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Weekly Quizzes In Lieu of Homework

Dr. Anna K. T. Howard, North Carolina State University at Raleigh

Anna Howard is a Teaching Professor at NC State University in Mechanical and Aerospace Engineering where she has led the course redesign effort for Engineering Statics. She received her Ph.D. from the Rotorcraft Center of Excellence at Penn State University and is one of the campus leaders of Wolfpack Engineering Unleashed. She has launched and is currently chairing the College Teaching Committee for the NC State College of Engineering.

Nicholas Garcia, North Carolina State University at Raleigh

Weekly Quizzes with No Homework

Abstract

Homework and class activities help engineering students stay engaged and on track with a given course. Traditionally in Statics at NC State University in the Mechanical and Aerospace Engineering department, homework has been split between those problems auto graded by a computer and more complex problems evaluated by graders and TA's. Recent research from Ohio Northern University[1] has shown an increase in overall semester grades when homework is replaced with weekly quizzes. It should be noted that ONU has smaller classes than at NC State, and quizzes were graded each week by faculty. Retakes were also available to students. Our current study investigates whether the results from ONU are replicable at a large university with large numbers of Statics students without any quiz retakes.

Weekly quizzes have been prepared for Statics which are graded primarily by computer with free-body diagrams graded by undergraduate graders. Homework is no longer collected in any form. The prior computer-graded homework quizzes are available as practice, and some of the prior on-paper homework assignments are available as Example Problems, but neither is required. Weekly quizzes are algorithmic and check units for the students. Partial credit is given only for incorrect signs of the correct answer: students must get the problem correct to receive credit. Longer problems are broken into parts with up to 30 separate questions graded.

Partial data from last fall, published at ASEE in June,[2] suggested that this approach with weekly quizzes might also show higher grades, as did the ONU research. This paper compares five semesters of exam grades during which Statics transitioned from all on-paper with some computer quizzes to all online with only weekly quizzes.

Introduction

Engineering education requires both transmission of knowledge and student practice. Students almost always benefit from having structure around their learning where students are held accountable for their problem solving. We would not, for example, hand a student a textbook and give a final exam. Educators provide the framework for students to absorb and apply what we're teaching.

Teachers must also assess the students in their progress from novice to expert. The assessment is necessarily individual so at least some of the assessments need to be as well. A good assessment of student learning needs to be whether they can apply their knowledge to a new, complex problem without overmuch assistance. The variety of student strengths often limits such assessments to an untimed assessment.

In the past, Statics has been based around a traditional format: derivations followed by a few examples in class with homework to follow. Since 2013, Mechanical and Aerospace at NC State has taught Statics as a flipped class with concept videos, example videos, and text book reading outside of class.[3] Homework was split between those problems auto graded by a computer and more complex problems evaluated by graders and TA's. The prevalence of answers on the

internet meant that these homework problems were written fresh for each semester, a sizeable time-sink but one that the instructor thought was necessary to ensure students practiced modeling systems which were unfamiliar and complex in an untimed, unaided fashion.

Recent research from Ohio Northern University replaced such homeworks with weekly quizzes.[1] That department showed an increase in exam grades when homework is replaced with weekly quizzes. It should be noted that ONU has smaller classes than NC State, and quizzes were graded each week by faculty. Retakes were also available to students. Our current study investigates whether the results from ONU are replicable at a large university with large numbers of Statics students without any quiz retakes.

Weekly quizzes have been prepared for Statics which are graded primarily by computer, but free-body diagrams are graded by undergraduate graders. Homework is no longer collected in any form. Although, the prior computer-graded homework quizzes are available as practice, and some of the prior on-paper homework assignments are available as Example Problems. Weekly quizzes are algorithmic and check units for the students. Partial credit is given only for incorrect signs of the correct answer: students must get the problem correct to receive credit. Longer problems are broken into parts with up to 30 separate questions graded.

