



## How Extra Credit Quizzes and Test Corrections Improve Student Learning While Reducing Stress

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Dr. Brian S. Rice is an assistant professor in the Manufacturing and Mechanical Engineering Technology Department at Rochester Institute of Technology since 2016. He joined the RIT faculty after spending over 25 years in applied research while working at University of Rochester Laboratory for Laser Energetics, Lockheed Martin Corporation, and Eastman Kodak Company. Areas of applied research include system dynamics and controls, solid mechanics, heat transfer, and fluid-structure interactions. Dr. Rice specializes in the application of CAE and optimization techniques in the design of efficient electromechanical systems. He currently holds six patents and is lead author on four journal articles.

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### **Abstract**

How does a teacher enhance in-class student engagement while maintaining a non-threatening classroom experience? What can teachers change to make exams a more positive learning experience? Both of these questions address key pedagogical issues that all teachers struggle with in higher education. To address these issues well known pedagogical techniques, in-class extra credit quizzes (ECQ) and optional test corrections, were implemented in a college introductory mechanics class at Rochester Institute Technology. Student surveys that consisted of multiple choice questions and open ended questions were used to judge the effectiveness of these pedagogical factors on learning. Survey results indicate that ECQ and test corrections were implemented in such a way that students believe that their learning was significantly enhanced while maintaining a non-threatening classroom experience. However there is no perfect solution. When using extra credit to enhance learning, care must be exercised to prevent unfairness among students and grade inflation. Details of how extra credit pedagogical strategies were implemented to minimize these negative effects are also discussed.

**Keywords:** stress, anxiety, extra credit, pop quizzes, attention quizzes, test corrections, teaching strategies, learning from mistakes, student engagement

### **Biographic Sketch**

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## 1. Introduction

Typing the search phrase “managing student stress XYZ” into any search engine, where XYZ represents your institution of higher learning’s acronym, will likely lead to a variety of services provided by your institute. In the last decade there has been a significant increase in college students experiencing anxiety, distress, and depression [1-3]. Beiter et al. list academics and the number one source of concern for college students [1]. According to Kohn and Frazer exams, pop quizzes, and being unprepared to respond to questions rank 4, 9, and 13 respectively out of the top 35 academic stress factors listed [4]. The effect of stress on learning, both positive and negative is discussed by Vogel and Schwabe [5], and Finch [6].

Numerous papers have shown that frequent, short in-class quizzes enhance learning. In-class quizzes have been shown to promote student attendance, engagement, completion of pre-class assignments, and provide feedback on performance [7-11]. Performance feedback is useful to both students and teachers in determining what material requires additional study. What can teachers do to reduce student in classroom stress while at the same time improve student learning? It has been shown that extra credit pop quizzes (ECQ) have many of the benefits non-extra credit pop quizzes (NECQ) without a significant increase in student stress [12-15].

Most students and teachers would agree that exams are an unavoidable evil to encourage learning. What can we change to make exams a more positive learning experience? “Failure is instructive. The person who really thinks, learns quite as much from his failures as from his successes.” This famous quote is credited to American philosopher John Dewey. Numerous researchers have shown the positive effect on learning when an optional post exam assignment is used to encourage students to revisit their test and learn from their mistakes [16-18]. Henderson states an added benefit that students experience less stress during the exam when post-test corrections are allowed [16].

Most teachers would agree that pedagogical strategies that promote classroom attendance and engagement, completion of pre-class assignments, learning from mistakes, and feedback on performance would help with student learning. Two such pedagogical strategies, ECQ and test corrections, are addressed in this paper. Implementing these teaching techniques while maintaining a non-threatening classroom environment is key to a successful outcome. The effect of these pedagogical strategies on grade inflation and fairness among students are discussed. These pedagogical strategies were introduced into an introductory engineering mechanics class in the Department of Manufacturing, Mechanical, and Electrical Mechanical Engineering Technology at the Rochester Institute of Technology during the 2017, 2018, and 2019 spring semesters. The course is for Electrical Mechanical Engineering Technology students. The course is taken after Statics and it consists of half semester of Mechanics of Materials followed by a half semester of Dynamics. The success on student learning of these pedagogical enhancements, is based on student surveys.

