score we care about is not the most current one (if the student was tested today), but rather their peak score. The important point to grasp in this argument is that the grades we assign in our classes should be meaningful to the people who will attempt to use them in their decision-making. For engineering education, this will primarily be two groups: (1) Companies trying to determine if the student has requisite job skills and (2) others in the educational system determining whether the student should be allowed to continue to more advanced classes. For both of these common-use cases, the most up-to-date measurement we can
take – the final exam – will be outdated by at least several months by the time that student needs to apply the skills from our course at their job or in their next course. As educators, we already expect that students will have forgotten some things they learned in prerequisite classes. What we care about – and what employers care about – is that the student will be able to rapidly and successfully reacquire the skills as they are needed. As we have argued, we can use previous mastery peaks to predict a minimum level of success for relearning.

How does this apply to the idea of optional final exams? A student who demonstrates a satisfactory level of mastery on an early exam – getting a B grade on the Fourier series section of a Linear Systems exam for example – should not need to be retested on that material if the student is satisfied with that grade. We will assume that the student would be capable of getting back to at least B-level performance on the final exam if given enough time to prepare. Therefore, it is a waste of that student’s resources to force them to take the exam. If, however, the student is not satisfied with the original grade, we should provide the final exam as an opportunity for the student to demonstrate improvement. These arguments are consistent with many of the ideas present in mastery-based assessment \[8\], indeed, some mastery-based assessment systems do not have comprehensive exams. However, we wish to examine modification systems we can make to the use of final exams in more traditional assessment schemes, in ways that do not require instructors to make wide-reaching and time-consuming changes to their existing methods.

**Final Exams Are Not an Easy Fix for Poor-Quality Tests**

While it is true that administering multiple tests on the same material can be used to gauge test reliability via classical testing theory, final exams are not a means to improving test reliability. Using multiple forms to evaluate reliability is only valid when the test population is unchanged between each exam, i.e. parallel form testing \[9\]. According to our model demonstrated in Figure 1 and Figure 2, this is not the case when comparing a test result from earlier in the semester with one taken produced later in the semester. Moreover, using two tests with poor validity or reliability is no more likely to produce valid and reliable results than using one test.

In privately discussing this issue with colleagues, the most persuasive argument we have heard in favor of final exams for the sake of improving reliability and validity is that because final exams are often not returned to students, they can be re-used and iteratively improved over many years, whereas new mid-semester exams must be generated for each class. Although this may be true in some circumstances, we must wonder whether instructors who have so little faith in their ability to create valid and reliable mid-semester exams should be using such exams at all. In our view, a more ideal solution would be to improve the quality of exams through the application of formal techniques for the design of problems \[10\].
Final Exams are Not the Only Way to Evaluate a Body of Knowledge

Perhaps the best argument in favor of the necessity of comprehensive final exams is that they provide instructors a chance to ask questions that could not be asked on previous exams, such as those that require synthesis of knowledge across many different topic areas covered in the course. This is a valid concern, as real engineering projects rarely require neatly compartmentalized knowledge. We would argue, however, that there are other opportunities for an instructor to assess a student’s ability to synthesize knowledge. Such questions could be asked on homework assignments prior to the end of the semester or be included as part of a course project or paper. This type of assessment might also better reflect real-world scenarios than answering questions on an exam and allow for more open-ended prompts.

### III. Why Students and Instructors May Benefit from Optional Final Exams

Thus far, we have gone to some lengths to argue there are no significant and unavoidable negative repercussions on the assessment process caused by allowing students to opt out of a comprehensive final exam. There are also several beneficial facets to the optional exam.

#### Student Health and Satisfaction

As we touched on earlier, the crunch time at the end of a semester is a time of great stress for students. Students self-report significant occurrence of nervousness, stress, headaches, eyestrain, lack of sleep, and disruptions to nutrition during the “cramming” period of final exam week. The severe changes in the immune system brought on by final exam stress have been well-documented in medical literature.

In Section V, we will show that the vast majority of students in our pilot studies reported positive feelings toward our optional final exam policy.

