
Retaking a Test Online

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Tests and midterms given during the running semester are, in the mindset of most educators, located somewhere between formative and summative assessment: more serious than homework, but still—as opposed to the final exam—mostly a learning opportunity. In the mindset of most learners, however, these venues are purely summative—they “flunked” or “did well” on a test, but mostly, they got it over with. Few students come to office hours to understand what they did wrong. If they had a bad day, they have no second chance to correct their mistakes, but more importantly, they do not receive any immediate incentive or reward to address detected deficiencies, or for deeper learning, reviewing, and understanding of the material after the test is over.

This paper discusses a mechanism used by a number of physics educators at Michigan State University to give students a second chance to succeed on a test and to encourage them to learn the expected material, even after the test is done. Students get to earn partial credit by solving a different, randomized online version of the test they just took. For a quantitative discussion and illustration of the mechanism, this paper uses the example of the first three tests in a second-semester 200-student introductory calculus-based physics course. The same techniques can also be used in classes or sections with smaller enrollments, but they work best for introductory courses where we typically ask the students for mastery of simpler concepts.

Randomized Exams

In large-enrollment introductory courses without teaching assistants, unfortunately bubble sheets are the only sustainable means to give frequent tests over the course of the semester. The online system used in this paper, LON-CAPA,¹ can generate randomized versions of the same questions, e.g., different graphs, images, numbers, options, and so on, from student to student. Instructors only need to write questions in one format, even if they plan to use the same question online, in print, or for bubble sheet exams. For example, a numerical answer field would be rendered for free-form entry including free-form physical units online, but for printed exams, randomized answer choices would be provided. Instructors can leave it to the system to generate the wrong answer choices, or provide algorithmically determined wrong answer choices themselves. Using both functions together results in 200 different versions of the same exam for our course (see, for example, Fig. 1). Randomized bubble sheet exams have been used for several years in our department and were found to be an effective way to reduce cheating.^{2,3}

The LON-CAPA system is by no means the only course management system in which computerized exams can be given. Other systems, such as WebAssign,⁴ Angel,⁵ Blackboard,⁶ or WebCT,⁷ have similar features that can be utilized. For a comparison see Ref. 8. However, LON-CAPA may be the only system that allows the very same randomized question to be used

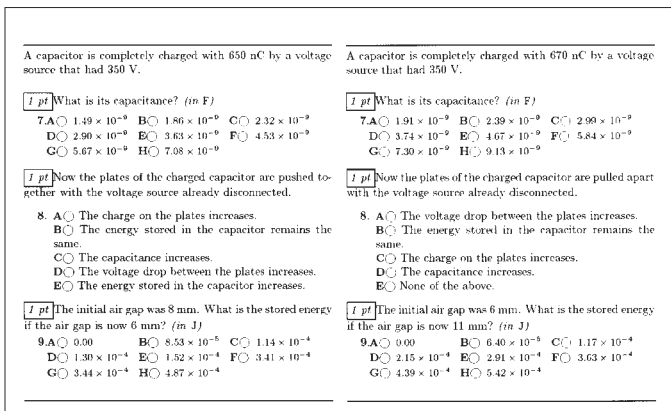


Fig. 1. Written version of a question from Test 2 in two randomizations.

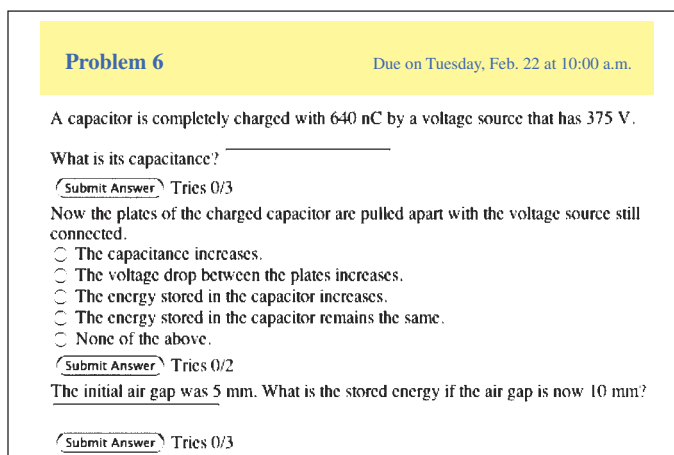


Fig. 2. Online version of the question in Fig. 1 in another randomization.

in an automatically graded bubble sheet and online mode.