## 2. Materials and Methods

The implementation of the pedagogical strategies, ECQ and test corrections, to the engineering mechanics class at RIT are described next. The details of the surveys used to judge the effectiveness of these pedagogical enhancements are also discussed. The grading breakdown for this class is shown below.

- In class quizzes (extra credit) 5%
- Homework 20%
- Project 10%
- Four exams 60% (15% each)
- Recitation/Lab 10%

## 2.1 Extra credit quizzes

Thirty-eight and thirty-five (computer based format) extra credit quizzes were given during the 2018 and 2019 lecture classes respectively; approximately 0.87 quizzes per class. If a student received 100% on every extra credit quizzes their final grade would increase by 5%. In general, the same quizzes were given over the two years of the study.

Depending on the difficulty of the quiz students were typically given 5-10 minutes to complete the quiz. Students were encouraged to try and solve the problem on their own first and then discuss the solution methodology and answers with classmates prior to submitting their quiz. Afterwards, as a class we would discuss the results and work out the solution in detail if needed. Typical extra credit quizzes are shown in Appendix C.

## 2.2 Test corrections

Students did not know beforehand if test corrections would be allowed. Four non-cumulative (paper-and-pencil format) exams were given during the semester each worth 15% of their final grade. Test corrections were not allowed on the 4<sup>th</sup> exam (given during finals week) due to time constraints. All four exams were designed to be completed within 50 minutes, though on the 4<sup>th</sup> exam students were allowed up to 120 minutes.

A typical exam was made up of ~4 multiple-choice questions worth a total of ~20% and ~2 non-multiple-choice computational problems (i.e. students perform calculations to find answer) worth a total of ~80%. Graded tests were returned within a few days of test completion. Partial credit, where appropriate, was given for non-multiple-choice problems. No partial credit was given for multiple-choice questions. Test mark-ups only identify where errors were made—not what they did wrong or how to fix it. Optional test corrections were due 1 week after students received their graded tests back. The ground rules for corrections are as listed below.

- No extra credit is given for corrections to multiple-choice questions.
- For any problem(s) a student wishes to redo, the entire problem(s) must be redone on a new sheet of paper.
- Students are allowed to get help from any source available (e.g. classmates, teacher, tutors, internet, etc.) but they must turn in their own solution.
- Test corrections along with the original exam are returned for grading.
- Exam grade is the average of the uncorrected and corrected exams (e.g. initial grade 65%, corrected grade 85%, actual grade is 75%).
- If their original grade was less than 70% the student must meet with their professor for an oral exam based on the test. This oral exam is often repeated multiple times until the student shows they have mastered the material at a level on par with their actual exam grade (e.g. 75% in the above example).
- A few students at random are chosen to meet with their professor for an oral exam based on their test corrections. (This rule was never implemented.)

### **2.3 Surveys**

This study took place during the 2018 and 2019 spring semesters. Class sizes were 22 and 17 for the 2018 and 2019 classes respectively. The same professor taught the course in 2017, 2018, and 2019. The class consists of forty-two 50 minute lectures and fourteen 50 minute recitation/labs. During the last week of classes two (paper-and-pencil format) surveys were given to the students. One survey dealing with the effectiveness of ECQ (see section 2.1) and the second dealing with the effectiveness of test corrections (see section 2.2). The response rate was 95% for the ECQ survey and 79% for the test correction survey over the two years. Each survey consisted of multiple-choice questions and one open ended question (additional comments or suggested improvements). The students were asked not to include their names on responses. Due to the small class sizes the data from the two years was combined for this report. All responses were tabulated by a neutral 3<sup>rd</sup> party and are summarized in Appendices A and B.

## **3. Results and Discussion**

In terms of this study NECQ and ECQ are computer based multiple-choice quizzes that often require numerical calculations and typically are completed in 5-10 minutes.

