This paper reports on an investigation of a new approach to grading quizzes and the effects it has on students’ performance in mathematics classes. The study examined five honors algebra II classes during the 2012-2013 school year. Students in three of the classes were able to replace their quiz grade with their test grade if it was higher (experimental group). Two of the classes were allowed to drop one quiz per quarter (control group). The study aimed to find if student achievement increased in the groups that were able to replace quiz grades and if there was change in student study habits. It was found through test results that the students with the quiz grade being replaced received a higher class average on a cumulative final. Also, through student surveys it was discovered that this indeed changed a majority of the student’s study habits. This thesis reports on the results and discusses implications for mathematics teaching at the high school level.
Possible Benefits of Quizzes on the Mathematical Achievement in a High School Honors Class

by
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A thesis submitted to the Graduate Faculty of North Carolina State University in partial fulfillment of the requirements for the Degree of Master of Science

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Biography

Joshua Benton Griffin was born on December 17\textsuperscript{th}, 1981 in Baton Rouge, Louisiana and was the son of Robert and Mary Griffin. He moved to Raleigh, North Carolina as a child and then again to Bunn, North Carolina at the start of his teenage years. He graduated from Bunn High School with honors in June, 2000 and began his college career at Vance Granville community college to be closer to home. After his first year of college he transferred to North Carolina State University and completed two years before dropping out due to the passing of his parents. After a three year break he went back to NC State and with the help of Eileen Williams, transferred into the mathematics education program.

Once in the education department he finished his coursework and completed his student teaching at Middle Creek High School under the guidance of Mrs. Chris Kennedy. After graduating in December, 2008 with a Bachelors of Science degree in Mathematics Education, he began teaching at Millbrook High School, teaching Introduction to High School Math and SAT Prep. Once the school year completed, a job opportunity at Middle Creek presented itself and with the help of Mrs. Kennedy, he started teaching at the school where he still teaches today. At Middle Creek he has taught everything from Intro to High School Math and Honors Algebra II. After his 3\textsuperscript{rd} year of teaching, Josh decided he would try to gain a Masters of Education and with help from Dr. Keene and Dr. Hollebrands he returned to NC State. After completion of his Masters of Science degree in Mathematics Education, Josh plans to apply to programs at NC State and UNC to get his Ph. D. in Curriculum and Instruction.
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Chapter 1: Introduction

With mathematics classes increasing in class size and more material being added to the curriculum each year, new pressures exist on teachers to support students’ mathematical learning. It is vital for us as teachers to help them to master the new mathematics they need to learn in any way possible. Sometimes just helping students do their best may be enough. Studies around the world have shown that it is common for students to have weak motivation and are less familiar with strategies they can use to assist them in learning mathematics (Feng & Hung, 2010). I contend this is because there exists a lack of motivational techniques in a mathematics teacher’s instructional arsenal. Through teaching, I have noticed that many students dislike mathematics, but that does not change the fact that every student is required to complete four years of mathematics in order to graduate. Mathematics has sometimes been shown to be the class that has been the reason for the highest number of drop-outs (Helfand, 2006). Even though teacher’s expectations do matter to students in the United States, one of the most critical issues in American education is that these students are not motivated by what happens in their schooling (Pressley, Dolezal, Raphael, & Mohan, 2003). This suggests that students are often not motivated to learn or perform at higher levels.

I first saw the intervention that was used in this thesis research while I was student teaching. A particular student did not do well on a quiz and my co-operating teacher pulled the student aside and made a deal with them. She told them if he did better on the unit test she would replace his quiz grade with that test grade. Although most students rarely use their graded exams to study (Cherepinsky, 2011), this student used their quiz, worked hard, and
mastered the content associated with the questions he previously answered incorrectly. I used this strategy in my own classroom a few years later and it had the same effect. I brought up the idea to do this on a more regular basis to my professional learning team, and it fostered mixed reviews. Their biggest concern was student cramming, which would lead to more information being lost once their knowledge has been utilized on the end of unit test. Cramming is a common bad practice that some students do before being tested. When a student studies unfamiliar facts again and again in immediate succession it makes them feel as if they embedded the information in their memory when it is actually not (Glenn, 2007). Some other concerns include students not taking the quiz seriously, inflating grades, and students not knowing the material when they should.

I felt that these were all valid concerns so I decided to examine this with two semesters worth of Honors Algebra II students all of which used common tests and quizzes. Each semester there was a control group and an experimental group. The control group was told that they would be allowed to drop their lowest quiz grade each quarter. This is a common practice in several high schools in Wake County and is what students at this particular school are accustomed. The experimental groups were told that if their test grade was higher than their quiz grade, they would have an opportunity to replace their quiz grade with their test grade. This experiment was implemented for each class over the entire semester of the course, with data collected in two classes in the first semester and three classes in the second semester. After the second unit in each semester, the class with the highest test average became the control group and was told that their lowest quiz will be dropped each quarter. The remaining class, or classes, were the experimental group and were
told that each quiz grade can be replaced by that units test score if their test score is higher than their quiz score. Each class was taught the same material in the same exact manner by the same instructor. The first semester’s experimental group was constantly motivated by the instructor by being reminded that if they earned a higher mark on their test it would also positively affect their quiz as well. The second semester’s experimental group, although given the same grading opportunity, did not receive the extra extrinsic motivational support by the instructor.

In this thesis, I first describe the literature that serves as a basis for my work. Then I will talk about the methods of data collection and analysis. Finally, I will discuss the results and conclusions.
Chapter 2: Literature Review

Some studies have been conducted with younger elementary students and researchers have found that they are generally highly motivated to learn mathematics. This is because they believe they are competent and that working hard will make them succeed (Middleton & Spanias, 1999). Those in the younger grades do not distinguish between ability and effort as a cause of success in a math classroom (Kloosterman, 1993). This behavior seems to moderate in middle school. Many of the students begin to perceive mathematics as the subject in which smart students succeed and all the other students just get by or fail (Middleton & Spanias, 2013). These student misconceptions are because the belief that success and failure are attributable to only ability and effort only rarely impacts their success. This attitude and belief carries over into high school and has prompted a need for mathematics teachers to address their students’ misconceptions.

When students come into high school with the misconception that effort is not needed nor will it help them, it affects their effort. This lack of effort leads to poor performance and therefore creates a cycle of negative feelings about mathematics for the student. This can lead some besides the student to think that only certain students can learn math or only some students have the ability to grasp certain higher level concepts. Although intelligence is strongly linked to students’ mathematical achievements, it is typically only in the initial development of competence in the subject (Murayama, Pekrun, Lichtenfeld, & Vom Hofe, 2012). Motivation paired with study skills are the most important factors in terms of student growth and this determines their growth in math achievement (Murayama, et al, 2012).
Some studies have looked at two different types of motivation: intrinsic and extrinsic. Intrinsic motivation, or the desire to engage in behavior for reasons such as enjoyment, challenge, pleasure or interest, shows a significant linear decrease as kids approach high school (Lepper, Corpus, & Iyengar, 2005). This decrease has been proven to be correlated with grades and standardized test scores. Some methods of evaluation, like state tests, are the basic reason of student’s detachment from the subject (Shio Kumar, 2012). When students do not perform up to their standards, they lose the enjoyment that comes from learning. Reason for this loss of enjoyment could be because the more students are made to think what grade they will get on an assignment, the more their desire to learn dissolves. This occurs because when students focus on grades, instead of the subject material they are given no opportunities to gain interest in what they are learning. This ironically means that their performance starts to drop (Kohn, 1994).

Grades can be one of the many types of extrinsic motivation, or motivation caused by outside sources. Harter (1978), Maehr and Stallings (1972) suggested that grades are perceived as important sources of control over learning. High stakes testing might be a motivational deterrent, but when used effectively, locally earned grades can help students want to perform well and even refresh their intrinsic motivation. If a student feels like they are achieving their grade goal, the degree to which students become intrinsically engaged in their school work increases. This happens because being successful in one’s studies promotes an appreciation for what one is learning. If the grade goal is not reached it may also intensify one’s concentration on doing better (Covington, 2000). This behavior is more obvious in advanced students, who are more familiar with success (Covington, 2000). One
way to tap into this behavior is to create a grading system that encourages intrinsic reasons for learning. Teachers should be able to provide incentives that actively strengthen and reward a students’ intrinsic motivation (Covington 1999).