Partial data from last fall, published at ASEE in June, suggested that this approach with weekly quizzes might also show higher grades, as did the ONU research.[2] Last fall the practice quizzes were required, but this semester they are completely optional. The quizzes do form a backstop for the grades on the weekly quizzes: a student who scores 100% on the three practice quizzes for the week is guaranteed at least a 50 on the weekly quiz.

Methods

This paper presents exam scores for the fall semesters 2019, 2021, 2022, 2023, and 2024. The varying requirements for Statics are shown in Table 1. The elements:

- On-paper homework (OPHW): daily problems were written by the author new each semester. Solutions provided to undergraduate graders who graded each homework. Due the following class period. Individual effort.
- Computer-graded homework (CGHW): daily HW (quizzes) graded in Moodle. Can be attempted three times with the highest grade recorded (with 30 minutes between each attempt). Open book, open notes, teamwork allowed, untimed.
- Weekly quizzes (WQ): quizzes with algorithmically generated values. 80-90% of these quizzes graded automatically in Moodle with FBDs graded by undergraduate graders in Gradescope. Individual effort.
- Backstops on weekly quizzes WQ: each week has 2-3 daily computer-graded homework assignments which assess the same material as the weekly quizzes. The final weekly quiz grade is the average of WQ and 50-70% of the CGHW from that week. (See amounts below). The backstop changed from 70% to 50% when students stopped even attempting the harder weekly quizzes.

***Table 1**. Percentage of final grade in Statics for each assessment for each semester considered*

	Fall 2019	Fall 2021	Fall 2022	Fall 2023	Fall 2024
On-paper homework (OPHW)	13%	12%	not available	some problems available as examples	some problems available as examples
Computer graded homework (CGHW)	10%	10%	10%	backstop 70% of daily quiz grades	backstop at 50% of daily quiz grades
Weekly Quizzes (WQ)			14%	17%	17%
Midterms (3)	14% each	13% each	13% each	13% each	13% each
Final exam	23%	22%	22%	22%	22%
In-class grades	10%	10%	5%	6%	6%
Prep quizzes		5%	5%	6%	6%
Projects	2%	2%	5%	10%	10%

We compared the grades on the exams and homework scores from four totals of students for five semesters. Fall 2020 has been excluded from this analysis because of the COVID-19 pandemic and, in our assessment, it was too different from the other semesters in terms of student struggles, grading (pass/fail in lieu of letter grades) and instructional delivery (solely virtual). We considered only fall as previous research has demonstrated that spring semesters are very different from fall semesters.[4] The remote learning students from Havelock and Asheville North Carolina are also not included in the analysis.

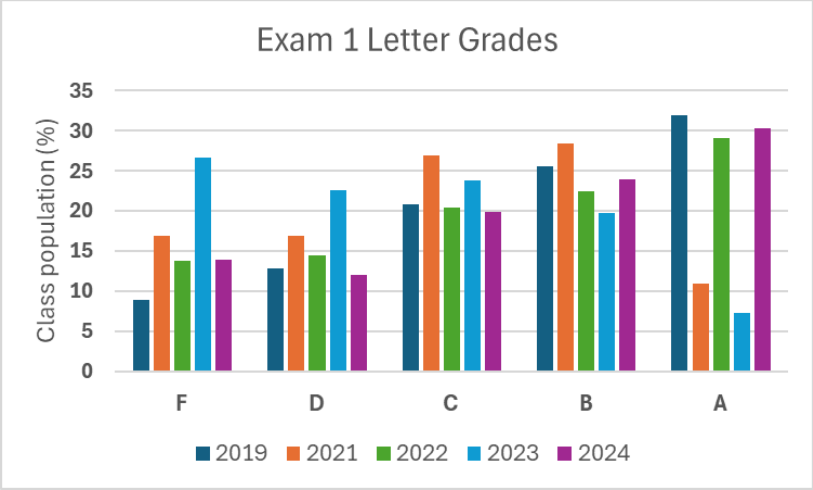
The assignments we will focus on in this paper are computer graded homework (CGHW), on-paper homework (OPHW), and the weekly quiz (WQ). Until Fall 2022, CGHW and OPHW were the two primary means of assessing student learning outside of class. Starting in Fall 2022, the outside class assessment shifted to weekly quizzes.