#### Student Academic Performance

Forcing students to take several comprehensive exams in different subjects during the same week is a recipe for obtaining test scores below the students’ potential. Aside from the negative impacts caused by insufficient prep time and decreases in test reliability induced by fatigue and stress, it can hurt students in their other classes. In addition to the obvious reduction in potential study time, research suggests that the process of retrieval-induced forgetting may cause people who are required to memorize large bodies of information to temporarily lose the ability to recall other pieces of information. Essentially, studying for your exam, may suppress a student’s ability to remember information from one of their other classes.

#### Benefits for Instructors

If increased student satisfaction and academic performance are not edifying enough for instructors in and of themselves, academic performance has been shown to be a reliable predictor
of the ratings instructors receive from their students, and general satisfaction tends to improve ratings in many categories via the halo effect\textsuperscript{[14]}.

Making final exams optional may also provide a reduction in workload when it comes to grading. As we will show later in our results, our optional exam policy reduced the number of final exams that we needed to grade by an average of 82%. As instructors are, themselves, often caught up in an assessment crunch at the end of the semester, this reduction in grading load may be quite welcome.

**IV. Description of Studies**

Having made our argument for why comprehensive final exams should be made optional in classes that use them, there are still many questions about how optional exams should be deployed in classes and what impacts they have on the students. To evaluate the dynamics of optional final exams, we deployed optional final exams in two different Electrical & Computer Engineering courses at the University of Wisconsin – Madison over a total of four course offerings.

*Course I: ECE551 – Digital System Design and Synthesis*

This course teaches students to use hardware description languages and instructs them in the principles of designing digital logic. The course is primarily taken by juniors, seniors, and first-year graduate students in computer engineering. Assessment typically includes a mixture of questions testing understanding, application, evaluation, and synthesis in short answer and constructed response formats.

*Course II: ECE252 – Introduction to Computer Engineering*

This course teaches students foundational concepts in computer engineering and computer science, such as transistors, logic gates, and memories. The course is primarily taken by freshmen from a variety of different engineering majors.

We experimentally deployed optional final exams in these courses with the goal of addressing the following questions:

- What fraction of students will choose to take an optional final?
- What is the pre-exam grade distribution of students who choose to take an optional final?
- How will the score distributions from an optional final exam compare to mandatory exams?
- How much impact will the optional final exam have on overall student grade outcomes in the courses we deploy the exam in?
- How will students feel about being given the choice of whether to take the exam?
We chose to deploy these exams in both a course targeted at senior students and a course targeted at freshmen so we could evaluate how students’ experience level and confidence impacted each of the questions listed above.

**Study I**

Study I was our pilot deployment of optional exams in ECE551, our senior-level course. In this course, students took two exams during the course of the semester, each covering approximately half of the course material. An optional comprehensive final exam was given during finals week. If students opted to take the final, it would be given equal weight to the two exams taken during the semester, or in other words, it was given a 33% fraction of the overall exam contribution to student grades. The course instructor did not give students individual advice on whether or not to take the optional final. Students were explained the weighting of the final in their overall grade. They were told that the exam’s difficulty and length would be similar to the exams they took during the semester. Students were required to commit to taking the exam no later than 72 hours prior to the exam period.

Both the mid-semester and final exams consisted of a mixture of short answer and constructed response questions. Question content was based on a set of desired learning outcomes for the course; this document was made available to students at the beginning of the semester. Exams were held in a proctored room with a 120 minute duration for the final exam and 90 minute duration for each of the mid-semester exams. Exams were graded by the instructor and TA using a predefined scoring rubric. Partial credit was given for constructed response questions and detailed in the rubric.

One week after the end of the final exam period all students, including those who opted not to take the final, were given a survey that asked them whether their opinion of including an optional comprehensive exam in the course was positive, negative, or neutral.

**Study II**

Study II occurred in ECE551 in the semester following Study I. Approximately 80% of the content on the final exam in Study II was identical to the content of Study I. As in all of our studies, copies of the final exam were not released to students to prevent potential communication of exam contents between students in different semesters. Copies of mid-semester exams were distributed to students; therefore material was not shared between the mid-semester exams of different studies. However, all exams were generated using the same set of desired learning outcomes as the blueprint.