Motivation for success students have on mathematics tests can be influenced by a combination of three different components. These components include intrinsic values, attainment values, and utility values (Wigfield & Eccles, 1992). Intrinsic values are the incentives inherent to being engaged in a task. This could be just the pure enjoyment of completing the task. In the field of mathematics this typically would be problems that have some type of active engagement such as a project or a learning lab type of situation. For any assessment, especially one seen in a traditional sense, this is a daunting task for an educator unless each student has a common interest and the test or quiz questions can be put in that particular context. Attainment values are related to competence information. Just like winning a game, students who have success in mathematics courses can be motivated to continue to perform at a high level to achieve this feeling. This success can be an addictive feeling because success can build self-confidence. Studies have shown that the correlation between self-confidence and achievement has been moderately strong (Kloosterman, 1988). In fact, this self confidence in mathematics has the strongest correlation with achievement than any other affective variable (Meyer & Fennema, 1986). Utility values are linked to direct or indirect consequences of performance. Punishment and reward are strong motivators for teenagers. Punishing students however for a bad performance can hinder test motivation. This can lead to a gradual change to the stress of hopelessness and helplessness (Willis, 2010)
Whatever value or values may impact test motivation, there are a few things that can influence and increase motivation. Improving the quality of the test items, embedding item in a context which has potential for information /control and offering incentives contingent on test performance (Baumert, 2001) are several things an educator can do to help students with testing motivation. With the Common Core State Standards (2010) wide-spread adoption, educators all over the nation are trying to not only improve the quality of the test questions but also include context meaningful to students. Besides stickers or a name on the wall, incentives to test performance, until now, have typically been left up to parents/guardians. As educators we should never underestimate the strength of an incentive, even the small ones (Kouyoumdjian, 2012). These incentives are also detrimental to students’ intrinsic engagement if misused or taken away. If the rewards are no longer available students have shown that they will display little or no inclination to continue their studies (Covington, 1998). This means that the will to learn for the students own sake can potentially be destructive by the impact of tangible rewards (Covington, 2000).

In summary, students coming into high school at one given time probably have been motivated to learn mathematics. This motivation typically was produced by a fear of mathematical failure. Unfortunately for secondary teachers, this time is typically seen in the younger grade levels. Since then, student’s motivation and mathematical self-worth have seemed to be reduced. This motivation however, either extrinsic or intrinsic, has not fully disappeared. There are several different ways that we as educators can bring this motivation back within our students. Studies have shown that success yields self-confidence. This confidence in itself can spark intrinsic motivation within a student. The problem with giving
our students success is at time it is not always possible. For some students success takes practice and we as educators cannot always make our students practice.

We can however provide other types of motivation besides confidence building that can lead our students to practice that will yield this success. If we come up with an intrinsic grading system such that it encourages students to learn by offering incentives contingent on test performance, then the students will be pointed in the direction of success. This system will have to also actively strengthen and reward a students’ intrinsic motivation. The grading practice will have to give students the feeling of control. When students believe they can control their outcome this in itself will give them motivation to try (Martin & Martin, 1983). This new mentality is similar to that of the one the students had in their younger years and can elevate students into the mindset that they too can succeed in mathematics yet again. A mentality such as this in turn will hopefully motivate students to work harder and that will help increase the students overall learning and understanding.
Chapter 3: Methods

Setting

This experiment was conducted in five honors Algebra II classes, during the 2012-2013 school year. Each class was made up of over thirty high school students whose grade levels ranged from the 9th to the 11th grade. The school is set up on a block schedule which means each semester a student will have four ninety minute classes. The Fall 2012 semester was composed of one experimental class and one control class, while the Spring 2013 semester was composed of two experimental classes and one control class. In all, one hundred and sixty eight students participated in this study (see Table 1).

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Number of students in experiment</th>
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<tbody>
<tr>
<td><strong>Number of Students in First Semester</strong></td>
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<tr>
<td>Control Group</td>
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<tr>
<td>Experimental Group</td>
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</tr>
<tr>
<td><strong>Number of Students in Second Semester</strong></td>
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<tr>
<td>Control Group</td>
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<tr>
<td>Experimental Group</td>
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</tr>
<tr>
<td><strong>Total Number of Students</strong></td>
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</tr>
<tr>
<td>Control</td>
<td>69</td>
</tr>
<tr>
<td>Experimental</td>
<td>99</td>
</tr>
<tr>
<td><strong>Total Students:</strong></td>
<td>168</td>
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I was both the researcher and instructor for all of these classes. Before this experiment I had three and a half years of teaching experience. Three of the semesters prior to the experiment, I taught at least one section of Honors Algebra II. I was very familiar with the subject and had taught all concepts that were taught in the experiment prior to the school year. I was a recent graduate from North Carolina State University in mathematics education; however teaching is my second career. Before teaching I spent time managing a restaurant and was experienced with working with teenagers. I have a high energy teaching style that focuses on the use of technology in cooperative, student centered lessons. This teaching style is a product of research based knowledge gained from undergraduate and graduate school at North Carolina State University. I am a strong advocate for student success and believe parental communication is key to help the student reach their potential of success. This has led me to send out emails to all parents each unit describing important test and quiz dates, data from previous test results as well as key concepts they should see their student practicing.

Participants

The distribution between boys and girls in each of the classes can be seen in Table 2.
Each total semester was composed of more girls than boys; however the second semester’s control group had more boys than girls. These students were honors level students that elected to sign up for a more rigorous course that is on a higher GPA scale (meaning an A would earn a 5.0 instead of a 4.0). Some of these students have been in honors mathematics for the previous two mathematics courses, and for others this is their first honors level mathematics course. The high school in which this experiment was conducted is in a suburb of a large city in the southeast United States and is mainly composed of middle to upper class families.
Procedure

Fall 2012

For the first two units, or chapters, I treated both classes in the same way and taught the class the same as in previous semesters. The only difference was I asked both classes to sign release forms and told them that I was conducting an experiment. They were told they would find out some of the specifics of the study later in the semester. During this time I kept track of the quizzes from both classes as well as the test data. A t-test revealed that the scores on these quizzes and tests were not significantly different; however, one class scored higher on the first test and quiz, and the other on the second unit’s test. This was done using an excel spreadsheet, where a t-test was performed on the entire classes’ test averages. Since the classes were not significantly different, I decided to use the class with the lower second unit test scores as my experimental group and the other as my control group. During the first semester, my control group was during 1<sup>st</sup> period while my experimental was during 4<sup>th</sup> period. For the second semester the control group was 2<sup>nd</sup> period while my experimental groups were 1<sup>st</sup> period and 4<sup>th</sup> period.

After the unit three quiz, I told the control group that they were getting an extra perk that the other class was not getting; at the end of the semester I would drop their lowest quiz grade. They were then told that my other class was not going to be given this opportunity. Undisclosed to them, this is typical in the math department at my school and several others in the county. The control group thought they were being treated more favorably and were told that if they talked to the other class then their privilege would be taken away and given to the
other class. I then told my experimental group if their test score is higher than their quiz score for each unit, I would replace their low quiz score with their higher test average. To keep the experimental group from talking to the control group, they were also made to think they were the only ones getting an extra perk. My rationale was that neither class wanted to give away what they thought was help so they would not talk about my research with the other class. I told them that I would only make the switch right before the end of the semester just in case someone ruined my experiment. In both classes, the quizzes were graded within a day and then handed back for students to do what they choose with them, however, they were asked to keep them to be recollected at a later date. After each test, the quiz from that unit was collected and the quizzes and tests were held together in a secure location. Each quiz and test was graded exactly the same. Points were awarded based on certain steps shown, and a rubric was used in order to help the grader be consistent.

Spring 2013

This process was repeated during second semester except I used three honors Algebra II classes and used the lowest two classes as my experimental group. During the first few weeks of the semester, I collected data on the quizzes and tests again, and the classes were still not significantly different. I decided to choose the class with the highest average of the combined two unit tests. The class with the highest test average also had the highest overall quiz average see Table 5. This class became my control group and the other two classes my experimental groups. I repeated the explanation of the procedure for introducing the use of the test to replace quiz scores in the experimental class and dropping the lowest quiz in the
same way as first semester after quiz 3 Regardless of the semester or class, the deception proved to work because none of the classes talked to anyone outside their own class about what was going on with our arrangement.

As stated in the IRB (Appendix C), immediately before grades were turned in all classes received both benefits. This kept grades consistent with one another and enabled me to conduct this experiment while being fair to both groups. Each semester’s classes were led through the same exact lessons and given the same assignments. As in the first semester experiment, the quizzes were graded within a day and then handed back for students to do what they choose with them, however, they were asked to keep them safe to be recollected at a later date. After each test, the quiz from that unit was collected and the tests and quizzes were held together in a secure location.

