

Active Learning: Post-Assessment Extra Credit Quizzes

Rachel Frankel

University of Cincinnati Blue Ash College

It is always disappointing when the class average on an exam is very low, both for the instructor and the students. Giving a three to four question extra credit quiz based on the test questions after the second of three tests can boost student morale, reduce grade anxiety, promote active re-learning of the material, and does not require a large time commitment from the instructor. Unique individualized scoring rewards students by adding points to their original test score. Results show that the quiz is an active learning strategy that motivates students to re-learn the material.

Introduction and Motivation

When a class does badly on a math exam it can be a time of disappointment and tension. Some students are angry at the instructor for “giving” them a bad grade. Others may cry. For some students this just confirms that they aren’t good at math and they will lack further motivation in the course. Still others may internalize the failing grade and feel worthless. Because of this some instructors may be tempted to inflate the scores. Other instructors may ignore the hostile learning environment and continue on. Both these attitudes ignore the crux of the issue: the assessment reflects the students’ lack of knowledge of the material. Since mathematical concepts build one on the other, this lack of knowledge can affect the rest of the learning in the course.

A first step is to analyze the test itself to ensure it truly assesses student knowledge. Combined with this is an assessment of student study habits to determine if the assessment is at fault. This can be achieved through self-reflection by both the instructor and each student. If the test is deemed “fair” and students have done due diligence, a way must be found to improve the test scores while holding students accountable for the material. After much thought and trial and error, it has been found that an extra credit quiz boosts student morale and grades and is an active learning tool. Data suggests that when used appropriately with a unique scoring method, students are motivated to re-learn the material.

Instructor Re-Assessment of the Exam

The first step after a very low test average outcome, is to re-assess the assessment to ensure that it reflects the course material accurately, and is a feasible and fair test of students' capabilities and their study efforts. The instructor should ask themselves the following questions:

- Were the exam questions similar to/consistent with the questions practiced in class, on the homework, on the review?
- Were the exam questions designed to trick the students rather than assess their knowledge?
- Was the instructor's grading rubric too harsh?
- Was the exam too long for the time period?
- Was there too much material all crammed onto one exam?
- Was the material too difficult for the students?

If the instructor reassesses the exam and the material being assessed and finds an anomaly as described in the questions above, one simple solution is to curve the grades. Since the assessment itself or the method of assessment was flawed, students were not able to demonstrate their knowledge.

Student Self-Reflection

Second, when the instructor returns the graded exams to the students a self-evaluation worksheet should accompany the graded exam. This worksheet asks the student to assess their performance on the exam (see (Frankel, 2016)). In addition to its purpose in encouraging and helping students to reflect on their work and understand their study needs, the worksheet is useful for the instructor to try to understand why the class failed the exam. Anecdotally, the author found that on one self-evaluation students answered the question, "Were the questions on the exam similar to the questions on the review?" with a resounding no. The instructor had taken quite a number of exam questions from the review, actually cutting and pasting the questions onto the exam and changing one number. This was surprising. It turned out that the questions on the review were to be answered using the online software which only checks if the answer is correct or not. The instructor was using a rubric that assigned four points to the method of answering the question and one point for a correct final answer. Consequently, to remedy this problem, the instructor now writes

detailed solutions to the review problems and posts them online so students would know what a complete answer and notation consists of. Grades improved on subsequent exams and students evaluated the written answers as being beneficial to their studying.

In another example, the majority of students reported on the self-evaluation that they had studied for the exam for an hour or less and very few students had completed all of the review problems. In this case student grades were not curved and students were urged to study for longer and to use the resources available to them.

Test Corrections and Take-Home Worksheets

Once the instructor concludes that both the test and their teaching were “fair” based on the instructor’s honest re-assessment of the exam and the students’ self-evaluation feedback, the core issue of students’ scant knowledge of the material must be addressed. Re-teaching the material is usually not possible due to the time constraints of the course. Test corrections and take-home worksheets are popular methods to help students actively re-learn the material.

The goal of test corrections is for the student to review the test and rework the questions, hence relearning the material. In practice, many students do not spend time figuring out the correct answers to the questions, rather they google the solution and write the answer down blindly. Interestingly enough, many students also just rewrite their incorrect solutions. When asked to explain why they got the question wrong, student responses were typically “because I didn’t understand the question” or “because you took points off,” even when given a prompt as to how to answer this question thoroughly, with thought and self-reflection. From experience, it can take an instructor more time to grade the test corrections than to grade the original exam: the instructor must compare each student’s test corrections to each student’s original test, determine if the student corrected the incorrect questions, read the new answers, and determine if the new answers are sufficient to add additional points. This can be very time consuming. Most important, this instructor has found that the goal of student learning and reviewing of the material has not been achieved.