Taking the Same Test—Again

The students in our course are using the same online system, LON-CAPA, for their reading and homework assignments. Since both the test questions and the students are already in the system, it only takes a few minutes to make the test questions available online to the students. Immediately after the written test is over, an online copy of the test opens up. This new version of the test can have the exact same questions that the students encountered during the written exam, or problems with the same words and different numbers for the variables as the written exam, or a different selection of multiple-choice concept choices in different random ordering. Which choice is imple-

mented depends on the preferences of the instructor and the capabilities of the online system used. The approach is the reverse of the frequent use of computer-based assessment as a practice test *before* an exam (for example, Ref. 9). In our courses the online homework serves this function.

Figure 2 shows an online version of the question from Fig. 1. In the first part of the question, the system rendered a free-form answer box and left the input of the correct physical unit to the student.

In our course, students are given 30 hours to complete the online version of the test, with two or three attempts to arrive at the correct answer. Since we have no way of monitoring student interactions during this time period, we explicitly allow students to collaborate on solving the retake exam, and we do not block any of the online threaded discussions that the system allows around individual questions. We feel comfortable doing this, since the randomization of the questions inhibits mindless copying of answers. Since we also do not curve the course grades, we have the added benefit of the constructive collaborations as students explain the physics to each other. Using the “block discussion” option inside of LON-CAPA would likely just shift the discussion to other online forums.¹⁰ Surprisingly, in spite of allowing collaborations, in an end-of-semester survey, the statement “I did the retakes by myself” received a rating of 0.6 ± 1 on a scale from “-2” (“strongly disagree”) to “2” (“strongly agree”), suggesting that about half of the students decided to work alone.

It is, of course, technically possible that a student has a friend take the entire online correction for him/her. At present, none of the authors has taken steps to prevent this, and in fact, we are not aware of any technology in a completely online setting to make this impossible.

Participation in the online retake, often referred to as “partial credit by corrections,” is completely voluntary and helps defuse the ubiquitous student issue in computer-scored examinations: “Why can’t I get partial credit?” The final score is then calculated according to the following formula:

- n : written (bubbled) score
- N : online (retake) score
- P : final score

$$P = \begin{cases} n & \text{for } N \leq n \\ n + 0.3(N - n) & \text{for } N > n \end{cases}$$

The students can thus earn “30 cents on the dollar” for the difference between their written and online score. As an example, a student might have a written score of $n = 8$, and an online score of $N = 12$, which results in a final score of $P = 9.2$ for the test.

One may ask what the right level of partial credit for the retake is. Clearly, partial credit significantly above 50% makes the written exams much less meaningful. Also, giving partial credit of less than 10% diminishes the attraction of the retake exercise in the eyes of the students. We find empirically that 30% partial credit for the retake strikes the right balance. At this level more than 95% participate in the retake opportunity.

In our course, online retakes are not offered for the final exam but only for the six topical tests that replace the two midterm exams traditionally given in this course.

Experiences

Experiences with this mechanism have been excellent for both students and instructors. Students, of course, will first and foremost appreciate the “bonus” points they can earn online but also the confidence they can gain, even after a test that did not go so well for them. The rate of correct online solutions is consistently over 90%.

Instructors appreciate a chance to catch a still highly motivated audience in a teachable moment with only a small additional effort on their part. Once a test is in place, it takes approximately 10 minutes to also provide an online version. In spite of the fact that students are basically spending twice the time on task and doing twice the work, no protest is heard. In fact, even complaints about a test being “too hard” or “unfair” have been greatly reduced by the new mechanism. Finally, if in the bubble sheet version some correct answers were selected by luck, students must now solve these problems in the retake.

In terms of actual grade changes, Table I shows the respective average scores for n , N , and P for the first

Table I. Maximum, average written, average online, and average final score for Tests 1, 2, and 3.

	Max Pts	n_{avg}	N_{avg}	P_{avg}
Test 1	12	7.8 (65%; 2.0)	11.6 (97%)	8.8 (73%; 2.5)
Test 2	16	11.4 (71%; 2.5)	15 (94%)	12.3 (77%; 3.0)
Test 3	14	7.8 (56%; 1.5)	13.5 (96%)	9.3 (66%; 2.5)