Differences in Intervention by Semester

The only difference between first and second semesters other than dropping/replacing of quiz grades was the motivation tactics used after the quizzes were graded. In the first semester, the control group was reminded after each quiz that if they did poorly, they would be allowed to drop their lowest quiz grade. We also discussed that because only one quiz was going to be dropped, the students would need to do their best on each test. I told the experimental group something different after their quizzes were returned. They were told that if they were unhappy with their quiz they had a chance on the next test to replace it if they received a higher mark. These speeches seemed to help the students in the experimental group focus during class and typically led to a very productive class following the pep talk. This
intervention, Intervention 1, was only done first semester. The difference between the first and second semesters’ experimental groups was the motivational remark I used in my speeches. During the first semester (Intervention 1) I would remind the experimental group students that if they put forth more effort and earned a higher grade on their test, it would replace their quiz score. I reminded students this fact every day between their quiz and test. Because of the results found in the first semester, which will be discussed later, I toned down the frequency of my speeches in order to see if they were the cause of the experimental classes’ success. This intervention, Intervention 2, happened during the second semester with two experimental classes versus the one control class.

Data Collection

The honors Algebra II curriculum has been broken down into 12 chapters or units. Most of these units have one quiz, however there are two units that have two quizzes. The breakdown of topics can be seen in the Table 3.
Unit 4, Quadratic Applications, does not have a quiz due to a projectile motion lab that takes the place of a quiz. Also, Unit 9, Operations on Functions does not have a quiz because it is a 3 day mini unit. The unit 9 assessment counts as a quiz grade therefore no test grades are given for Unit 9. All of the tests are free response except for the Unit 6 (Rational Expressions) where there are some multiple choice. Partial credit is awarded on every test and quiz based upon correct steps being shown. For example on the absolute value test, if a question where a student has to solve an absolute value equation is worth 4 points and student could set up the problem correctly into two equations but could not solve the each equation correctly, then they would be awarded 2 out of the 4 points. The tests typically take

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic</th>
<th>Number of Quizes</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Absolut Value Equations/Functions</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Factoring &amp; Radicals</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Complex Numbers &amp; Quadratic Equations</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Quadratic Applications</td>
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<td>5</td>
<td>Cubic Functions</td>
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<td>6</td>
<td>Rational Expressions</td>
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</tr>
<tr>
<td>7</td>
<td>Rational Functions</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>Matrices &amp; Systems</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>Operations on Functions</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
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<tr>
<td>11</td>
<td>Logarithms</td>
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</tr>
<tr>
<td>12</td>
<td>Conics and Circles</td>
<td>1</td>
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</tbody>
</table>
an entire class period which is 90 minutes where the quizzes typically take about half of the
class period (45 minutes). Each test has a bonus worth 5 points extra credit for a maximum
score of 105. Each bonus is all or nothing meaning there is no partial credit for a bonus. An
eexample of the Unit 11 test and quiz can be seen in the Appendix.

As well as the test and quiz data, written surveys were given to each of the classes. At
the end of each semester, every class was asked a series of open ended questions about the
experiment. I chose open ended questions because I did not want to influence their responses
with options. The first two questions were provided before the experiment was fully
explained so students could reflect on what they experienced. After those two questions
were recorded then students were made aware of the complete experiment and both grading
practices. (To ensure students were not upset about not receiving what the other class was
given, all classes were told that they would receive the benefits from the control group and
the experimental group.) Next students were asked several questions that had them compare
the two grading practices and how they perceived it would affect them. These questions can
be seen below:

Control Questions

1. What are the benefits of dropping your lowest quiz grade?

2. After I gave you your quiz back what did you do with it? Did you look over
   it?

3. Could you think of anything else that would inspire you to go over missed
   material?
4. Out of both methods which do you think would help you more and why?

5. How would each method make you feel about the quiz/test and their importance?

Experimental Questions

1. What do you think are the benefits of replacing the quiz grade with a higher test grade?

2. After I gave you your quiz back what did you do with it? Did you look over it?

3. Could you think of anything else that would inspire you to go over missed material?

4. Out of both methods which do you think would help you more and why?

5. How would each method make you feel about the quiz/test and their importance?

Quantitative Data Analysis

In this section, I explain the data analysis on quizzes and tests that were performed. After each semester I printed out all of the students grades and saved them into a folder. Once the semester was over, I changed the students names to numbers (to maintain anonymity) and entered all of these grades into an excel spreadsheet. After all of the data was entered I used the excel spreadsheet to compute class averages for each test. I completed a t-test on the first two pre-implementation units then again on the final exams to see if the
class averages were statistically significant different from each other. When we express that our results are statistically significant we stating that the probability of our data being this different is not due to chance alone but to some factor in the experiment. I recorded all of the quantitative data and data analysis on a separate sheet and made tables out of my findings using excel. A t-test is a statistical test that assesses whether the mean of two groups are statistically different from each other. It is especially appropriate whenever you want to compare using a two group randomized experimental design. This is appropriate in this study because we are comparing the means of two different group’s class averages. The first two test t-tests on the pre-implementation tests confirmed that there was no significant difference in achievement in the classes. All p-values were over .10 with an alpha level of .05. The rest of the scores are discussed in the results chapter.

In addition to looking at just test and exam scores, another way to look at how students’ achievement changed was to consider if students’ learned from the mistakes they made when on the test. To do this, I chose one chapter, Chapter 11. I looked at 4 similar questions that were seen on both the quiz and the test. I tallied how many students missed one of these quiz questions then examined their test to see if they made the same mistake twice.

Qualitative Analysis

The surveys given at the end of the semester in each class were collected and stored until the end of the school year. At the end of the year, responses were typed in an excel
spread sheet and sorted based on content. For the first question responses were sorted into seven different “bins” based on the context of the response with the caveat that a response to be counted in multiple different bins. The different categories include:

- No benefit
- Raises grade
- Motivated to achieve at a higher level
- Causes less stress
- Keeps student focused
- Chance to redeem their self
- Gives more time to learn

If a student mentioned anything about their overall numeric grade in the class it was coded as such. Otherwise, the response was coded to main point the student was trying to portray.

The second question asked was a “yes” or “no” question; however there were some responses that stated that the experiment had no effect, so the data was sorted into three categories; yes, no and no opinion. The third question asked students to come up with an idea that would help motivated students to work harder to understand missed material. This question was looked at, but found to have very little relevance to the study. The fourth question asked which method they thought would help them more. Still there were some students that expressed either both would have the same effect or they had no opinion. This led to three different categories; Replace, drop or no opinion. The fifth and final question asked students to express how each method would make them feel about the test or quiz. Just like the third
question, this was found to have no correlation to the study and has been left out of the findings. After all of the surveys were recorded and read, pie charts were made that represented the findings for three of the five questions in order to get a side by side comparison.
Chapter 4: Results

This experiment had both quantitative and qualitative results. This chapter discusses the pre-implementation quantitative results before any of the post-implementation results. The post-implementation quantitative results are discussed before the qualitative results and are separated by semester due to the different interventions used for each semester. A brief comparison between the semesters quantitative data is given and an example of the results in a later unit is given. After, the qualitative results are discussed for the entire school year including actual student comments.

Quantitative Results- Pre-experiment

The first semester’s pre-implementation assessments can be seen in Tables 4-5. These class averages were used to determine which class would be the control group and which would be the experimental group.

| Table 4 |
|---------------------|-----|-----|-----|-----|-----|
| **First semester pre-implementation scores** |     |     |     |     |     |
| **Test Scores**     | **T1** | **T2** |     |     |     |
| CONTROL             | 94.18182 | 89.09375 |     |     |     |
| EXPERIMENT          | 96.31429 | 88.37143 |     |     |     |
| **Quiz Scores**     | **Q1** | **Q2.1** | **Q2.2** | **Q3.1** |     |
| Control             | 94.91176 | 92.63333 | 95.35294 | 89.53125 |     |
| Experiment          | 94.88235 | 91.65714 | 98.84848 | 84.48529 |     |
As stated previously, the control group earned a lower initial unit one test score, however they outscored the experimental group in three out of four quizzes and on the test that was closest to implementation of the experiment.

During the second semester three classes were involved in the experiment. Just like in the previous semester, pre-implementation data was evaluated in order to deduce which class would remain the control group. Below is a table that scores the pre-implementation results for the second semester’s test and quiz averages.

### Table 5
**Second semester pre-implementation scores**

<table>
<thead>
<tr>
<th>TEST AVERAGE</th>
<th>T1</th>
<th>T2</th>
<th>Combined Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTROL</td>
<td>94.36364</td>
<td>88.94115</td>
<td>91.65241</td>
</tr>
<tr>
<td>EXPERIMENT 1</td>
<td>92.34483</td>
<td>89.83333</td>
<td>91.08908</td>
</tr>
<tr>
<td>EXPERIMENT 2</td>
<td>94.19355</td>
<td>87.24138</td>
<td>90.71746</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>QUIZ AVERAGE</th>
<th>Q1</th>
<th>Q2A</th>
<th>Q2B</th>
<th>Q3A</th>
<th>Combined Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTROL</td>
<td>86.47059</td>
<td>94.5</td>
<td>94.14706</td>
<td>95.60606</td>
<td>92.68093</td>
</tr>
<tr>
<td>EXPERIMENT 1</td>
<td>84.875</td>
<td>93.74074</td>
<td>94.77419</td>
<td>95.04516</td>
<td>92.25877</td>
</tr>
<tr>
<td>EXPERIMENT 2</td>
<td>85.54839</td>
<td>91.8</td>
<td>94.32258</td>
<td>93.87097</td>
<td>91.38548</td>
</tr>
</tbody>
</table>

As seen above in Table 5, the class that had the highest combined average in not only the quizzes but also the tests was chosen to remain the control group.
Quantitative Experiment Results

The findings in this section are separated into the two different interventions that were performed in the two semesters. Intervention 1, done in the first semester, is given first with the test results being show before the quiz results. Intervention 2, done in the second semester, has two experimental groups and is first broken down class by class for tests and quizzes before the experimental groups are combined. Just like Intervention 1, Intervention 2 has test scores being displayed before the quiz scores.

