

## **Weekly Quizzes in Lieu of Homework in Large Sections**

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### Abstract

The best paper in the Mechanical Engineering Division at the 2022 ASEE Annual Meeting in Minneapolis showed that student learning increased with weekly quizzes rather than daily homework.<sup>1</sup> The authors' work built on several recent papers showing that mastery learning with multiple attempts at each quiz increased student success.<sup>2-4</sup> Engineering Statics at NC State University has long included daily homework assignments, so the pivot to weekly quizzes will need to be adopted over multiple semesters and adopted for large enrollment sections.

This work-in-progress paper details the methods we used to administer weekly quizzes to a class enrollment of almost 400 students with minimal grading help. As we were unable to create multiple quizzes in one semester, we can evaluate whether multiple quizzes are necessary to see the increase in student learning. Our comparison is between students enrolled in Fall 2021 and Fall 2022. Both semesters required daily homework quizzes in Moodle (3 attempts, highest score taken), but for Fall 2022 the on-paper homework was left as optional and the weekly quiz was implemented. We show a slight improvement in the average midterm grades despite having only one attempt at most quizzes.

### Introduction

The goal of all engineering education is for students to learn and retain the material to a sufficient extent that they can apply their knowledge in novel situations.<sup>5</sup> Challenging students to learn to this level has become more problematic as anxiety levels have risen to epidemic levels with the corresponding grade inflation students have come to expect.<sup>6-7</sup> Averill et al wrote:

“The second practice is for students to memorize the solution for a specific example problem and then reproduce parts of that solution for any similar problem on an exam. The goal of this is to maximize partial credit rather than to actually solve the problem at hand. This strategy works so well because partial credit has steadily become so generous that many students no longer feel the need to solve problems correctly.

“In many cases, the desired grade in a class can now be obtained through a combination of copying online solutions to obtain a nearly perfect homework score and maximizing partial credit on exams by memorizing example problems. It is possible for a student to successfully pass a class without correctly solving even a single engineering problem.”<sup>8</sup>

Teams around the country are looking for ways to avoid this partial-credit trap, encourage mastery learning, and minimize anxiety. During the 2022 ASEE Annual Meeting in Minneapolis, the best paper in the Mechanical Engineering Division showed that student learning increased with weekly quizzes rather than daily homework. Our team decided that it was time to try something new.

## Local Limitations

During Fall 2022, Statics in Mechanical and Aerospace Engineering at NC State University began implementing weekly quizzes. Because cheating is also endemic, the team decided that the questions should use randomly generated inputs.<sup>9</sup> Mastery learning with empathy requires giving students multiple attempts to show that mastery. Initially the plan had been to create multiple quizzes, deliver them in Moodle (our learning management system on campus), and grade small sections by hand.

NC State University implemented Moodle 4.0 for Fall 2022 on campus. At that time, the Calculated question type which would allow us to code the questions for the students was not functional in Moodle 4.0. Grading these quizzes by hand was impossible due to the enrollment in Statics for this semester: we had 381 students enrolled at the beginning of the semester in the sections taught by Anna Howard with only 20 hours per week of undergraduate grading help. (And the graders only put in 12.4 hours per week in the end.) Over Fall 2022 the team succeeded in part: one quiz was produced for each week of material in Statics with feedback for every student. Retakes were available only for weeks 1 and 2.

One additional limitation: Fall 2022 still suffered from the pandemic malaise. Every faculty teaching during this fall which we spoke to had horror stories from this semester. Anecdotally, we noticed very high student fatigue and low preparation. Our experiences in class led us to expect even lower exam grades than we would typically see.

## Google Suite and Gradescope

NC State University is one of many Google campuses. The team used Google sheets to provide randomized inputs to each student for every question. Students were able to look up the numbers they were assigned by finding their student number in the spreadsheet.

The quizzes themselves were delivered as PDFs. Students looked up their values, and worked the problems on the quiz. (Because each student had unique numbers, the six students who posted their work to Chegg were easily identified by finding which student number was assigned those values.) The team created a Google form for each quiz where students could enter their answers. Long problems were broken into parts; one 3-dimensional rigid-body equilibrium problem had 27 separate answers for students to enter.

Each Google form can be linked to a Google sheet, a spreadsheet where we could calculate the answers the student should have gotten with the numbers they were assigned. Because the form answers could allow units, we also programmed the grading of units for all answers. Where true mastery learning would count a sign error as completely incorrect, we often chose to give partial credit because of the lack of retakes which the team had time to create. Each student was provided feedback to indicate what they had scored on every part of every problem.

Additionally, students were required to submit their scratch work and free-body diagrams to Gradescope. This provided a disincentive for students to submit random numbers and allowed the undergraduate graders to provide feedback to the student free-body diagrams. Furthermore, students submitted a signed honor code with their scratch work. Having the scratch work on

Gradescope also allowed the instructors and teaching assistants to help students find their mistakes in office hours after the quizzes were graded.

### Preliminary Results

We hoped that even with a minimal implementation of these weekly quizzes we could see some overall improvement in exam grades. We compared exams grades from Fall, 2022 with the grades from Fall 2021. In both semesters, Statics students had three midterm exams and a final exam. The exams, while not identical, tested the same material. Both semesters the questions were chosen from prior year tests where averages were comparable.