### **3.1 Extra credit quizzes**

In an effort to enhance student in-class engagement, 53 graded in-class pop quizzes, were introduced into an introductory engineering mechanics class during the 2017 spring semester. These quizzes were a combination of non-extra credit quizzes (NECQ) and extra credit quizzes ECQ. Several students expressed frustration with the NECQ in terms perceived unfairness and the resulting stress pop quizzes caused them. Based on this input, during the last eight weeks of the semester quizzes were almost exclusively ECQ. The simple change of making all quizzes ECQ completely changed the attitudes of those students who were stressed by NECQ. Students' complaints about the unfairness of the quizzes ceased and complaints about not having enough time to complete the quizzes mostly disappeared. The author believes the when quizzes were extra credit they were no longer perceived as a punitive but as a beneficial. This belief is supported numerous studies [12-15].

Based on the perceived success of ECQ in 2017 the author implemented surveys in 2018 and 2019 to get anonymous students input if ECQ were beneficial to their learning. Detailed results of the survey are in Appendix A. Table 1 is a subset of the multiple choice question responses. Sample size was 37 which represented a 95% response rate. The ECQ were introduced to enhance student engagement. Students gave question 2 on engagement a 4.5/5.0 positive rating. Students gave using ECQ again next year a 4.8/5.0 positive rating.

Table 1. Subset of the multiple-choice extra credit quizzes survey results.

question text	average	sample size	% of 1s	% of 2s	% of 3s	% of 4s	% of 5s
2. Did the extra credit quizzes help keep you engaged during class?							
(No) 1---2---3---4---5 (Yes)	4.5	37	0%	3%	3%	35%	59%
6. What most closely represents your emotion when you hear the words Pop Quiz?							
(Relaxed) 1---2---3---4---5 (Anxious)	3.7	37	0%	11%	27%	41%	22%
7. What most closely represents your emotion when you hear the words Extra Credit Quiz?							
(Relaxed) 1---2---3---4---5 (Anxious)	2.0	37	35%	38%	16%	11%	0%
9. Should I do extra credit quizzes next year?							
(No) 1---2---3---4---5 (Yes)	4.8	37	0%	0%	0%	19%	81%

ECQ were used instead of NECQ to reduce students stress. Survey questions 6 and 7 were included to see if this actually happened. A boxplot showing the students' emotional response to hearing the words pop quiz (NECQ) and (ECQ) is shown in Fig. 1. As the boxplot infers, a two sample t-test confirms that the means are significantly different at a 95% confidence valve. Table 2 contains the t-test statistics. ECQ are shown to significantly reduce student stress level compared to a NECQ, a significant benefit to learning [5, 6, 12-15].