Take home worksheets which are comprised of questions similar to those on the exam are another way to get students to actively learn the material that has been assessed. In this instructor’s implementation,

students received extra credit points for answering the questions on the worksheets. One of the pitfalls of this approach is that it necessitates the instructor to write a new version of the test and to grade the equivalent of another exam, which is time consuming. Further, students tended to collaborate with each other on the assignment. The collaboration usually took the form of copying down others' solutions. Also, students turned to tutors, the internet, and others to get the solutions rather than figuring them out for themselves. This instructor discovered that on a take home worksheet, with specific "no cheating" restrictions, more than half the class turned in identical worksheets. Prosecuting the students for cheating took an inordinate amount of time and led to a hostile classroom attitude. Again, the ultimate goal of getting the students to actively learn the material was not achieved.

A More Promising Approach: The Extra Credit Quiz

The best active learning approach that this instructor has found is an extra credit quiz covering the material that was tested. Extra credit always motivates students. The quiz counts as both a regular quiz grade and for extra credit points to incentivize all students to re-study the material that was assessed, including those few students who performed well on the exam. In this way all students can raise both their test score and their regular quiz score average.

The quiz is given in the first fifteen minutes of the class period one week after the exam is returned to students. This is to ensure that students who miss the class session where corrected exams are returned to students still have sufficient time to prepare for the quiz. Only three or four questions, based on the exam questions, will be on the quiz.

Detailed solutions to the exam are posted online so students can see the correct way to solve the problems. Students also have access to all the materials that were available for test preparation such as review problems and their solutions, homework problems, extra practice problems, and class lecture notes. Students are encouraged to not just memorize the test solutions but to practice additional problems from the test preparation materials. The quiz reduces test anxiety as there is now only a finite amount of material or problems to study and studying can be targeted.

Scoring

The addition of extra credit points to the test score is unique and personal for each student: up to one-third (1/3) of the points lost on the exam will be added to the exam score. For example: if the original exam was out of 60 points and a student scored 39 points, the student could have a maximum of $1/3 \times (60-39) = +7$ points added to the original 39. A student could go from $39/60 = 65\%$ (D) to $46/60 = 77\%$ (C+). If the student scores 100% on the extra credit quiz then the entire 7 points are added to the original test score. The points are pro-rated depending on how the student scores on the extra credit quiz. For example, if a student scores 91% on the extra credit quiz, then $0.91 \times 7 = 6.37$ points are added to the original test score. See the table below.

Table 1: Scoring Method

Scoring Method			
Original Test Score	Points 39/60	Percentage 65%	Grade D
Maximum Possible Extra Credit Points Added to Test Score	$1/3 \times (60 - 39) = + 7$ points		
Score on the Extra Credit Quiz	Points 20/22	Percentage 91%	
Extra Credit Points Added to the Original Test Score	$91\% \times 7 = + 6.37$ points		
Final Test Score	Points (39 + 6.37)/60 = 45.37/60	Percent 75.6%	Grade C

This unique scoring method was developed to motivate students to re-study and to reward students who do. It is also designed to help students who did badly on the exam due to a one-time event such as child care issues or work issues the night before this specific exam. It also helps students who have studied for the test but who experienced high anxiety during the test and “blanked out.” Mostly, it aids students with borderline grades as it gives them the extra boost to the next grade category.

The addition of a maximum of $1/3$ or 33% of the points lost on the original exam may be adjusted to more or less of a percentage. From personal experience, the author has added a maximum of $1/2$ or 50% of the points lost on the original exam which resulted in many students' final scores being rather high so students' proficiency in the material was not reflected in their scores. Further, colleagues have reported adding a maximum of $1/5$ or 20% of the points lost which this author deems too few to incentivize students.