We are comparing the exam scores from each semester semester to semester. Since student learning is not directly measurable we use grades as proxy data, and deduce whether or not student learning has increased or decreased. This comparison is imperfect: the exams were not identical so inevitably some have higher averages than others. (And the exams had been the same, students would have shared the exams which would have skewed the results in different ways.) Efforts were made to keep the exams as comparable as possible.

Results

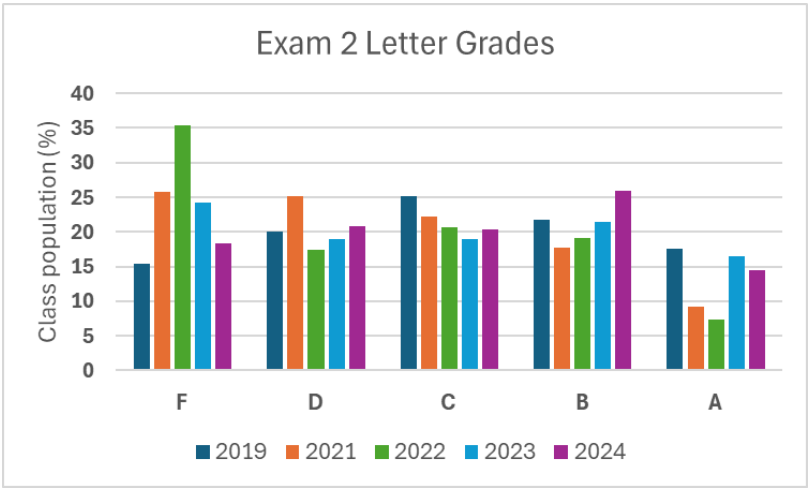
Exam grades are binned in the charts below. An A is 87-100. B's are 77-86.9999 and so forth. Results are given as a percentage of the class population. Exam 1 typically focuses on familiar material from calculus I–II and physics I including 2D and 3D equilibrium. Exam 2 includes fewer prerequisites: the focus is on equilibrium of rigid bodies in 2D and 3D. Exam 2 also includes friction. Exam 3 covers distributed loads, centroids, moments of inertia (area and mass), and fluid statics. The final exam is comprehensive. Exam 1 is given at the end of week 3, Exam 2 at the end of week 8, and Exam 3 in the middle of week 12.

Figure 1 - Normalized letter grade scores for 2019–2024 Exam 1



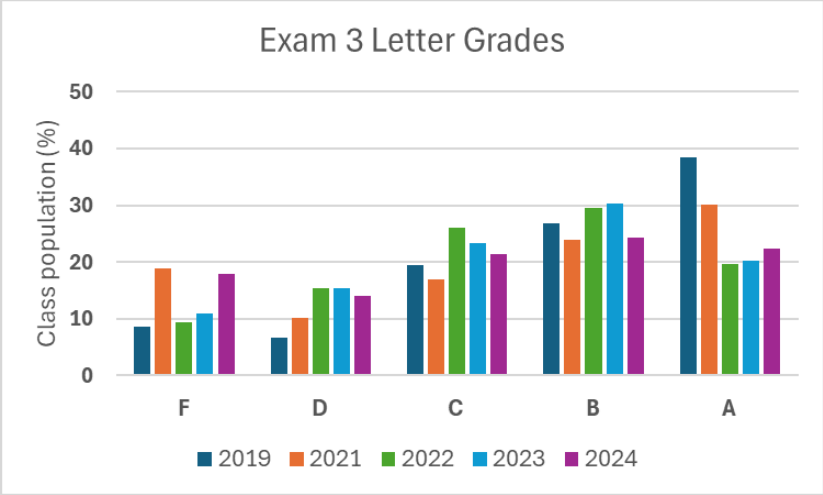
The Exam 1 grades shown in Figure 1 did not show an immediate improvement with the weekly quizzes change. But the number of A's seem to have returned to a pre-pandemic level. And the number of D's and F's shows improvement though not statistically significant improvement.