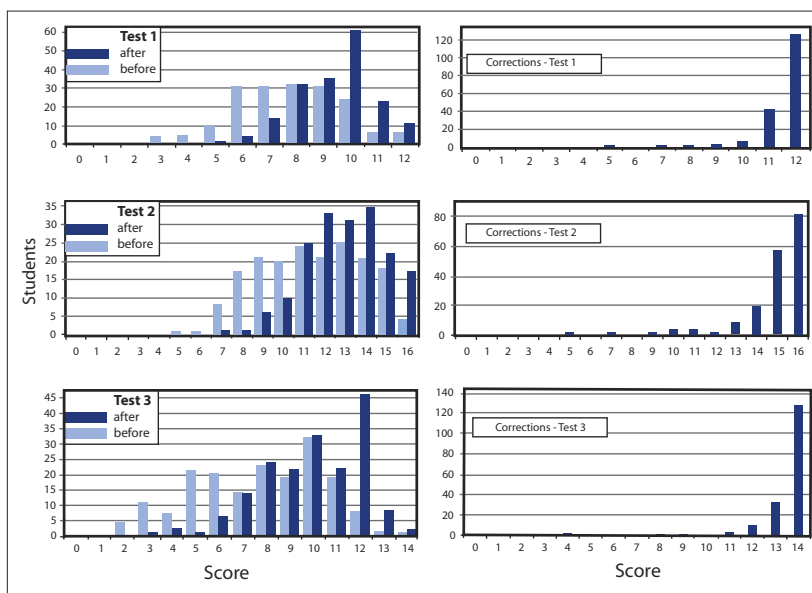


Fig. 3. Histograms for Tests 1, 2, and 3 (columns, left to right) of written score n , online score N , and final score P (rows, top to bottom).

three tests in the aforementioned course. For tests with a good written score (e.g., Test 2), the online retake does not make much of a difference—for Tests 1 and 2, the average grade went up by half a number grade from 2.0 to 2.5 and from 2.5 to 3.0, respectively. For tests that did not go so well (e.g., Test 3), the online retake makes a bigger difference; here, the average grade went up by a complete number grade, from 1.5 to 2.5.

Student participation turned out slightly lower for the test that went better: For Tests 1 and 3, the student participation in the retake was 97.8%, while for Test 2, “only” 95% of the students participated in the retake opportunity.

In all cases, though, the online retake did not lead to grade inflation in the sense that every student automatically obtains a perfect grade. In the implementation presented here, retaking exams also does not lead

to a loss of discrimination between weaker and stronger students. If instructors are worried that the overall class average is raised, they are still free to employ a curve. One may also argue that students deserve a better grade if they learn better and that if the class learns better as a whole, a higher average grade may be justified. This is also illustrated in the histograms (Fig. 3). The online retake by its very design makes the largest contribution in the extreme lower end of the score distribution, where the most remediation is needed.

We realize that the reliance on multiple-choice exams is not without problems (see, for example Ref. 11). If the in-class version of the test was of the simple “plug-and-chug” variety, adding a retake component will not improve the quality of the test. But as the Force Concept Inventory¹² has shown, it is possible to extract information on concept mastery with these simple tools, if applied properly.

We find that using the right concept questions can lead to deeper reflections on the part of the students during the retake process. In the survey, the statement that the retakes were worthwhile apart from getting more points was rated 1.1 ± 0.9 , and the statement that retakes helped learning was rated 1 ± 0.9 .

Retakes can even be used as an effective means of peer instruction: The statement that the online discussion around the exam retakes helped learning was rated 1.3 ± 0.7 . At present, we are working to incorporate peer instruction questions as developed by Mazur and his group¹⁴ into our question pool.

In summary, the retakes increase student time-on-task and appear to help students master the difficult concepts they encounter in introductory physics.

Outlook

In LON-CAPA, online resources, including problems, can be shared across semesters, courses, and institutions.¹³ As questions are being deployed, both written and online, the system automatically collects information on their degrees of difficulty and discrimination, and associates those with the problem resources themselves. As more and more of this usage-based data get collected, we will be able to reliably increase the randomization of exams to a level where we can substitute or rearrange whole question parts without generating unfairly easy or hard exam versions. This mechanism may enable full mastery-

based exams, where students (with decreasing credit in scores) can take retakes of retakes until they have demonstrated sufficient mastery of the respective topics and concepts.

Conclusions

Online retakes of tests are providing an additional teaching venue within large-enrollment physics courses and are a means to stress the formative aspects of tests. They motivate students to revisit material not mastered on the tests and to spend additional time on task learning it.

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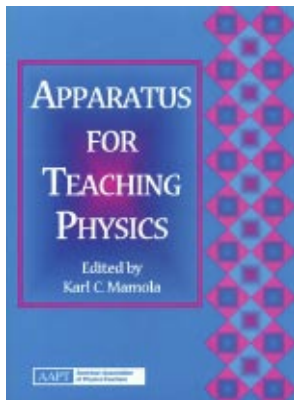
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