Table 6 has the numerical values for each of the post-implantation test results for Intervention 1. These tests included Test 3 through the cumulative final exam. Tests 4 and 9 are not included because those units did not contain quizzes and therefore are not applicable.

<table>
<thead>
<tr>
<th>Test Scores</th>
<th>T3</th>
<th>T5</th>
<th>T6</th>
<th>T7</th>
<th>T8</th>
<th>T10</th>
<th>T11</th>
<th>T12</th>
<th>Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTROL</td>
<td>86.61818</td>
<td>85.43333</td>
<td>97.5</td>
<td>87.15385</td>
<td>92.1875</td>
<td>94.33333</td>
<td>84.9375</td>
<td>91.36364</td>
<td>85.14</td>
</tr>
<tr>
<td>EXPERIMENT</td>
<td>90.09375</td>
<td>89.32353</td>
<td>93.91667</td>
<td>91.35485</td>
<td>94.5</td>
<td>96.54545</td>
<td>90.76471</td>
<td>95.5625</td>
<td>88.28656</td>
</tr>
</tbody>
</table>

Figure 1 below shows a visual representation from the tests and the final (exam created by me) during the first semester. As stated previously an intervention (Intervention 1) was used where the instructor provided extra motivation by reminding students in the experimental group that they could improve their overall score if they earned a higher score.
on the unit test. A double vertical line has been drawn to show where the implementation of the experiment took place. Every score to the right of the line is when Intervention 1 has been implemented.

![Figure 1: Graph of first semester's tests and final averages (Intervention 1)](image)

As described earlier, the first two unit test scores were combined and a t-test was performed to show that these score were not significantly different (alpha level of .05). The nine remaining tests (after the classes were told about the dropping/replacing of the quiz grades) show that with an exception of one unit, the experimental group was consistently higher than the control group. The cumulative state-authored final also shows a three point difference after a square root curve is implemented for both classes. After the curve, the control group’s average was an 85.1 while the experimental group’s average was an 88.2.
However, before the curve the control group’s average was a 64.14 and the experimental group’s average was a 69.14. A t-test, seen in Table 7, revealed that these scores were significantly different with an alpha level of .05. This means that the classes went from being similar to being significantly different after a semester’s worth of material.

\begin{table}
\centering
\begin{tabular}{|l|c|}
\hline
\textbf{Test 1/2} & \\
\hline
\textbf{t-test (1 Tail)} & 0.396497 \\
\hline
\textbf{Experimental Average} & 92.21739 \\
\textbf{Control Average} & 91.67692 \\
\hline
\end{tabular}
\end{table}

The data also addresses the concerns of some teachers with regards to the quiz averages dropping after students finding out they can just use their test grade as well. Table 8 shows the numerical results of each quiz average for the first semester.
The higher averages are highlighted and two thirds of the quiz averages are higher in the experimental group. Figure 2 shows another visual representation of the quizzes in the same semester.

![Graph of first semester's quiz averages](image)

**Figure 2:** Graphs of first semester's quiz averages
As far as quizzes the experimental group earned scores fairly close to that of the control group, if not slightly higher. As shown above, there is a jump for both groups after quiz 3.1 when the experiment was revealed to the classes. The experimental group’s average rose while the control group’s average dropped. I contend that the control group found out that one of their lowest quiz grades would be dropped and because of this, some of the students studying could have gotten lackadaisical or comfortable in not putting forth the effort needed to learn the material. On the other hand, the experimental group just received a wakeup call from the previous quiz. They now know that if they do better on the test, they can replace their lower quiz score. Because of this, the experimental class displays a higher level of focus as mentioned previously which could explain the rise in the class average. This may be true because, when students attribute their failure to lack of effort opposed to a lack of ability, it can cause the student to pursue a “mastery-oriented cognition-affect-behavior” pattern. This can be characterized by optimism; positive emotions; constructive self-improvement attempts; and sustained or enhanced effort, persistence and performance (Dweck, 1999)

Unit six was the only when the control group’s test average was higher than that of the experimental group. This can be explained by looking at the quiz average for unit six. The control groups quiz average was just above a 78 which to a high school student on a seven point grade scale is a low C. I have found that a low C to an honors student does not typically fit their grade goal. I think these students usually expect an A or B in each of their classes because they are competing to get into college. Falling short of their grade goal in some cases may intensify a student’s concentration on doing better (Covington, 2000).
The motivation seen in the control group similar to the motivation I am trying to elicit in the experimental group during this experiment. I contend that the problem with this reaction in the control group is that it will be short lived, hence why there is only one spike like this in the control group's data. Once a student continues to fail assessments, and they continue to see bad grades, their self-worth starts to drop. This will not only damper their motivation, but it will also start a downward trend in their average. When students fail on a regular basis, learned hopelessness sets in and causes student resignation and academic withdrawal (Au, Watkins, Hattie & Alexander, 2009).

The second semester’s data was collected from three honors algebra II classes; two were experimental classes where students believed I would replace quiz averages with tests when higher, and one was a control class, where students believe that I would drop the lowest quiz at the end of the semester. Table 9 shows the numerical test averages for all three classes. One of the major differences is that the experimental group scores are not consistently higher than that of the control group.

<table>
<thead>
<tr>
<th>TABLE 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second semester post implementation test results (intervention 2)</td>
</tr>
<tr>
<td>TEST AVERAGE</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>CONTROL</td>
</tr>
<tr>
<td>EXPERIMENT 1</td>
</tr>
<tr>
<td>EXPERIMENT 2</td>
</tr>
</tbody>
</table>
Figure 3 is a graphical representation of Table 9. Looking at figure 3, it is clear that there are some differences and similarities between the semesters. Although there are instances where an experimental group is higher, it is only in a minimal number of units that this occurs.

![Second Semester Graph](image)

**Figure 3: Graph of second semester’s tests and final averages (Intervention 2)**

Table 10 shows the actual combined test averages of the experimental groups with the second intervention compared to the second control group. The highest average for each test is highlighted.
Table 10

Second semester post implementation combined test results (intervention 2)

<table>
<thead>
<tr>
<th>Combined Test</th>
<th>T3</th>
<th>T5</th>
<th>T6</th>
<th>T7</th>
<th>T8</th>
<th>T10</th>
<th>T11</th>
<th>T12</th>
<th>MSL</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTROL</td>
<td>89.13793</td>
<td>91.1875</td>
<td>90.40625</td>
<td>89.75758</td>
<td>91.76788</td>
<td>94.14815</td>
<td>92.67742</td>
<td>90.94118</td>
<td>90.32353</td>
</tr>
<tr>
<td>EXPERIMENT</td>
<td>87.96667</td>
<td>89.9861</td>
<td>92.67097</td>
<td>90.5</td>
<td>92.66667</td>
<td>93.40741</td>
<td>92.55</td>
<td>91.52381</td>
<td>91.1129</td>
</tr>
</tbody>
</table>

Figure 4 combines the averages of the experimental groups to see a visual comparison between the two types of classes.

![Graph](image)

Figure 4: Graphs of second semester's combined test and final averages

Looking at both of these charts one can see it takes a while for the experimental group’s class average to surpass the control group’s average. The reason behind this could be due to the lack of motivation provided by the instructor. With the previous semester the students were...
instantly reminded of the impact of a high score on a test. Although students were aware of what was going on, it may not have registered what the extra effort would do to their course average. I hypothesize that the students thought their grade would instantly go up without the extra effort. It wasn’t until after the sixth week’s progress report that the students made the connection that they were wrong and were able to motivate themselves to achieve their full potential. From then on the experimental group’s combined average stayed at or above that of the control groups with the exception of unit ten to which they were only six tenths behind.