Fall 2021 students were assigned on-paper homework problems after every class day, submitted and graded by undergraduate graders in Gradescope. In Fall 2022, those homework problems were still accessible, but only the weekly quizzes were submitted or graded. (Spring semester grades are statistically different from Fall semester grades.<sup>10</sup>)

Exam grades were available for 330 students from Fall 2021 and 337 students from Fall 2022. Exam grades did go up, but not much: 10 points, 0.5 points, 6 points, and 3 points for midterms 1-3 and the final exam, respectively. Topics covered in each test are shown in Table 1.

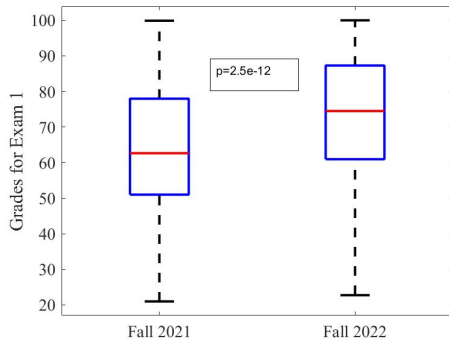
*Table 1: Topics Covered on Each Exam*

Exam 1	Exam 2	Exam 3	Final Exam
Forces in 2D and 3D Particle Equilibrium in 2D and 3D	Moments Rigid Body Equilibrium in 2D and 3D Friction (slipping/tipping) and Wedges, Belts	Distributed Loads Centroids Moments of Inertia (area and mass), Product of Inertia, Polar Moment Fluid Statics	Trusses in 2D and 3D Frames & Machines Internal Forces Shear and Bending-Moment Diagrams

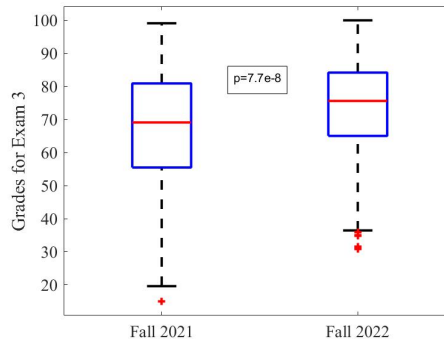
We ran 2-tail statistical T-tests between the grades for each exam to compare Fall 2021 and Fall 2022 exam performance. The 2-tail T-test was appropriate because the grades for each exam approximated a normal distribution. Figures 1-3 show grades and the significance of differentiation level for each midterm exam between the two semesters. For midterms 1 and 2 and the final exam, the increase in the exam grades was significant at  $p < 0.05$ .

As figures 1-4 indicate, there is significant difference between the grades for two groups of students, which suggests that eliminating homework and replacing it by weekly quizzes increased students' efficiency and success through exam 1, exam 3, and final exam. However, there was no significant difference for exam 2, which could be due to the topics covered in the second midterm exam.

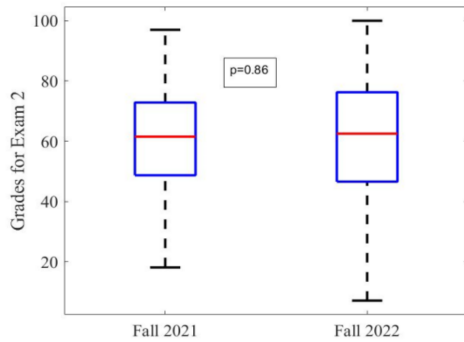
**Figure 1. Exam 1. Averages 63.3 & 72.8 out of 100**



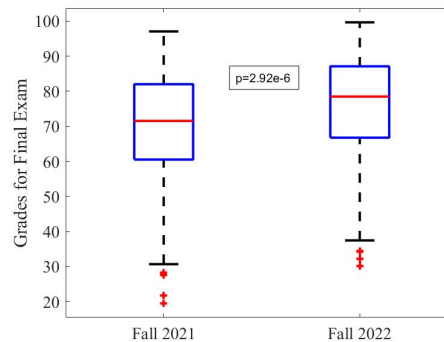
**Figure 3. Exam 3. Averages 67.2 and 74.1 out of 100.**



**Figure 2. Exam 2. Averages 61.1 and 60.9 out of 100**



**Figure 4. Final Exam. Averages 70.0 & 75.7.**



## Conclusion and Discussion, Future Work

Grading the quizzes required hours still to code the answers. Student complaints that the homework was too much work were replaced with complaints that the quizzes were too much work. However, both produced student learning in the majority of situations. These preliminary results show that omitting homework assignments and replacing them by weekly quizzes may improve students' grades if not their happiness.

The university worked with the worldwide Moodle community to correct the Calculated question type. During Spring 2023, these quizzes are being moved to Moodle though the Gradescope submissions are still required. Students have anecdotally reported seeing their quiz scores immediately as a good thing.

The question was raised: is all this work worth it? The team believes that the algorithmic questions will be useful for longer than the single-answer questions where solutions can be copied verbatim. We learned that the weekly quizzes motivated students to come to office hours and ask more questions than daily homework. We observed that some students seemed to take weekly quizzes more seriously than similar homework problems. In the end, the team decided that the quizzes were worth the effort.

In the future multiple quizzes will be produced so that students can demonstrate mastery. The preparation quizzes and other computer-graded homework may be phased out or moved to optional. We hope that these evaluation methods will help students learn and retain the material into their future classes.

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