In this study we modified the parameters of Study I to allow students limited control in the weighting of their final exam score. Students were allowed to decide whether they wanted to give the final a weighting equal to ‘0’ (ungraded), ‘1’ (weighted equal to one of the mid-semester exams, as in Studies I and III), or ‘2’ (weighted equal to both of the mid-semester exams, i.e.
50% of their overall exam grade). Students were allowed to decide this weighting at any time prior to turning in the exam and were informed of this option prior to deciding whether to take the final.

**Study III**

Study III occurred in ECE252 in the semester following Study II. Unlike Studies I & II, this study used a course that has a population composed primarily of freshmen. In this course, four midterm exams are given over the course of the semester, each covering about a quarter of the material. The optional final was given during finals week and was weighted to have double the impact of a mid-semester exam (33% of overall exam contribution to student grades, equivalent to that in Study I). No individual advice was given to students, but they were told the exam weighting. Students were not required to inform the instructor that they would take the exam in advance.

Unlike the format of the midterm examinations, which were similar to those in ECE551, consisting of short answer and constructed response questions, this final exam consisted entirely of multiple choice questions. Midterm exams were given during 50-minute lecture periods, whereas the final was given a 2-hour period. The midterms were graded by the TAs with each TA responsible for grading one or two questions for all students to ensure consistency. The final, on the other hand, was graded electronically based on the multiple choice answer key.

**V. Results and Analysis**

**Who Takes Optional Finals?**

The first issue we wished to examine was related to the number and type of students who would take the optional final exam, since the decision to take the exam was left entirely to the students. As instructors, we sought three properties from this self-selection process:

1. That we would see a significant fraction of the class on both sides of the choice of whether to take the optional final. If nearly all students took the exam, then we would not have achieved the goal of reducing the final exam workload for many students. On the other hand, if none (or very few) of the students took the final exam, some instructors might view the work of administering an additional exam to be too high.
2. That all students with borderline non-passing grades would take the final.
3. That all students who had already earned the highest grade would not take the final.

Table I shows the percent of students opting to take the final exam for each of our three studies, as well as the aggregate of all the studies, broken down by their course averages prior to choosing whether or not to take the optional final.

Our initial concern in comparing these numbers was that one of the prime influences on a student’s decision of whether to take the final would be his or her performance on the exams
throughout the semester. We posited that low exam averages would increase student incentive to take the final and that large standard deviations in scores would identify cases where there are a large number of failing students in a class. As shown in Table II, bulk statistics for mid-semester exam scores were very similar between Studies I-III.

### Table I: Fraction of Students Choosing to Take the Optional Exam

<table>
<thead>
<tr>
<th>Pre-Final Exam Course Average</th>
<th>Study I (n = 44)</th>
<th>Study II (n = 39)</th>
<th>Study III (n = 151)</th>
<th>Aggregate (n = 234)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Students</td>
<td>18%</td>
<td>54%</td>
<td>10%</td>
<td>18%</td>
</tr>
<tr>
<td>&lt; 70%</td>
<td>75%</td>
<td>50%</td>
<td>53%</td>
<td>57%</td>
</tr>
<tr>
<td>70-75%</td>
<td>50%</td>
<td>100%</td>
<td>16%</td>
<td>56%</td>
</tr>
<tr>
<td>75-80%</td>
<td>25%</td>
<td>80%</td>
<td>10%</td>
<td>23%</td>
</tr>
<tr>
<td>80-85%</td>
<td>14%</td>
<td>66%</td>
<td>4%</td>
<td>9%</td>
</tr>
<tr>
<td>85-90%</td>
<td>0%</td>
<td>66%</td>
<td>0%</td>
<td>14%</td>
</tr>
<tr>
<td>&gt; 90%</td>
<td>10%</td>
<td>9%</td>
<td>0%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Comparing the studies, we expected to see a sharp increase in the number of students who chose to take the optional exam in between Study I and II. As shown in Table I, about three times as many students in Study II chose to take the exam compared to Study I. We believe that this is because students in those studies were told that they could sit for the exam and decide whether or not it would be counted before handing it in. This provision exposed the exam-takers to less risk (provided they could successfully predict their performance once seeing the exam) and allowed students to sit for the exam without feeling as much pressure to study heavily. Additionally, students in Study II could increase the weighting of the final exam to 50% of their overall exam score, or double the weighting of the optional exam in the other three studies. This suggests – perhaps not surprisingly – that increasing the impact of the exam is an effective way of controlling how many students take it. However, it would be interesting to see whether the same trend existed if the students were not allowed to opt-out after previewing the exam.