One thing that mirrored the results of the first semester was the success of the experimental groups state-authored final exam score. This final exam, instead of a teacher made final exam like in the first semester (Implementation 1), a state mandated standardized test was given instead. Although the scores this time were not significantly different in the second semester, each experimental class was still over a point higher on the state test whose scores were determined by taking the fourth root of the raw score. This “fourth root curve” took the students raw score (written as a decimal) and took the fourth root of it. This changes a .25 to a .70. Before the curve, the each experimental group’s average was a little over three points higher than that of the control group’s average. At the start of the semester the overall average of the experimental group was over a point and a half below that of the control group. At the end of the semester, the experimental group’s scores ended up being over a point and a half above. The two and a half point swing may not be statistically significant, but it still shows improvement in the student’s overall achievement in this set of data. What is surprising with the second semesters’ data was the lack of involvement from
the instructor paired with the success of the student. This data shows that students without motivation provided by the instructor, scored higher on a cumulative test, when they initially scored a point lower.

The quizzes for this unit were very similar to that of the previous semester. The post-implementation averages for all three classes are displayed in Table 10.

Table 11
Second semester post implementation quiz average (intervention 2)

<table>
<thead>
<tr>
<th>Quiz Average</th>
<th>Q3B</th>
<th>Q5</th>
<th>Q6</th>
<th>Q7A</th>
<th>Q7B</th>
<th>Q8</th>
<th>Q10</th>
<th>Q11</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTROL</td>
<td>88.1875</td>
<td>87.90323</td>
<td>75.77419</td>
<td>87.81818</td>
<td>88.18182</td>
<td>89.90909</td>
<td>92.4</td>
<td>74.62069</td>
</tr>
<tr>
<td>EXPERIMENT 1</td>
<td>73.06652</td>
<td>88.16667</td>
<td>87.33333</td>
<td>90.45161</td>
<td>86.66667</td>
<td>90.12903</td>
<td>86.75</td>
<td>74.42857</td>
</tr>
<tr>
<td>EXPERIMENT 2</td>
<td>75.38889</td>
<td>77.03704</td>
<td>78.33333</td>
<td>90.7931</td>
<td>82.92857</td>
<td>94.41935</td>
<td>90.67857</td>
<td>73.44</td>
</tr>
</tbody>
</table>

Figure 5 shows another visual representation of the quizzes of all three classes. Although a little cluttered, it can be seen that these quiz scores were close to one another.
There are a few quizzes that have the control group significantly higher than that of the experimental groups. The most noticeable is that of quiz 3B. This is the first quiz after the explanation of the project. Since I decided not to discuss the implications and possible benefits of this, it seems that the students were not motivated in their studies as was predicted by some experienced teachers. This suggests that it is highly important for an instructor to fully explain and spend some time on how this can help students’ growth and achievement. Below is a table with the experimental group’s combined quiz average.

Figure 5: Graph of second semester's quiz averages
The higher average for each quiz is highlighted. Just as the previous semester, the control group did not earn higher averages on all of the quizzes. Figure 6 shows another visual representation of the quiz averages from both groups.

![Second Semester Graph](image)

**Figure 6: Graph of second semester's combined quiz averages**

When we look at both of the experimental groups combined, it shows that with the exception of quiz 3B and quiz 4, the quiz scores are fairly close to one another in averages. This could
also be justified very similarly to the test scores. Yet again, it wasn’t until the second progress report at week 6 that the experimental group’s average started to climb.

Conclusions

The results suggest that when teacher-produced motivation is paired with students’ internal motivation, this new method of grading could help increase students’ achievement on their exams. This achievement could be contributed to many different factors although it would be difficult to conclude what that factor is for each individual student. One factor that may help explain the success would be student use of the quizzes. I have already noted that students typically do not go over previous assessments, but one thing that was observed with the experimental groups was the use of the quizzes. Each student that did not perform well used their quiz in order to learn previously un-mastered material. This evidence can be seen by the reworked questions that were missed in the experimental groups’ quizzes. Although this is not done by every student, it still is seen which was not apparent in any of the control groups’ quizzes.

Additional Quantitative Analysis

For each unit there were several quiz questions that were similar to what the student will see on the test. Although the numbers were different, the process in which they are solved was the same. In this section I report on the analysis of the quizzes and tests in one particular unit to see if students missed a similar question for the same reason by first looking at the quiz then comparing it to the work that was shown on the test.
Basic logarithmic properties and concepts are taught in Unit 11 and had one of the lowest quiz averages in both semesters. The appendix has an example of the quiz (Appendix B) and test (Appendix A). For this unit there were 4 questions on the quiz that assesses the same concepts which were on the test. For example quiz question 5 is very similar to the 8th question on the test and can be seen below.

Quiz #5)                      Test #8)

Although the numbers are different, both questions require students to go through the same process in order to solve. Other corresponding questions can be seen in Table 13 below.

<table>
<thead>
<tr>
<th>Quiz</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
</tr>
</tbody>
</table>

Out of these 4 questions there were 22 instances in the experimental group in which a student missed one of these questions. As seen in Table 14, 72.7% of the time the student that missed the quiz question got the concept correct on the test. For the control group there were 29 instances in which a question was missed. For this class only 62.1% of the time the student corrected their mistake and got the question correct on the test.
Table 14

Unit II test and quiz comparison (intervention 1)

<table>
<thead>
<tr>
<th></th>
<th>Missed on Quiz</th>
<th>Corrected on Test</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td>29</td>
<td>18</td>
<td>62.06897</td>
</tr>
<tr>
<td>Experimental Group</td>
<td>22</td>
<td>16</td>
<td>72.72727</td>
</tr>
</tbody>
</table>

An example of this seen in student work is given below in Figure 7 and Figure 8.

In Figure 7, the student in the control group did not know how to combine the logarithmic equation. Instead of realizing that when you subtract logs, you divide the inside he simply
just subtracted and dropped the logs completely. A few days later when this student took the test he/she repeated the same mistake they did on the quiz.

![Image of quiz and test questions](image)

**Figure 8: Experimental quiz and test comparison**

Figure 8 shows work from a student in the experimental group. This student understood that when you subtract logs you divide the “inside” however he/she did not understand how to complete the problem or realize there was more to do after that. On their test, this student was able to finish the problem and get a correct solution. The mistake he/she made on the quiz was corrected and this resulted in a higher score on the test.

The control student shown in Figure 7 had a lower test score than what he/she gained on the quiz. This was a result of repeating the same mistake for multiple problems. The experimental student on the other hand received two letter grades higher on their test opposed to their quiz because all of their mistakes were corrected come test time.
For the second semester, results were not like that of Intervention 1. All three classes had about the same amount of missed questions, and all three of these classes corrected their mistake about 67% of the time. This could be explained by the two different interventions which will be discussed later.

Qualitative Results

Because the grading practices were different for both groups, the initial questions asked were slightly different. I believe I can compare these responses because the questions were similar in nature. The first question was asking what they previewed the benefits to the grading practice they received. The second question asked if it affected their study habits (if at all) and how. After these two initial questions the experiment was explained as stated previously and the remaining questions were exactly the same.

The first question I asked the control groups was: “What are the benefits of dropping your lowest quiz grade”. I sorted the 64 responses into 5 categories. These categories included: no benefit, increase in grade, motivates to master material, helps reduce stress, or helps keep the student focused. Table 15 is the results of the data from this first question and Figure 9 is a visual representation of the results.
Table 15
Control groups first survey question response results

<table>
<thead>
<tr>
<th>Question 1: What are the benefits of dropping your lowest quiz grade?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control Groups</strong></td>
</tr>
<tr>
<td>First Semester</td>
</tr>
<tr>
<td>no benefit (0)</td>
</tr>
<tr>
<td>no benefit (2)</td>
</tr>
<tr>
<td>Second Semester</td>
</tr>
<tr>
<td>no benefit (2)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>no benefit (2)</td>
</tr>
<tr>
<td>Motivated to master (4)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>First Semester</td>
</tr>
<tr>
<td>keep focused (1)</td>
</tr>
<tr>
<td>keep focused (0)</td>
</tr>
<tr>
<td>Second Semester</td>
</tr>
<tr>
<td>keep focused (0)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>keep focused (1)</td>
</tr>
<tr>
<td>keeps focused (0)</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

|                  | no benefit (2) | 3.13%          |
|                  | raises Grade (47) | 73.43%       |
|                  | Motivated to master (4) | 6.25%      |
|                  | less stress (7) | 10.93%        |
|                  |                  |                |
|                  | keep focused (1) | 1.56%          |
|                  | Redeem (0)       | 0%             |
|                  | gives more time to learn (0) | 0%        |

Figure 9: Control group survey question and results
From these responses, over 75% of these students either thought of their overall grade opposed to the knowledge they gained or saw no benefit to just dropping a quiz. An example of this is: “Dropping the lowest quiz grade helps our grade and allows us to have a bad day and not have it ruin our grade. Sometimes people might forget to study or just not get a subject so dropping the lowest quiz grade lets us do that” (Student C22.02). This suggests that these students only think of a quiz as a number in the grade book and not a tool used for achievement. The remainder of these students did see some educational or motivational value, although over 10% just saw the dropping of a quiz grade as a stress release. For example, Student (C22.07) stated: “The benefits of dropping are my grade gets higher, I don’t freak out over a bad quiz grade and I have a little wiggle room”. This stress being released is still an important aspect to student’s growth. This is because mathematics anxiety that can be caused by this stress has been shown to be a significant factor of learning success (Cates & Rhymer, 2003). Another example is: “It allowed us to protect ourselves if a smart student messes up, which allows us not to stress as much. Also, if a student is doing consistently bad it won’t matter that much so I believe it’s very helpful and plays stronger for the good students rather than the lazy” (Student C22.34). This student claimed that dropping one quiz could alleviate some of the pressure of testing, however, they did not think about how it would help/affect their understanding. In summary, the control group had their numeric grade in mind and not the knowledge they were getting out of the class.