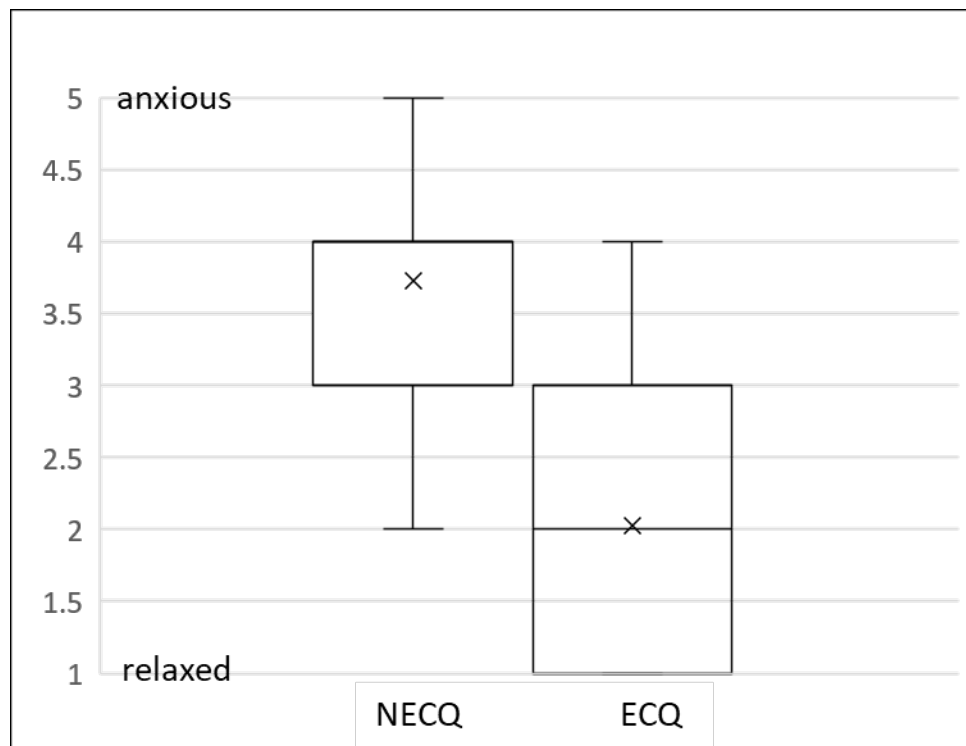


Figure 1. Students' emotional response to hearing the words pop quiz (NECQ) and extra credit quiz (ECQ).

Table 2. T-test confirms that the means are significantly different at a 95% confidence valve.

	<i>Variable</i>	<i>Variable</i>
	<i>1</i>	<i>2</i>
Mean	3.72973	2.027027
Variance	0.869369	0.971471
Observations	37	37
Hypothesized Mean Difference	0	
df	72	
t Stat	7.633638	
P(T<=t) one-tail	3.7E-11	

The students' responses to the open ended survey question (additional comments or suggested improvements) provide additional insight into the effectiveness of ECQ. Below is a subset of student responses.

1. "A little less time with class quietly trying to figure it out. Time could be used more effectively (especially if it is an 8am class)."
2. "Explain the quiz afterwards, leave open longer."
3. "The structure at the extra credit quizzes is ideal for class engagement."
4. "Set work time for each quiz (2 min)."
5. "The extra credit quizzes were very helpful if they were quizzes that could take away points from my grade. I would get very anxious and probably hate them."
6. "The quizzes really brought discussion about the topics and allowed for minds to change about the problems are solved."
7. "Keep the quizzes open a little longer to make sure everybody can submit the quiz."
8. "I honestly do enjoy the use of extra credit quizzes because it is a very good way to know if you have somewhat of a handle on the material".

ECQ were introduced to increase student engagement and provide feedback for both the student and teacher. ECQ were used instead of NECQ to reduce student stress. Student responses 3 and 6 describe how ECQ increased engagement. Student response 5 spoke to how ECQ reduced stress compared to NECQ. Student response 8 explained how they provided valuable feedback. The main issue encountered with ECQ was how long to give students to submit their answers prior to discussing the ECQ as a class. This was expected and was one of the main differences of opinion among students. Responses 1 and 4 wanted less time and responses 2 and 7 wanted more time. Typically the students were polled to see who needed more time. Once ~2/3 of the class were done, a warning was given that ECQ would close in 60 seconds. Next the class was polled to see who got the correct answer. The amount of time spent on reviewing the ECQ was based on this poll.

Three of the main objections made by teachers to ECO are grade inflation, unfairness among students, and additional grading time. A typical student received a 2.7% increase in their final grade as a result of ECQ. A teacher can always make the required work slightly harder to make up for this, but given the benefits provided by the ECQ this author doesn't consider this a significant issue. In order to maintain fairness, all students in class are eligible to participate. As discussed above some students wanted more time and others wanted less. As demonstrated in the 2017 semester, when the quizzes went from NECQ

to ECQ complaints about needing more time virtually went away. Lastly, while time was required to make-up the ECQ, no time was required to grade the electronic quizzes. Based on the survey results, the use of ECQ in this class and others will be continued by the author.

### 3.2 Test corrections

In a further effort to enhance students' learning from their mistakes, test corrections were introduced during the 2018 and 2019 spring semesters. Students did not know beforehand if test corrections would be allowed. Even after test corrections were first introduced students were told future test corrections were not guaranteed. They were informed that test corrections on exam 4 weren't possible due to time constraints. In the 2017 semester test corrections were not used. In the 2018 semester, test corrections were used on exams 2 and 3. In the 2019 semester test corrections were used on exams 1 and 2. Table 3 shows a comparison of exam averages with and without corrections. (Data for uncorrected exam 2 in the 2019 semester is not available.) The recorded score used to compute the final average are shown in gray when corrections were allowed.