Figure 2 - Normalized letter grade scores for 2019–2024 Exam 2



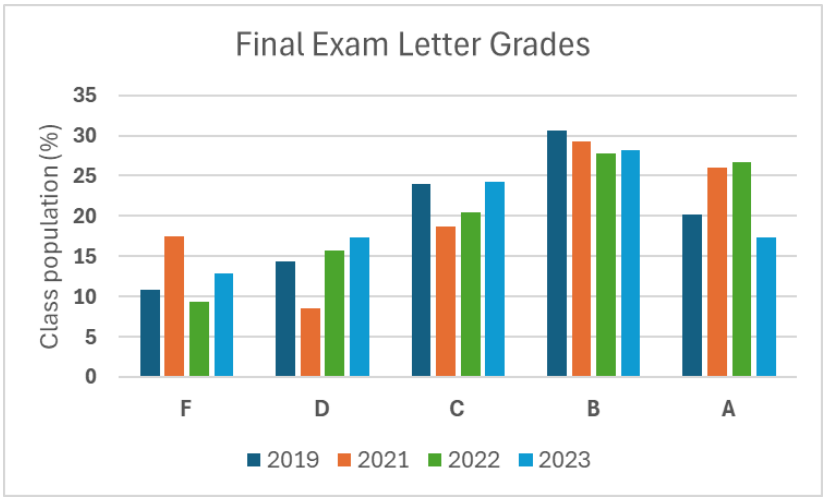
Exam 2 has more content than exam 1 and more of it is unfamiliar. This exam typically has the lowest average of any of the exams. Again, the student grades shown in Figure 2 seem to suffer more from the pandemic than they have improved with the weekly quizzes. However, there is a rise in the number of A's and B's over the pandemic years which is encouraging.

Figure 3 - Normalized letter grade scores for 2019–2024 Exam 3



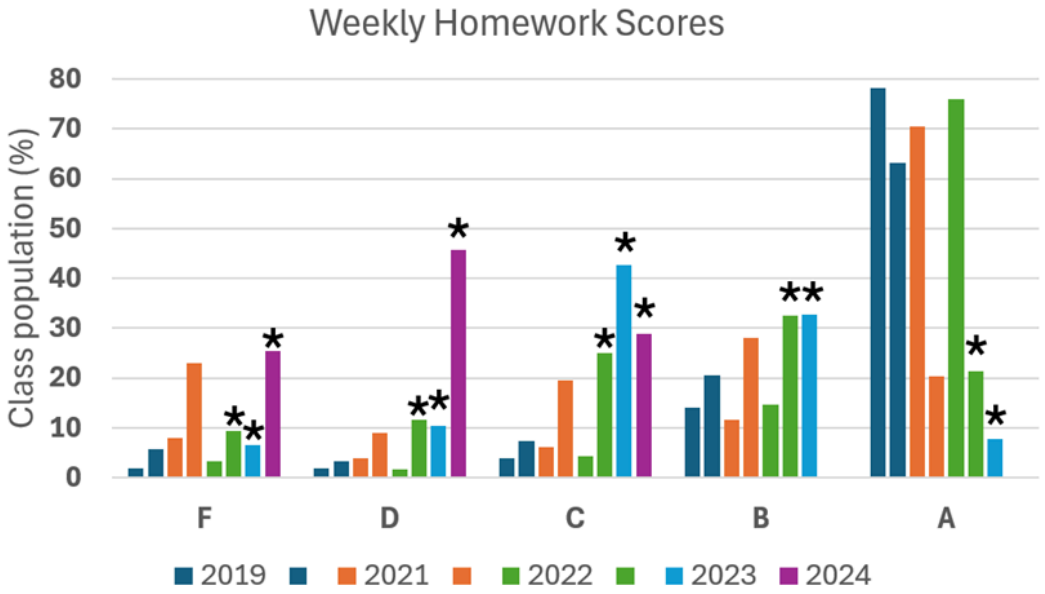
Exam 3 grades are shown in Figure 3 and likewise do not show improvements. We believe that the exam 3 in 2019 was an easier test than some of the others. Even without considering that bar, there is not a noticeable difference between the 2021 year and the 2024 year in the numbers of students receiving each grade.