The first survey question for the experimental groups is very similar to that of the control group. They were asked: “What do you think are the benefits of replacing the quiz grade with a higher test grade?” For the first question I wanted the student to only think
about this new grading practice and not compare it to what they have had in the past. I grouped their responses into 6 different categories. The categories include: raises grade, helps motivate to master material, reduces stress, keeps students focused, and gives the student an opportunity to redeem themselves. The results of the 87 responses are given in Table 16 and the visual representation is given in Figure 10.

### Table 16
Experimental groups first survey question response

<table>
<thead>
<tr>
<th>Experimental Groups</th>
<th>87 total responses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Question 1:</strong></td>
<td>What do you think are the benefits of replacing the quiz grade with a higher test grade?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>First Semester</th>
<th>Second Semester</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>no benefit</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Raises Grade</td>
<td>7</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>Motivated to master</td>
<td>5</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Less stress</td>
<td>10</td>
<td>5</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>First Semester</th>
<th>Second Semester</th>
<th>Total</th>
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<tbody>
<tr>
<td>no benefit</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Raises Grade</td>
<td>24</td>
<td>21</td>
<td>45</td>
</tr>
<tr>
<td>Motivated to master</td>
<td>17</td>
<td>15</td>
<td>32</td>
</tr>
<tr>
<td>Less stress</td>
<td>21</td>
<td>21</td>
<td>42</td>
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</tbody>
</table>

<table>
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<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>keep focused</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Redeem</td>
<td>5</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>gives more time to learn</td>
<td>2</td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>First Semester</th>
<th>Second Semester</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>keep focused</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Redeem</td>
<td>15</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>gives more time to learn</td>
<td>12</td>
<td>12</td>
<td>24</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>First Semester</th>
<th>Second Semester</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>keep focused</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Redeem</td>
<td>15</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>gives more time to learn</td>
<td>12</td>
<td>12</td>
<td>24</td>
</tr>
</tbody>
</table>

|               | 1.14%          | 17.24%          | 13.79% |
In these responses, only 27.6% of the students mentioned something about their grade getting a boost from the replacement. Instead, their responses were linked to subject achievement. In fact, almost 20% mentioned that replacing the quiz was a direct link to the amount of material they mastered. A little over 24% of the students mentioned the relief of stress that occurs from assessments. An example of one of these statements given by an experimental group student is: “I felt less stress to perform well on the specific nature of the quiz, allowing me to focus on the broader nature of the test. Also, I know that if I did not perform adequately on the quiz, I could study for the test and could fix my mistake” (Student E21.18). The difference between this statement and the control student’s statement is clear. The control statement implies that dropping the quiz grade only helps those that are already motivated. The experimental student’s statement also conveyed the decrease of stress but
also stated that this would help motivate to learn previously un-mastered material. The release of stress can also be explained because it gives the students more time to learn, as 13.7% of the experimental group indicated. This could be a solution, not a source of, the cramming concern mentioned by some of my professional learning team members.

Looking at the two sets of data side by side in Figure 11, it is clear what the majority of each group was thinking. The light purple and brown in each pie chart is the percentage of each class that stated the benefit of this experiment was to raise their grade. Every other color can be linked to their achievement of the subject. The majority of the experimental group is now using the quiz as a tool to enrich their learning, while the majority of the control group just looks at the quiz as another grade in the book.

![Figure 11: Comparison for survey question 1](image-url)
Previous research has shown that motivation is related to whether or not students have opportunities to self-govern or make important academic choices (McCombs, 2013). The students in the experimental group have the option to raise their quiz grade each unit. This gives them a decision of whether or not the grade stays where it currently is or if it rises with a little extra effort. When students are able to decide if the quiz will impact their grade, they are more apt to use the quiz as a tool instead of just using it traditionally as a grade.

The next question the control group was asked pertained to what they did with their quiz after it was handed back. At first, I stated “what did you do with the quiz after I gave it back” and some of the class stated their response. After a few moments and some puzzled looks I asked “did you look over it” to those not responding. The results can be seen numerically in Table 17 and visually in Figure 12.

### Table 17
Control groups second survey responses

| Question 2: After I gave you your quiz back what did you do with it? Did you look over it? |
|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Intervention 1                  | Intervention 2                  | Total                           |                                  |                                  |                                  |
| No (12)                         | No (22)                         | No (34)                         | Yes; rarely/once (11)           | Yes; used it as a tool (1)       | No opinion (1)                  |
| Yes; rarely/once (11)           | Yes; used it as a tool (0)       | Yes; rarely/once (11)           | Yes; used it as a tool (1)       | No Opinion (1)                  |
| No opinion (1)                  |                                 |                                 |                                 | No opinion (2)                  |
| 0.53125                         | 0.171875                        | 0.265625                        | 0.03125                         |

64 Total responses

Yes total :28

0.4375
I grouped their responses into 4 categories. The responses that stated they did nothing with the quiz to enhance their learning are indicated in red. The most common response in this category was “I put it in my folder/book bag”. The orange color represents a response such as “I always made a 100” so it is categorized as no opinion. The light blue represents the students who admitted to looking over the quiz but only right after it was handed back. Although this was a yes, it is not certain that the students reworked missed problems or did anything more than just look at their grade. The dark blue represents responses that have evidence where the student stated that they not only looked over the quiz but either used it as a study tool or used it to master items they missed. Regardless of the shade of blue, the yes responses still counted for less than half of the class. This means that the majority of the class admitted to the instructor that they never looked at the quiz once they saw their grade. Sure evidence that the more than half of the class did not use the quizzes to their advantage.

Figure 12: Second control group survey question and result
For the experimental group, a more direct question was asked. They were asked if the experiment changed their study habits and if so, then how. From the experience I had with that one student before I decided to collect this data, I knew that this grading practice had a huge potential to change a student’s study habits. Because of this, I wanted to get straight to the point so I could investigate what those that experienced the change went through. In my opinion, the quantitative data results were not very surprising, however, their survey responses (qualitative responses) were. The numerical statistics can be seen in Table 18 and a visual representation can be seen in Figure 13. In Figure 13 the blue represents yes; their study habits were changed, green is no; their study habits didn’t change, and orange is no opinion; they made a 100 each time.

<table>
<thead>
<tr>
<th>Experimental Group</th>
<th>87 total responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 2: After I gave you your quiz back what did you do with it? Did you look over it?</td>
<td></td>
</tr>
<tr>
<td>Intervention 1 Yes (27)</td>
<td>No (1)</td>
</tr>
<tr>
<td>Intervention 2 Yes (22)</td>
<td>No (5)</td>
</tr>
<tr>
<td>Intervention 2 Yes (22)</td>
<td>No (8)</td>
</tr>
<tr>
<td>Yes (71)</td>
<td>No (14)</td>
</tr>
</tbody>
</table>

\[ 0.816091954 \quad 0.16091954 \quad 0.022988506 \]
Most of the yes responses did indeed state how their habits changed. Below are some examples of these responses.

- “I would say I studied for the tests more than I ever had in any of my math classes. Math has always come naturally to me so I never studied because I knew I could scrape by with a Mid B. With this new motivation I studied more for my tests so that I could accomplish more than a B.” (Student E21.21)

- “YES!! The quiz helped me see what I needed to work on. It made me what to study more because I didn’t want the grade that I got on the quiz to be the grade that I got on the test.” (Student E21.16)

- “It changed my study habits because the quizzes slapped me in the face when I didn’t study, so I studied more than I normally would for the tests” (Student E21.14)

- “Yes, my study habits improved greatly. I started actually learning how to do the math instead of cramming last minute and forgetting all of it. The things I didn’t know on the quizzes I went back and relearned for the test.” (Student E21.20)

- “Yes it did change my study habits a little. The way it changed was that instead of just caring about the grade I went back to learn what I didn’t get right or understand so in the future if I saw it again I would know how to use it”. (Student E24.20)
“Replacing the quiz grade did motivate me to change my study habits. By getting the quiz back I knew which parts of the quiz I needed to focus on and was able to better my understanding of that topic”. (Student E24.25)

The no responses could have been as recorded no for several reasons. Out of all 3 classes, 14 students said that replacing the quiz did not change their study habits for the test. Seven students of these fourteen said that the reason it did not change their study habits is because they were already redoing their missed questions on the quiz. Out of all 3 of these classes, there were several grades that were right around a 100. Some of those students were the ones that already used good study habits or that stated that they did not need to study for math because it came naturally for them. Other explanations could be due to already good study habits or because the students still refused to advocate for themselves by studying. These were six of the fourteen responses. Even though some of these no change in study habits did not need an adjustment there were still 81% of the students that admitted that their behaviors changed in a positive way. Examples of some of the no responses are given below.