Frequency

It is recommended to only use the extra credit quiz option once per term. It is suggested that the quiz be given, if necessary, after the second of three exams. Giving the option of an extra credit quiz more often than once per term disincentivizes students as it puts them in the mindset that they don't have to study for the original exam but can make up the points at a later time. This actually minimizes their study time and effort rather than maximizes it. This rationale also applies to giving the option of the extra credit quiz after the first exam. Then students expect such a quiz after subsequent exams, even if told that this will not be the case. When a student does not do well on the first exam in a course this can be attributed to not knowing how to study or the instructor's assessment style. It serves as a "wake up call" for students to use the available resources and to start studying for the next exam in order to succeed in the course. It establishes the course as a "real" one that requires time and effort. Giving the extra credit quiz after the first test may decrease the gravity of the course in the students' psyche and discourages active learning efforts. Similarly, the third exam is given a few weeks before the final exam and students may need the rush of adrenaline (or panic) caused by a low test score to motivate them to study for the final exam of the course.

Results

The results from the original test and the extra credit quiz were analyzed for College Algebra (Fall 2016), Applied Calculus 1 (Spring 2017, Spring 2019), Applied Calculus 2 (Fall 2016), and Engineering Calculus 1 (Fall 2018). The class averages on the original test were about 63-64%, with the cut off for passing at 65%. This means that most of the class failed the test. Whereas, the average on the extra credit quiz was about 73-74%, a C average. Admittedly there were fewer problems on the extra credit quiz but

the time allotted to each question of about five minutes was the same as allotted for each question on the original test. Further, the questions chosen for the quiz reflected the questions that most students answered incorrectly on the original test. It may be inferred that students reviewed the material as evidenced by the higher-class average on the extra credit quiz.

More evidence that students reviewed the material can be seen in the actual breakdown on scores on the extra credit quiz. A little less than half of each class's students raised their grade by over 10 percentage points on the quiz as compared to their original test score. This means that many students who had borderline grades, grades that were at the near the cut offs of each grade, were able to raise their grades. With the unique scoring method these students were able to raise their grades from high D's to C's, high C's to B's, and high B's to A's. The grades of students who scored below 60% on the original test were analyzed to see if these struggling students were able to learn the material and achieve higher scores. While some students who failed the original test went on to score highly on the extra credit quiz, the majority of these students failed the extra credit quiz too. It could be that the extra credit quiz helped those students who had a one-time hardship when taking this test such as childcare or work issues or sickness but given a second chance have learned the material. Whereas the students who are struggling before the test for various reasons, still struggled on the extra credit quiz. Their grades should not be artificially inflated through curving as they do not have a solid grasp of the material being assessed.

The Study

To determine the effectiveness of the extra credit quiz in motivating student learning, students' scores and the class average score on the original exam were compared to students' scores and the average scores on the extra credit quiz.

The study involved classes in College Algebra (Fall 2016), Applied Calculus I (Spring 2017, Spring 2019), Applied Calculus II (Fall 2016), and Calculus I (Fall 2018). The results are presented in Tables 2-6 below.

Table 2: Number of students in College Algebra who scored in the A, B, C, D, and F ranges on the original test, on the quiz, and after extra credit points were added to their original test score.

College Algebra			
Grade	Original TEST Score	Quiz	New Test Score
A	4	15	14
B	8	3	10
C	11	5	8
D	2	5	4
F	26	23*	15
Class Average	61.9%	59.7%	72.0%

*These numbers include 4 students who scored 0 on the extra credit quiz because they did not take it.

Table 2, above, shows the original test scores and class average in two sections of College Algebra in Fall semester 2016. The average original test score was a very low almost 62% with 12 students in the A and B range and only a total of 23 students passing the exam (a grade of C- or above) and with 28 students failing it. Extra credit quiz scores were much higher with 18 students in the A and B range but still with 28 students failing, although this number includes 4 students who did not take the quiz and therefore scored 0. These four students are responsible for skewing the quiz average so it is less than 60%, even worse than the original test average. In this case, up to $\frac{1}{2}$ or 50% of the points students' lost were added to their original test scores, rather than $\frac{1}{3}$ or 33%. This is reflected in the quite high number of A's and B's after the addition of the extra credit points to the original test score. After this adjustment, 24 students earned A's and B's and 32 students received passing grades, while 19 failed for a class average of 72%.

Table 3: Number of students in Applied Calculus I in Spring 2017 who scored in the A, B, C, D, and F ranges on the original test, on the quiz, and after extra credit points were added to their original test score.

Applied Calculus I Spring 2017			
Grade	Original TEST Score	Quiz	New Test Score
A	11	25	16
B	7	16	20
C	10	9	14
D	12	5	8
F	34	19*	16
Class Average	63.1%	73.1%	75.0%

* This number includes 3 Applied Calculus I students who did not take the extra credit quiz.