### Table II: Student Exam Scores Prior to Choosing Whether to Take the Optional Exam

<table>
<thead>
<tr>
<th>Mid-Semester Exam Average</th>
<th>Study I (n = 44)</th>
<th>Study II (n = 39)</th>
<th>Study III (n = 151)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Std. Dev.</td>
<td>13.6%</td>
<td>13.1%</td>
<td>13.6%</td>
</tr>
</tbody>
</table>

Comparing Studies I and III, we can reason about how differences between courses may impact students’ decisions to take optional final exams. The students in ECE551 were about twice as likely to opt to take an optional final exam when exams were weighted equally. This may suggest that senior students in Study I, who may be savvier about exam preparation, are more...
likely to view an optional exam as a chance to improve their grade than their freshmen counterparts.

What about our ideal goals of having all students with failing or borderline grades choose to take the exam and having all students who were already in the top grade tier skip the exam? Table I breaks down the percentage of students in each of 6 different score ranges who opted to take the final exam. Looking at the aggregate data from all three studies, we see that the fraction of students taking the final exam who already had an average score of over 90% of the total points in the course was fairly low – only about 5%. Conversely, students in the borderline regions of the score distribution opted to take the exam at the highest rates. That said, this was still only about a 50-60% rate, so instructors who are concerned about getting a second chance to evaluate these borderline students may want to add a stipulation into their exam policy that forces students with failing or borderline scores to take the exam.

One last point of interest in the distributions is to note that students in the 80-90% range – around the ‘B’ mark in our grade distributions – generally did not choose to take the optional final exam, except in the case of Study II. This is consistent with our earlier arguments about the reduction in risk presented by allowing students to opt-out of having their final exam graded. Without this option, students may see the possibility of getting an A with a good performance on the optional exam but judge that it is not worth the risk of scoring worse.

**How Do Students Perform on Optional Finals?**

The next issue we will explore is student performance on optional final exams relative to their performance earlier in the semester. Remember that part of the rationale for making comprehensive exams optional rather than doing away with them entirely was to give students who believed that they had significantly improved their mastery of the material after the mid-semester exam a second chance to demonstrate their knowledge.

| Table III: Comparison of the Scores of Students Who Took the Final Exam to Their Mid-Semester Exams |
|-------------------------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Final Exam Average                              | Study I                        | Study II                       | Study III                       |
| Average                                         | 80.3%                          | 87.2%                          | 73.1%                           |
| Average Difference from Midterm Exams (Absolute)| +14.9%                         | +15.6%                         | +12.6%                          |
| Standard Deviation of Difference                 | 5.9%                           | 7.8%                           | 7.2%                            |
Table III shows the difference in bulk score statistics of students who chose to take the final exam versus the score distributions of the same students’ mid-semester exams. There is some subtlety to interpreting the data in this table. Looking at the average score on the optional exams, it is fairly similar to the average from the full student population on mid-semester exams for Study I (within 2%) and Study III (within 3%). In Study II, however, the average score is about 10% higher (absolute) than the mid-semester exams, despite containing mostly identical content to the
final exam in Study I and using a similar grading rubric. There are two points to note in explaining this difference. First, Table I shows that the distribution of students choosing to take the final exam in Study II skewed higher than in Study I. Second, Study II gave students the option to decide to have their final exams ungraded. Therefore students who self-assessed that they would not get a good score were able to remove themselves, pushing the average score of the graded exams higher.

This improvement effect can also be seen in the other studies when looking at the change in scores between the midterms and final when considering only the students who opted to take the final exam. As shown in Table I, students who opted to take the final exam did roughly 15% better on average than in the midterms. Histograms of the score increases for each of the studies are shown in Figure 3. This more detailed look at the score improvements tells a slightly different story than the bulk averages.