Figure 4 - Normalized letter grade scores for 2019–2024 Final Exam



The final exam is comprehensive in each semester. Figure 4 shows the data up to 2024 where the data is not available at the time of this draft submission. No real difference is seen here.

Figure 5 - Normalized weekly homework scores for 2019–2024



There was some concern that the quizzes were harder than the homework. The grade comparisons on homework vs weekly quizzes certainly bore out that belief. Note that the first have multiple bars for the CGHW grades and the OPHW grades. (The computer-graded homework is the left bar for 2019, 2021, and 2022.) Again, final data for 2024 is not yet available. The weekly quiz grades counts are shown with an asterisk over the respective columns.

Table 2 shows the overall averages for each of these learning objects for each year.

Table 2. Tabulated average exam scores across semesters.

	Fall 2019	Fall 2021	Fall 2022	Fall 2023	Fall 2024
Exam 1	78.2	71.2	75.1	66.6	76.2
Exam 2	72.3	65.7	63.2	69.3	70.5
Exam 3	80.6	73.7	75.7	75.1	73.5
Final exam	75.2	72.3	76.4	73.6	-
CGHW	91.4	86.8	90.2	-	-
OPHW	85.2	69.1	-	-	-
WQ	-	-	75.5	73.6	60.7

Discussion

The weekly quiz grades are not as high as the on-paper homework grades, but both assignments seem to serve for students to learn the material. It was expected that the students would rather reduce the number of daily assignments in lieu of a weekly quiz where they could work at any time; unfortunately, neither the student contentment nor the student preparedness seems to have improved.

What has definitely improved is the reduction in workload for the instructor. Preparing new homework problems was a large task. These quizzes which have so many variables which change from student to student has cut down on the cheating (which we've caught.)

Students never liked the on-paper homework. The homework problems were new and complicated. Every semester some students submitted the copyrighted problems to Chegg and were turned in for cheating.

In 2022, the weekly quizzes were new. For the first half of the semester, Moodle was not ready to support the grading of units, so the quizzes were turned in using Google forms. By the end of the semester, we had moved to Moodle. The student evaluations for this semester definitely showed the unhappiness of students with the weekly quizzes. In 2024, these quizzes are mostly smoothed out and student approbation has declined noticeably. In 2024, students were also given two attempts at the weekly quiz – though with different numbers. This likely

This paper concerns replacing the on-paper homework and computer-graded homework with weekly quizzes. The class in 2019 and 2021 included one semester-end project; the newer classes have included four open-ended projects over the course of the semester. The psychological effects of this change on students have not been studied but could have impacted the results below.

Conclusion and Future Work

Changing the homework to weekly quizzes did not show a marked improvement in student exam grades but it did lower the workload of the instructor and the number of honor code sanctions which had to be imposed. In the future additional versions of the weekly quiz should be written so that students' second attempt could be with different problems. Eventually, a large enough stable of quiz questions could allow students to continue to improve their grades over the course of the semester.

True mastery learning where a student must pass these quizzes to pass the class must wait until more assessments are available.

References

[1] – Hylton, Blake J., Funke, Lawrence. "Journey towards competency-based grading for mechanical engineering computer applications", ASEE 2022 Annual Conference, Minneapolis, Minnesota, June 26-29 2022, paper ID 37531.

[2] - Howard, A.K.T, Dashti Cole, A. "Weekly Quizzes in Lieu of Homework in Large Sections." Proceedings of the 2023 American Society for Engineering Education Annual Conference & Exposition, Baltimore, MD, June 2023.

[3] - Howard, A.K.T. "Flipped Classroom – Ten Years Later." Proceedings of the 2019 American Society for Engineering Education Annual Conference & Exposition, Tampa, FL, June 2019.

[4] - Howard, A.K.T, Stimpson, M.J., "Online-Only Statics Compared to Flipped Class," Journal of Online Engineering Education, vol. 9 (1), 2018.