Table 3- Test scores with and without test corrections.

year	# samples	exam 1 %	exam 2 %	exam 3 %	exam 4 %	average %
2017-no corrections	21	84	83	83	92	85
2018-no corrections	22	87	65	81	78	78
2018-corrections	22	87	78	88	78	83
2019-no corrections	17	73	N/A	92	81	82
2019-corrections	17	83	86	92	81	85
gray equals test corrections included in grade						

When given the option of doing test corrections 80% of the 61 students participated. Figure 2 is a comparison of exam scores before and after test corrections. (Before and after data exists for 3 out of the 4 times corrections were allowed.) The exam scores (ordinate) in Fig. 2 are the average of the uncorrected and corrected exams. Points falling on the 45 degree line mean that corrections to the original exam were not made. All students with an initial grade below a 60% made corrections. The lower the grade the greater the points that can be gained by making corrections. This is intentional, it encourages students to review and correct their exam that would benefit the most.



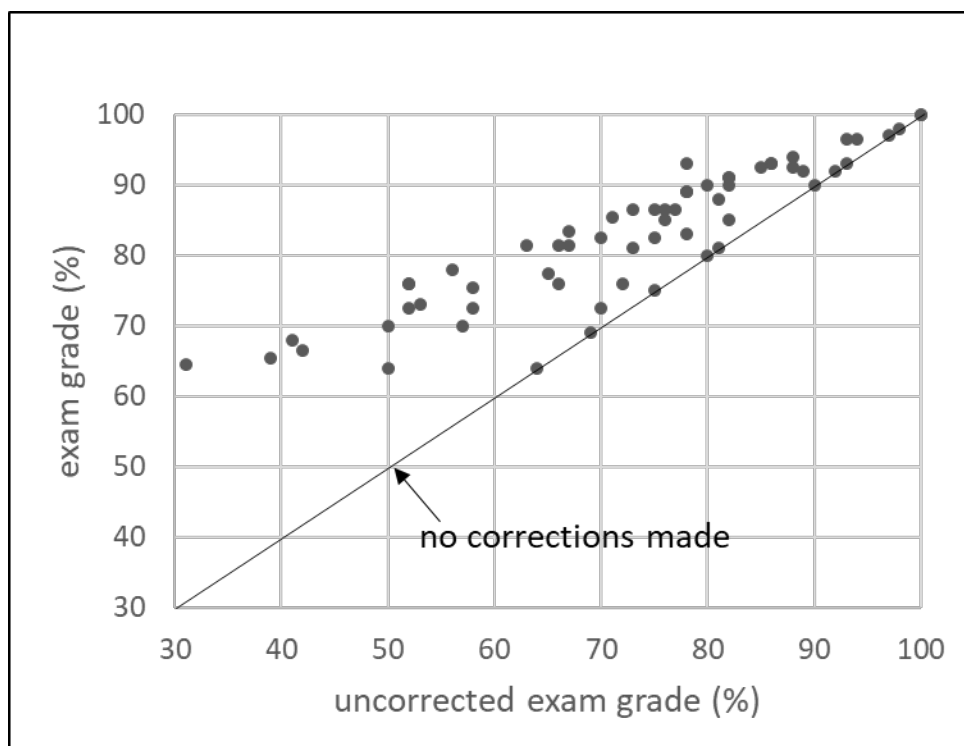


Figure 2. Comparison of exam scores before and after test corrections.

If the student's original grade is less than 70% they had to meet with their professor for an oral exam based on the test material. This is done to verify that these students truly learned the material; versus just copying another student's correct solution. The oral exam is often repeated multiple times until the student shows they have mastered the material at a level on par with their improved exam grade. For example if their initial grade is 65% and their corrected grade is 85% their new exam grade is 75%. In order for the student to receive this grade they had to demonstrate during this oral exam that their knowledge was on par with a 75% exam grade. During these oral exams many students have difficulty explaining how they solved the problems. This often led to student questions and self-reflection by both the student and teacher that allowed both to identify common misconceptions.