We can see that a few high-end outliers in Studies II and III scored as much as 30% higher on the optional final exam than on their midterms. This reinforces the point that there is value in keeping an optional final exam rather than eliminating the exam entirely, as it gives some students who have performed poorly a chance to redeem their scores in a significant way. Aside from the addition of these high outliers and lack of low outliers, the shape of these distributions appear consistent with typical exam distributions for these courses, but larger sample sizes are needed to state this with confidence.

Although it is tempting to try to compare the score distributions on the optional exam to the midterm exams for the entire student population, it would be problematic to draw conclusions from such a comparison because Table I shows that the students who chose to take the exam clearly do not represent a uniform sample. Because optional test-takers tend to be those who scored poorly on the initial midterm exam, they have greater opportunity to improve their scores by large margins than a random sample of the student population. Moreover, one might speculate that students who scored poorly on their midterm exams but did not withdraw from the class might have greater motivation to do well on the final exam in order to achieve a passing grade, and might therefore invest more time in studying for the exam. Our score distributions for the optional final exam did not show any outliers on the lower end of the distribution, but such ‘low-score outliers’ appeared in the mandatory midterm exams for the courses in our studies. Although we did not ask students directly about motivation levels in this study, the very fact that they chose to take an optional final exam indicates some higher level of motivation. Another possible explanation for the lack of low-score outliers is that some significantly underperforming students remove themselves from the student population by withdrawing from the course.

We were also interested in whether these higher exam scores actually made a meaningful difference in a student’s overall score in the courses in our study. Naturally this is entirely dependent on the weight that exams have in a given course. For the course in Studies I & II, exam scores contributed 40% to the final grade; in Study III they contributed 33%.
In Table IV, we see that the optional exam produced average increases in overall score ranging from 1.5-3.0% in our three studies. The higher change and standard deviation in Study II can be attributed to the option in Study II for students to select whether they wanted the final to be weighted equivalent to one or two mid-semester exams.

<table>
<thead>
<tr>
<th>Table IV: Impact of Optional Exam on Overall Course Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study</td>
</tr>
<tr>
<td>Avg. Change in Overall Score (Absolute)</td>
</tr>
<tr>
<td>Standard Deviation of Change in Overall Score</td>
</tr>
</tbody>
</table>

Although these changes are not large enough to shift a student from an ‘F’ to an ‘A’, they are certainly enough to allow students who are on the borderline between grades to move up to the higher grade. Of course, instructors are by no means limited to using the same weightings used in our studies or even committing to a completely point-based system.

How Do Students Feel about Optional Exams?

Given that the purpose of our optional exam policy was to make life easier on our often overworked engineering students, we wanted to ask our students directly whether they liked this policy. Although it might seem obvious to some that students would appreciate the chance to skip an exam, it is worth remembering that students also appreciate consistency among classes. Moreover, asking the students to make the decision about whether or not to take the final exam puts additional responsibility on their shoulders and asks them to do some extra self-evaluation.

At the end of each study, we asked all the students, whether they had opted to take the exam or not, to state whether their overall opinion of the optional final exam policy was positive, negative, or neutral. The results were collected anonymously and are presented in Figure 4.

![Figure 4: Results of the student opinion survey on their overall feelings towards the optional final exam policy.](image-url)
Results were largely positive, ranging from 77% positive in Study I to 90% positive in Study II. In cases where students did not have a positive view of the optional exam, they usually expressed a neutral/no opinion response. Only one respondent across all three studies stated a preference for mandatory exams over optional ones. Because the surveys were taken independently anonymously, it is not possible to correlate the opinions to whether or not the respondent chose to take the optional final during their study, but this would be an interesting question to follow up on in future studies.

**VI. Discussion**

We believe that making comprehensive final exams optional is a valid strategy that instructors can take to reduce the stress and workload of their students without making significant compromises in the quality of their assessment. Our studies have shown that students responded very positively to the policy in each of our test classes.