- “My study habits were unchanged. Until such time as the school system is burning and dead I will learn all material presented to the best of my ability”. (Student E21.18)

- “Replacing the quiz grades changed my study habits in no particular way. I always try my hardest for every test and quiz. This experiment made me realize what I needed to work harder on”. (Student E24.27)

- “No, nothing can make me study I have little drive to actually study. The material has to be really hard”. (Student E24.09)

- “No, but only because I was an idiot and did not try”. (Student E14.33)

- “No, it did not change any study habits. My habit has always been to learn from my mistakes on anything. I can see though how this experiment would change other peoples study habits that don’t normally do that”. (Student E14.15)
During the final data collection, after students responded to the second survey question, I explained the experiment to each class and I answered students’ questions. Once all the students understood that every student was given the same benefit at the end of each quarter, the third survey question was asked. This question was: “Out of both methods which one would help you more and why”? The tally of each groups’ response can be seen in Table 19 and Table 20. A visual comparison of each class can be seen in Figure 14.

Table 19

Control Group's Fourth Survey Response

<table>
<thead>
<tr>
<th>Control Group</th>
<th>Out of both methods which do you think would help you more and why?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention 1</td>
<td>Replace (30)</td>
</tr>
<tr>
<td>Intervention 2</td>
<td>Replacing (24)</td>
</tr>
<tr>
<td>Total</td>
<td>Replace (54)</td>
</tr>
</tbody>
</table>

84.38% 10.94% 4.69%

64 total responses
After hearing both options, the majority of students in all classes that they thought replacing the quiz would benefit students more than just dropping one quiz at the end of each quarter.
When all the classes were combined, over 85% percent of students thought replacing the quiz was the best option as opposed to only about 10% thought dropping would be the best option, as seen in Table 21. Fourteen students in the control group stated in survey question one that they liked dropping the quiz grade for motivational reasons. Out of these fourteen students, only one of them said they would prefer to keep dropping a quiz (instead of replacing). This shows that the minority of the students in the control group that liked the dropping the quiz for motivational reasons was focused on achievement instead of their numeric grade. A visual representation can be seen in Figure 15. These students that put their understanding before their numeric grade expressed that the replacing method would help them achieve their achievement goals better than just dropping a quiz.

Table 21
Combined fourth question results

<table>
<thead>
<tr>
<th>ALL CLASSES</th>
<th>151 responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replace (54)</td>
<td>Drop (7)</td>
</tr>
<tr>
<td>replacing (75)</td>
<td>Dropping (8)</td>
</tr>
<tr>
<td>Replace (129)</td>
<td>Drop (15)</td>
</tr>
<tr>
<td>85.43%</td>
<td>9.93%</td>
</tr>
</tbody>
</table>
The students who were in the experimental group were the only students to have experienced both methods from this experiment and previous mathematics classes. Some of their responses to why they think replacing is better were quite insightful. A few of these responses are given below.

- “I think replacing lower quiz grades when you do better on the test helps a lot more. Especially to learn material because you’re really motivated to get higher test grades if you didn’t ace the quiz. So you would study really hard. You put more effort in because you know no where your weaknesses are” (Student E21.29).

- “Replacing the quiz grade helps master the material easier because I would need to relearn incorrect info. On quizzes that come up on tests and it would force me to mater the information thoroughly” (Student E24.26)

- “I think replacing the quiz grade helps more. If you just drop the quiz grade, it doesn't motivate anyone to try harder for the test” (Student E14.24).

- “Replacing the quiz grade because you don't have to worry about the quiz as much as it teaches you to go back and look at your mistakes and try better for next quiz” (Student E14.21).
Students can be very insightful and even those students that have not seen the benefit of replacing a quiz have an idea of what this new grading practice could do for them. This can be seen from the responses of the control group. Some of these responses for the control group were very similar to that of the experimental group and from some of the responses it was easy to tell that the students got it and could see the possible benefits. Some of these responses are given below.

- “The replace quiz grade would help better b/c if you already knew your grade was going to get replaced, if you messed up on a quiz problem you have a reason to go back and look at it. If I had known about it I would have looked at the problems I missed instead of just putting it into my folder” (Student C22.14).

- “Replacing the quiz would motivate me more. I'm lazy I'm not going to work unless I have to. So this method would help with that. The quiz should let me know if I get it, then the test is the real indicator. For me, this would help for me to know how hard or how much I need to study” (Student C22.33).

- “I believe that replacing quizzes with test grades would motivate a student more. It would help a student who tries to get better and would have no effect on a student who doesn't. I think this would help me more as well” (Student C11.33).

- “Replacing will help more because it would not be as stressful. Usually when I take a class I get stressed daily knowing I have borrowed time before a quiz to understand what I am being taught. If I knew that my quiz grade will be replaced if lower than at least I won’t stress as much, but will still try just as hard. It will make going to class a little less pressuring and slightly more understanding towards students’ circumstances” (Student C22.29).

The majority of both groups recognized the benefits of replacing the quiz instead of just dropping it. Even though the control group did not knowingly have the experience of the quiz replacement, they understood that this could be something that would help motivate them to learn previously missed material. These control students also hypothesized the quiz replacement would reduce stress and also change their study habits indicate that the quiz
could transform into a tool that can be used to test their own knowledge. This was born out by the results of this study.

Not only did the experimental group’s students change their study habits or use of their quizzes, but their class morale also changed. Once the experiment started and students heard the opportunity they were given, their outlook toward the class and the instructor changed. Even only being around the students for a short two weeks, the rapport was instantly established. It was noted that the report for the control group took significantly longer. When you build a rapport with a student it builds a bond with them that ultimately will increase motivation within the student (Willis, 2010). When a teacher has a report with their students not only does teaching become easier, but it also becomes more fun for both the student and the instructor. Studies have shown that instructor/student rapport is related to classroom connectedness and enhances student participation (Frisby & Martin, 2010).
Chapter 5: Discussion

In this section, there will be a brief summary of the results and a comparison between the two different interventions used for the experimental groups. Also a recommendation for best practices will be given based on the outcomes of each intervention. Some of the limitations of the study will also be discussed at the end of this section as well.

Summary

Although the scores of the students on the cumulative finals were not statistically different, each experimental group did earn a higher class average on the test. Also, through class surveys given at the end of the semester over 84% of each class thought that replacing the quiz would benefit not only their motivation, but also their overall understanding. In the experimental groups, 81% of the participants stated that replacing their quiz with their test grade also positively impacted their study habits. This can be compared to the control group where only about 44% used their quiz as a tool. These findings suggest that this new grading practice does indeed boost student motivation which in turn has increased students’ performance on a cumulative final.

Comparing the Two Interventions

This study has shown that using the alternative grading practice of replacing low quiz scores with related test scores encourages students to put forth more effort without hurting their overall class average or self-worth. In this section, I discuss the difference in the results from the two semesters. In the first semester, the students in the experimental class were
constantly reminded after each quiz and before each test about the opportunity given to them. After each quiz, I would state something to the effect of “remember, if you don’t like your grade or you realize you did not put in enough effort so far this unit, you have time to correct that mistake if you put forth the work”. This helped encourage the students to learn from their mistakes and master what they previously could not master.

The reminders from the instructor refreshed the student’s intrinsic motivation. Deci (1975) stated that intrinsic motivation would increase if a person’s feelings of self-determination are increased. Pointing out that the students can not only do well on a future assessment but also increase the grade of a previous assessment raises a student’s feeling of self-determination. This encouragement did not occur in the second semester and I think that explains why the students’ grades did not start to rise sooner. The extra push from the instructor made a difference in the students’ effort.

Between the two semesters it was obvious that reminding students that they had an opportunity to perform at a higher level made a difference. Instead of just relying on the intrinsic motivation, the addition of the teacher provided extrinsic motivation proved to help the students especially in the earlier units. When students are pushed and the motivation is both internal and external, their drive to perform at a higher level seems to be stronger.