Surveys were used in 2018 and 2019 to get anonymous student input to determine if test corrections encouraged learning from their mistakes. Table 4 shows the multiple choice question responses. Sample size was 31 which represented a 79% response rate. As expected student responses to the question—Should test corrections be used next year?—was an overwhelmingly positive 4.9/5. Who doesn't want to significantly improve their grade? But the more important question was, did correcting test mistakes help with material understanding. Again the response was an overwhelmingly positive 4.8/5.

Table 4. Test corrections multiple-choice survey results.

question text	average	sample size	% of 1s	% of 2s	% of 3s	% of 4s	% of 5s
1. Did correcting test mistakes help with material understanding? (No) 1---2---3---4---5 (Yes)	4.8	31	0%	0%	3%	16%	81%
2. Should I do test corrections next year? (No) 1---2---3---4---5 (Yes)	4.9	31	0%	0%	0%	10%	90%

Even more insightful are the students' responses to the open ended survey question (additional comments or suggested improvements). Below is a subset of student responses. (A complete list of student responses is in Appendix B.)

1. "As long as it is unexpected it is beneficial. If corrections opportunities are guaranteed, people will not try as hard."
2. "Doing corrections forces you to see what you did wrong. This shows where your weaknesses are."
3. "Helps understand which parts were incorrect and to redo them correctly."
4. "Great ideas to have students engaged in the test after taking it. Most will get tests back and never look at it again until the final. Test corrections helped to avoid that."
5. "Not only did test corrections help cement ideas, they also saved grades which was extremely important w/each exam being 15% of the final grade."
6. "I like this a lot because it gives me chance to see what I do wrong and fix it. It also helps to meet with you and understand what I do wrong."
7. "Test corrections are a good idea to make students want to figure out what they did wrong. Otherwise students don't correct them."
8. "The test correcting did help understand. It also made me work more for my grade to go up."
9. "I enjoy the test corrections a lot because it allows me to really understand what I got wrong. Instead of just moving on with the material with a still faulty understanding of the material."

Test corrections were introduced with the hope that students would learn from correcting their mistakes. Responses 2, 3, 4, 6, 7, and 9 all discussed the positive effect test corrections had on their learning by revisiting their mistakes. As mentioned previously, if the student's original grade is less than 70% they had to meet with their professor for an oral exam based on the test material. I believe this is the most important rule to participate in optional test corrections. Response 6 reinforces this belief. Only 2 of the responses, 5 and 8, even mentioned grade improvement as a reason to do test corrections. Response 1 suggested that students might not try as hard on the initial test if they know beforehand that corrections will be allowed. One professor I mentioned test corrections to expressed this same concern.

Three of the main objections made by teachers to test corrections are grade inflation, unfairness among students, and additional grading time. When test corrections were allowed the overall class average test score increased by 5% in 2018 and 3% in 2019 (see Table 3). This resulted in their final class averaging improving by 3% and 2% for 2018 and 2019 respectively. This increase in grades, if not justifiable, can easily be offset. For example by making the exams slightly more difficult, but given the benefits provided by test corrections this author doesn't consider this a significant issue. Based on the student survey a significant portion of the grade increase was justified as a result of improved student learning. In terms of fairness all students that received a grade less than 100% are eligible to participate. The issue of

unfairness was never mentioned in the survey by any students nor was this topic ever mentioned to me over the two years of using test corrections.

Finally, since approximately 80% of the tests required regrading, more time was spent grading the exams. Though the increase was minimized by two factors; 1) Initial test grading mark-ups only identified where errors were made—not what they did wrong or how to fix it; 2) In general the test corrections were mostly correct and little to no partial credit is given. One area that did require a significant amount of additional time was the oral exam required for students receiving a grade below 70% on the first attempt. This one-on-one time with students, as mentioned previously, was very beneficial to the student and teacher. Given the small class size it was manageable, roughly an additional ~4 hours per semester was required. Based on the survey results the use of test corrections in this class and others will be continue by the author.