A large concern we had prior to implementing the policy was whether students would make what we deemed to be the right choice about whether to take the exam. Even allowing for a process of pure self-selection by the students, our results were fairly promising; test-takers tended to be those whose scores needed the most improvement, and students who had already earned high grades generally did not take the exam. We observed that the Freshman students in our studies were less likely to choose to take an optional exam than Juniors and Seniors. We also noted that giving students a chance to opt out of having their exam graded at the last minute, and thereby reducing much of the risk of taking an optional exam, can significantly increase the number of test-takers if that is desired. One point of potential concern is that only a little more than half of the students who were scoring in the lowest overall grade bracket of our test courses chose to take the final exam. As instructors, we often struggle the most about determining grades for students who are on the border between passing and non-passing and appreciate having more complete assessment information for these students. Therefore, there may be some value to going to a hybrid approach where the final exam is mandatory for students with grades below some threshold and optional for those above.

Our studies showed that the students who took our optional exams tended to score much higher on the optional comprehensive exam than on their mid-semester exams. An important concern when interpreting these scores is that it is not possible to normalize (i.e. curve) them based on previous exam distributions because the students choosing to take an optional exam do not represent a uniform sample of the entire population. Therefore, some additional care must be taken in assessing the difficulty and scoring of an optional exam to make sure it is not significantly easier or harder than the mid-semester exams. We recommend using techniques such as test blueprints and pilot testing to tune the difficulty. For classes where test security is sufficient to re-use the same (or largely similar) final exams between semesters this becomes less of an issue since historical data can be used to interpret distributions.
Because our test-takers showed a significant average improvement in overall score, there is also concern about whether those who opted not to take the exam would have also improved. This is important in classes where grading is determined based on a curve. We believe in principle that students who opt not to take the exam should not potentially have their final letter grade decreased because test-takers have shifted the curve upward. Therefore we recommend setting the grading curve prior to the final exam and only reevaluating the grades of those who took the exam.

VII. Future Work

Our pilot studies have given us valuable insight into the dynamics of deploying optional comprehensive final exams and identifying the variables most worthy of future study. We can, however, only make limited conclusions based on the statistical evidence produced from such studies. In the future, we plan to reexamine some of the issues raised in this work using experimental studies that include a control group of students that is forced to take the exam and compare their outcomes to the students who are given the option not to take the exam. The impact of exam incentives on student opt-in rates highlighted in this paper will be important for the design of such experimental studies; achieving large enough samples of students who opt-in and opt-out is necessary to obtain reliable results from statistical modeling tools. In the first semester of our study, for example, too few students opted to take the optional exam to allow the use of t-tests to compare optional exam scores to those of the other studies. In future work, our incentives studies can be used to better predict the number of participants when designing the experiments.

A topic we plan to revisit in future studies is the question of how much a student’s perception of his or her grade impacts their likelihood to take an optional final exam. In this study we examined opt-in rates based on student grades, but our conclusions are based on an assumption that students have accurate conceptions of their current grades. Although all needed grade information was publically available to the students in our studies, we do not know whether students used this information correctly (or at all) when deciding whether or not to take the final exam. In future studies, students might be surveyed to determine their perception of their current grade and to ask them what factors were the most important in deciding whether to take the optional exam.

VIII. Conclusion

In this paper, we have made a case for the elimination of mandatory comprehensive exams and presented the results of three pilot studies examining the use of optional exams as a replacement for the mandatory final exams present in many engineering classes. In our studies we found optional exams to be overwhelmingly well-received by students and discovered that adjustments to exam parameters, such as their score weighting and whether students have the option to opt-
out during the exam, had large impacts on the number of exam participants and on their score distributions.

We are firm believers that there is no “one size fits all” solution to the problem of effective classroom assessment. We believe that optional final exams have the potential to be a positive policy in many classes that use a comprehensive final exam, but recognize that they may not be a good fit for every class. While we advocate that all engineering instructors think about means of reducing assessment overload at the end of courses, optional exams are only one possible means to that end. By presenting our studies of the primary dynamics of deploying optional exam policies, we hope that we have made them a feasible option in the collection of assessment strategies available to instructors.

Bibliography