Table 3, above, compares the original test scores with the quiz scores and the new test scores with the extra credit points added for three Applied Calculus I sections in Spring 2017. Again, the average on the original exam was a failing grade with 18 A and B grades and 28 student earning passing grades of C- and above, but a majority of the class, 46 students, failing the exam. Forty-one students did very well on the quiz, earning A's and B's, and this boosted the final test scores with the extra credit points factored in. Thirty-six students scored in the A and B range with the addition of the extra credit points to their test score, 50 students passed the exam, with only 24 in the failing range. The exam average was lifted to a very respectable 75%.

Table 4: Number of students in Applied Calculus I in Spring 2019 who scored in the A, B, C, D, and F ranges on the original test, on the quiz, and after extra credit points were added to their original test score.

Applied Calculus I Spring 2019			
Grade	Original TEST Score	Quiz	New Test Score
A	6	25	7
B	5	5	13
C	15	9	20
D	13	6	8
F	22	16	13
Class Average	64%	73.7%	73.8%

Table 4, above, compares the original test scores with the quiz scores and the new test scores with the extra credit points added for three Applied Calculus I sections in Spring 2019. The average on the original exam was a failing grade with 11 A and B grades and 26 student earning passing grades of C- and above, but a majority of the class, 35 students, failing the exam. Twenty-five students did very well on the quiz, earning A's, and this boosted the final test scores with the extra credit points factored in. Twenty students scored in the A and B range with the addition of the extra credit points to their test score, 40 students passed the exam, with 21 in the failing range. The exam average was lifted to almost 74% a C grade.

Table 5: Number of students in Applied Calculus II who scored in the A, B, C, D, and F ranges on the original test, on the quiz, and after extra credit points were added to their original test score.

Applied Calculus II			
Grade	Original TEST Score	Quiz	New Test Score
A	6	13	6
B	4	11	12
C	6	9	7
D	10	7	20
F	24	10*	5
Class Average	63.8%	72.7%	72.0%

* This number includes 3 Applied Calculus II students who did not take the extra credit quiz.

Table 5, above, shows the original test scores, the quiz scores, and the new test scores with the extra credit points added for two sections of Applied Calculus II in Fall 2016. The table shows the low original test percentage of 63.8% with only ten students scoring in the A and B ranges and only 16 students passing the exam with the grade of C- or above. Thirty four students failed the exam. The quiz scores are much better with 24 students in the A and B range and a higher average. Finally, the amended test scores with the extra credit points added in were much better at 18 students in the A and B range and 25 passing the exam with 25 still failing the exam and an acceptable average of 72%.

In is also interesting to look at a higher-level course, Calculus 1 in Table 6. The sample size of 36 students (two sections) is small, but the numbers reflect the reality that students did not study very long for the original test (determined by student reporting of study hours on a self-reflection after the test) and did not seem to study much for the extra credit quiz either. This is evidenced by not much change in the number of D and F grades between the original test score and the new test score with the extra credit points factored in. It is heartening to see that more students pulled themselves from a B to an A grade.

Table 6: Number of students in Calculus I who scored in the A, B, C, D, and F ranges on the original test, on the quiz, and after extra credit points were added to their original test score.

Calculus I Fall 2018			
Grade	Original TEST Score	Quiz	New Test Score
A	6	12	10
B	7	4	6
C	6	7	5
D	2	2	2
F	15	11	13
Class Average	64%	73.3%	71.88%

Table 7, below, takes a closer look at the quiz scores by comparing students' scores on the exam and on the quiz. In Applied Calculus I, Applied Calculus II, and Calculus I a little less than half of the students (49%, 48%, and 47.2% respectively) did much better on the quiz than on the original

exam, their scores went up by at least 10 percentage points. An additional 19.2%, 24%, and 25% of students raised their scores by 2 to 9 percentage points on the quiz. Of course, there will always be students who are not motivated to take the opportunity to earn additional points and stayed the same or did worse on the quiz compared to their scores on the exam.