#### **4. Conclusions**

In this study, daily in-class extra credit quizzes (ECQ) and optional test corrections were implemented to enhance student learning in a college introductory mechanics class at Rochester Institute of technology. Based on student surveys (n=37), in-class engagement was enhanced as a result of ECQ while maintaining a non-threatening classroom environment. Based on student surveys (n=31), student learning from mistakes was enhanced as a results of extra credit test corrections. When using extra credit to enhance learning, care must be exercised to prevent grade inflation and unfairness among students. Based on student surveys, ECQ and test corrections were implemented in such a way that unfairness among students wasn't an issue. It is the author's belief that when pop quizzes are made extra credit and exam corrections are allowed, students perceive these activities as less punitive and more beneficial to learning; resulting in lower student academic stress. Both of these changes to the class did however cause grade inflation. On average, students earned 2.7 and 2.5% of extra credit as a result of ECQ and test corrections respectively. This increase in grades, if not justifiable, can easily be offset. For example by making the exams slightly more difficult. Though based on the student surveys a significant portion of this grade increase was justified as a result of improved student learning. Based on the student survey results and the author's experience with the use of ECQ and test corrections, the author will continue their use.

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## Appendix A- Extra Credit Quizzes Survey Results

question text	average	sample size	% of 1s	% of 2s	% of 3s	% of 4s	% of 5s
1. Did the extra credit quizzes aid in your understanding of material covered during class?							
(No) 1---2---3---4---5 (Yes)	4.5	37	0%	0%	14%	27%	59%
2. Did the extra credit quizzes help keep you engaged during class?							
(No) 1---2---3---4---5 (Yes)	4.5	37	0%	3%	3%	35%	59%
3. Were in-class extra credit quizzes a good use of class time?							
(No) 1---2---3---4---5 (Yes)	4.5	37	0%	3%	8%	30%	59%
4. What was the level of difficulty?							
(Too easy) 1---2---3---4---5 (Too hard)	3.2	37	0%	3%	76%	22%	0%
5. Did you find collaborative (group) or individual extra credit quizzes more beneficial?							
(Individual) 1---2---3---4---5 (Collaborative)	3.5	37	5%	8%	32%	35%	19%
6. What most closely represents your emotion when you hear the words Pop Quiz?							
(Relaxed) 1---2---3---4---5 (Anxious)	3.7	37	0%	11%	27%	41%	22%
7. What most closely represents your emotion when you hear the words Extra Credit Quiz?							
(Relaxed) 1---2---3---4---5 (Anxious)	2.0	37	35%	38%	16%	11%	0%
8. How often did you come to class							
(Almost never) 1---2---3---4---5 (Almost always)	4.4	37	5%	3%	3%	22%	68%
9. Should I do extra credit quizzes next year?							
(No) 1---2---3---4---5 (Yes)	4.8	37	0%	0%	0%	19%	81%

### Additional comments or suggested improvements:

- “A little less time with class quietly trying to figure it out. Time could be used more effectively (especially if it is an 8am class)
- The extra credit quizzes are a great incentive to pay attention and participate in class. However, more often than not, I had trouble solving them based on their difficulty
- I know you re-use extra credits so you do not post them online however finding a way to use them to study for exams would be very useful. It would be helpful for the HW's as well
- Q5: As class, groups tended to turn into individual. Add comments: Focus more on course material during class, an ECQ at the beginning to give the students who make class on time is great, although you seemed rushed on the material due to trying to fit in ECQ's throughout class. Instead have them all the end and if you don't get through them all either have them open until following class or until midnight that day.
- ECQS encouraged attendance, but all class material was easily self taught from uploaded lecture slides and the tests easy enough to do well without attendance
- Explain the quiz afterwards, leave open longer

- I would do more paper extra credit quizzes & actually award partial credit on them so that we get awarded for at least giving them an attempt and more importantly for being in class
- The structure at the extra credit quizzes is ideal for class engagement
- When going over problems in class, you sometimes skip intermittent steps. Going through these can be beneficial.
- Don't average all the scores together. If you miss one or two quizzes it tanks your average
- Have students go up to the board to show solutions to extra credit quizzes
- You were and awesome professor this semester. Thanks for a great class.
- Set work time for each quiz (2 min)
- Very well taught class. Easy to understand and professor is very helpful and patient.
- The extra credit quizzes were very helpful if they were quizzes that could take away points from my grade. I would get very anxious and probably hate them
- Spending more time on difficult concepts
- For each exam, the practice exams are helpful but a written overview at specific topics with specific hard work or book problems to reference would be (illegible)
- A good deal of the EC quizzes were in between theory-based & number crunching. It would be better if more were theory based first (analyze problem) then number crunching
- The quizzes really brought discussion about the topics and allowed for minds to change about the problems are solved
- Give more questions related to discussed topic first before complex questions
- Practice problems with step by step solutions
- Show us final answer of extra credit quizzes after we complete the quizzes
- Use pointer to prevent blocking what is being explained
- Keep the quizzes open a little longer to make sure everybody can submit the quiz
- Extra credit that was given and due next class were helpful. Extra credit due 5 mins after it was opened was not always helpful
- Keep up the good work
- I honestly do enjoy the use of extra credit quizzes because it is a very good way to know if you have somewhat of a handle on the material
- Try and get the HW to line up the class. I kinda liked having to almost teach myself some stuff, but some people I know had trouble."

## Appendix B- Test corrections Survey Results

question text	average	sample size	% of 1s	% of 2s	% of 3s	% of 4s	% of 5s
1. Did correcting test mistakes help with material understanding? (No) 1---2---3---4---5 (Yes)	4.8	31	0%	0%	3%	16%	81%
2. Should I do test corrections next year? (No) 1---2---3---4---5 (Yes)	4.9	31	0%	0%	0%	10%	90%

### Additional comments or suggested improvements:

- “I appreciated that tests were generally more easy than HWs, but were still challenging enough to make use of test corrections
- As long as it is unexpected it is beneficial. If corrections opportunities are guaranteed, people will not try as hard. Also, if the class average is high enough it might not be worth it. Also, uploading Practice Exam Solutions at some point ... after the corrections, might be helpful
- Honestly speaking, I have had trouble studying for your test. Partially, it is my own fault, because I usually wanted last minute to do the homework. I think the issue I had was identifying the objective in daily lecture. You give a high amount of information in a short period of time and its often hard to distinguish the fundamental concepts from details.
- I would suggest potentially holding the final exam during the last day of class and then allow for test corrections at the designated time of the scheduled exam by the school to your office where to receive the points back. They have to make believe they considered the material. Test corrections are great because some students while understanding the material suffer from testing anxiety limiting their performance
- They were very beneficial, especially the lottery
- The test corrections can stay the same
- Doing corrections forces you to see what you did wrong. This shows where your weaknesses are
- It's very helpful to go through your mistakes
- Helps understand which parts were incorrect and to redo them correctly
- More clear understanding of examples that appear on the exam
- Great ideas to have students engaged in the test after taking it. Most will get tests back and never look at it again until the final. Test corrections helped to avoid that.
- It is a very fair way to earn points back
- Not only did test corrections help cement ideas, they also saved grades which was extremely important w/each exam being 15% of the final grade
- I like this a lot because it gives me chance to see what I do wrong and fix it. It also helps to meet with you and understand what I do wrong
- Test corrections are a good idea to make students want to figure out what they did wrong. Otherwise students don't correct them
- Mark specifically what is wrong in the question
- The test correcting did help understand. It also made me work more for my grade to go up
- Thanks for the opportunity to improve our learning
- I enjoy the test corrections a lot because it allows me to really understand what I got wrong. Instead of just moving on with the material with a still faulty understanding of the material.”

## Appendix C- Typical Extra Credit Quiz

Find the spring constant  $k$  in terms of  $L, A, E$  for a constant cross section bar under an axial load, hint:

$$k = \frac{\Delta F}{\Delta L}$$

- ☐  $EL/A$
- ☐  $L/AE$
- ☐  $AE/L$
- ☐  $A/EL$

Figure C-1. Typical question from the Mechanics of Material portion of the class, students were given ~5 minutes to answer this question.

The directions of the tangential acceleration and velocity are always

- ☐ perpendicular to each other.
- ☐ in the same direction.
- ☐ collinear.
- ☐ in opposite directions.

Figure C-2. Typical question from the Dynamics portion of the class, students were given ~3 minutes to answer this question [19].