Overall, these results show that students restudied the material. Further, it seems that most students had now mastered the material, which is the goal of the extra credit quiz. The statistics in Table 7 from College Algebra reflect the same trend. 52.7% of students did better on the quiz than on the original test which shows that students reviewed the material tested and understood it. Surprisingly, 47.3% of students did the same or even worse on the quiz than on the test. That is almost half of the class. So half of the class had not mastered the material. Even extra credit did not motivate this half of the class to study. These results may be explained by the fact that the extra credit quiz was given after the first exam, rather than after the second of three as in Applied Calculus I, Applied Calculus II, and Calculus I. It can be hypothesized that since students were only three to four weeks into a 15-week semester the gravity of their grade situation had not hit and they felt that they would improve on the second, third, and final exam. Therefore, they did not feel motivated to review the material and take advantage of the extra credit opportunity. Further, students in College Algebra are usually in their first or second semester of college and are learning algebraic concepts that are typically taught in high school algebra classes. College Algebra students are, in general, weaker, and less motivated than calculus students. All these possibilities could explain why so many students did the same or worse on the quiz than on the original exam.

Table 7: Students’ quiz scores are compared to their original test scores to see if students scored higher or lower on the quiz than on the original test.

Courses	Score on quiz differed from test score by 10 or more percentage points upward	Score on quiz differed from test score by 2 to 9 percentage points upward	Score on quiz and score on test were about the same	Score on quiz was worse than score on test
College Algebra	(20) 39%	(7) 13.7%	(5*) 10%	(19) 37.3%
Applied Calculus I	(66) 49%	(26) 19.2%	(15**) 11.1%	(28) 20.7%
Applied Calculus II	(24) 48%	(12) 24%	(4***) 8%	(10) 20%
Calculus I	(17) 47.2%	(9) 25%	(6) 16.7%	(4) 11.1%

*This number includes 4 college algebra students who did not take the extra credit quiz and therefore were assigned a score of 0 points or 0% on the quiz.

** This number includes 3 applied calculus II students who did not take the extra credit quiz and therefore were assigned a score of 0 points or 0% on the quiz.

*** This number includes 3 applied calculus I students who did not take the extra credit quiz and therefore were assigned a score of 0 points or 0% on the quiz.

Table 8, below, shows the quiz results for students who scored below 60% on the original exam. The sixty percent cut off was chosen because 60% and below is a failing grade of F. The results show that of the Applied Calculus I and College Algebra students who failed the original exam, about half of these students also failed the extra credit quiz. These students are weak and remained weak. Even the motivation of extra credit to boost their grades in exchange for studying a set amount of the material (the solutions to the original exam and the associated review problems) was not enough to encourage them to study and learn the material. What is heartening are the results of students who failed the original exam but took the opportunity to improve their grades by studying. About an equal number of students improved their grades from F’s to C’s, B’s, and even A’s. These motivated students are the ones who are justly rewarded by extra credit quizzes. They will put forth the time and effort and be rewarded for it. The results from Applied Calculus II are quite good: only 29.2% of students who failed the original exam also failed the extra credit quiz. Therefore,

70.8% of students who failed the original test seem to have studied for the quiz and improved their grades. But the small sample sizes for this class may not reflect results that can be generalized.

Table 8: Analysis of students who failed the original test and their scores on the extra credit quiz.

Courses	Failed test and scored above 90% on quiz	Failed test and scored between 80% and 89% on quiz	Failed test and scored between 70% and 79% on quiz	Failed test and scored between 61% and 69% on quiz	Failed Test and scored 60% or below on quiz
College Algebra	(2) 7.7%	(2) 7.7%	(2) 7.7%	(2) 7.7%	(18*) 69.2%
Applied Calculus I	(6) 10.7%	(8) 14.3%	(10) 17.8%	(6) 10.7%	(26**) 46.4%
Applied Calculus II	(3) 12.5%	(4) 16.7%	(5) 20.8%	(5) 20.8%	(7***) 29.2%
Calculus 1	(0)	(0)	(4) 26.7%	(2) 13.3%	(9) 60%

*these numbers include 4 college algebra students who did not take the quiz and were assigned a score of 0 points and 0%.

** these numbers include 3 applied calculus I students who did not take the quiz and were assigned a score of 0 points and 0%.

*** these numbers include 2 applied calculus II students who did not take the quiz and were assigned a score of 0 points and 0%.

Conclusion

Results from this study show that extra credit quizzes are effective in incentivizing student learning, especially if used after the second of three exams. The unique scoring method of adding up to 1/3 of the points lost on the exam has also been effective in encouraging students to learn the material without giving them unearned points. Further, the quizzes are not too time consuming for the instructor to write and to grade. Finally, giving an extra credit quiz creates a more positive attitude in the classroom in that

students feel that the instructor is working in concert with them to help them succeed and this positive attitude can be crucial for student success.

References

Frankel, Rachel, After the Test: What Now (2016)? Post Assessment Reflection, *AURCO Journal*, 22, 82-93.