The second semester when the external motivation was not provided by the instructor, it took the students’ time to realize the benefits of this experiment. This means that the student’s intrinsic motivation is delayed. I think intrinsic motivation can be produced by a multiple of ways including:
• Educational results that factor from their own control
• Believe they have the skills to be effective, or self-efficacy beliefs
• Interested in mastering a topic, not just getting good grades
• Enjoy what they are learning

When a student turns that poor mark into a higher one, it gives them a taste of success. This success allows the student to truly believe they have the skills to be effective and shows the student that their results came from their own control. Success is also addictive which after time will help develop an interest in mastering a topic because it makes the student feel knowledgeable, in control, and good about themselves.

Reflections on Results as a Teacher

Reflecting on this experiment, I decided to apply the intervention of replacing quiz grades to every one of my classes in the following semesters. I did however make a few changes. I changed the requirements for me to replace the quiz and also how I graded the quizzes.

In order for me to replace the quiz I told students they had to make quiz corrections. This ensures that all students will have to carefully review and correct their quizzes in order to receive the benefit. I came to this conclusion by looking back over the previous year’s data. It became apparent that a few of the students refused to look over their quiz and never really improved much. It made me think that they took the raise of grade as like a lottery. Yes, sometimes it would get higher with no extra added work, but that to me took away the
point of what I wanted the student to learn. I wanted to make sure that all students were using their quiz as a learning tool. When students are required to make the corrections it ensures that they are at least making an effort to learn from their mistakes. With this new addition I’ve noticed an even higher success rate and some of the highest test scores I’ve ever had.

I also changed how I graded the quiz. After this experiment I became more of a strict grader on the quizzes because with the replacing it affects the student’s overall grade very minimally. I believe this would hold a student more accountable and get them in the habit of representing solutions in a way that the instructor desires. If a student did not perform well on a quiz then they would be able to fix their mistakes in time for the test. I believe this conditioning could help them on a state final or in future mathematics courses when their instructor wants something in a particular way.

Limitations of Study

There are several limitations to this study. First off, this experiment was conducted exclusively in an honors class and one particular school. I believe that performing this experiment in a different climate may yield different results depending on the population of the students present.

One factor that could have impacted this study was the parental involvement. Grades were always posted next day with an email sent to parents with the class results. I believe this would tempt parents to check their student’s grade. If the student’s grade was unsatisfactory then I believe those students in the experimental group would use the excuse
“I can raise it after my test” in order to free them from trouble. This also would add pressure in a different direction. If parental communication did not occur, I am uncertain that the results would mirror the ones found in this experiment.

Also, the fact that the researcher played the role of teacher as well, could have some unintended bias. Each test was graded on the same point scale and rubric however bias or human error could always play a role. Either grading the control group’s tests or the experimental group’s quizzes more harsh would change the outcome of the experiment. I believe that if the experimental group’s quizzes were graded harsher it would have motivated them to study more and would not accurately reflect the students’ level of knowledge. Precautions were taken to try to avoid bias tendencies; however it always is a possibility. Since these classes were taught at different blocks, and the lessons were not scripted, classes could have been taught differently. Questions asked in one block were not always asked in the other block(s) so some students could have been exposed to different questions.

This experiment was done on a very small scale. Because of the small sample of students this could be a limitation. Just because these results were seen in this particular sample, it does not mean that is will be as beneficial to the entire population of Honors Algebra II students. The climate of this particular school is unlike that of every other school in the county, let alone the state or nation. It is impossible to have every school be exactly the same. For example, if the majority of these students came from a lower SES family I believe the results would be different.
Conclusion

Through this experiment I have come to the conclusion that replacing a quiz grade with the corresponding unit’s test score can be beneficial to not only their grade, but more importantly, their understanding. If an instructor is involved with parental communication and requires students to go over missed material on a quiz, then a student’s overall understanding of a topic will increase. I believe that it is also important to provide motivation between the quiz and the test in order to help ensure students remain focused and effectively learn from their mistakes. In my opinion, giving the opportunity to replace a quiz grade with a higher test score is beneficial to the students and can not only help students in their current class, but can also mold their study habits and help them in future classes as well.

Research also supports the analysis and results of this study. The research suggests that replacing the quiz grade with a higher test grade may help the student’s motivation to achieve at a higher level. When a student is motivated to work harder it will help build their study skills which will help with the student’s academic growth. This is because motivation, added to study skills, is the most important factors in terms of student growth (Murayama, et al, 2012). Once a student starts a trend of success, this too can impact their achievement. Studies have shown that the correlation between self-confidence and achievement has been moderately strong (Kloosterman, 1988). Previous studies that this self confidence in mathematics has the strongest correlation with achievement (Meyer & Fennema, 1986). This
study encourages students to learn from their mistakes which in turn will build self-confidence and achieve more.
References


Appendices
Appendix A: Example of a Unit Test

Honors Algebra 2

Test A: Logarithms #2

Name: ______________________

Date: ______________________

1. Write the equation in exponential form: \( \log_2 128 = 7 \).

2. Write the equation in logarithmic form: \( 49 = 7^2 \).

3. Simplify \( 4 \log x + 3 \log y \) to a single logarithm.

4. Expand \( \log \frac{a^2 b^3}{c^4} \) using properties of logs.

Solve the following equations. All work must be shown!

5. \( \log_4 (5x + 1) = 2 \)

6. \( \log , 24 - \log_7 x + 5 = \log_7 8 \)

7. \( \log_{10} x + \log_{10} x + 3 = 1 \)

8. \( 6^x = 42 \)

9. \( 3^{x-2} = 14.5 \)

10. \( 8 + 3e^{3x} = 26 \)

11. \( \frac{1}{2} \ln x - 7 = 2 \)

12. \( \log_6 17 = x \)
13. In 1950, a U.S. population model was million people, where \( t \) is the year. What did the model predict the U.S. population would be in the year 2000?

A. 255 million  B. 247 million  C. 288 million  D. 263 million

14. Which equation is equivalent to

A.  
B.  
C.  
D.  

15. A single microscopic organism divides into two organisms every 3 days. Using the formula \( \frac{A_{(t)}}{A_{(t=0)}} = \left(2^{\frac{t}{3}}\right) \), where \( t \) is the time in days, \( N(t) \) is the number of organisms at \( t \) days, and \( N(t=0) \) is the number of organisms at \( t=0 \). Approximately how long would it take one organism to produce a population of about 10,000 organisms?

A. 1,667 days  B. 126 days  C. 333 days  D. 40 days

16. James purchased a truck for $25,900. The value of the truck decreases by 12% per year. What will be the approximate value 8 years after the purchase? \( A = P(1 + r)^{-t} \)
17. The Wongs bought a new house three years ago for $92,000. The house is now worth about $113,000. Assuming a steady annual percentage growth rate, approximately what was the yearly rate of appreciation?

18. The half-life of a radioactive isotope is 7 years. Initially, there are 100 grams of the isotope. How long will it take for there to be 15 grams of the isotope? \( y = a \left( \frac{1}{2} \right)^t \), where \( t \) is time over half-life.

19. Isabella invested $500 at 6% annual interest, compounded quarterly. The value, \( A \), of an investment can be calculated using the equation \( A = P \left( 1 + \frac{r}{n} \right)^{nt} \). Exactly how long will it take for her investment to be worth four times as much (quadruple) in value?
20. For what approximate value of $t$ will the value of the fund be $50,000? (Assume that the fund growth continues according to a best-fit exponential model based on the data in the table.)

<table>
<thead>
<tr>
<th>Time (t)</th>
<th>3</th>
<th>5</th>
<th>7</th>
<th>9</th>
<th>11</th>
<th>13</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of Fund</td>
<td>$15,700</td>
<td>$18,400</td>
<td>$21,400</td>
<td>$25,000</td>
<td>$29,100</td>
<td>$34,200</td>
<td>$39,700</td>
</tr>
</tbody>
</table>

Bonus: Solve. Show all work! \[ 4^t = \sqrt[5]{5^{t+2}} \]
Appendix B: Example of a Unit Quiz

Honors Algebra II
Quiz Form A

Name___________________

1)  

4)  

5)  

6)  10

2)  \(\log x - \log 6 = \log 15\)
### Appendix C: IRB

**North Carolina State University**  
**Institutional Review Board for the Use of Human Subjects in Research**  
**SUBMISSION FOR NEW STUDIES**

#### GENERAL INFORMATION

<table>
<thead>
<tr>
<th><strong>Date Submitted:</strong></th>
<th><strong>August 28, 2012</strong></th>
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<td><strong>1a. Revised Date:</strong></td>
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**Title of Project:** Subject mastery linked to quiz performance

- **Principal Investigator:** *Josh Griffin*
- **Department:** STEM Education
- **Campus Box Number:** 7801
- **Email:** jgriffin@wcpss.net
- **Phone Number:** 919-270-6255
- **Fax Number:** _____
- **Faculty Sponsor Name and Email Address if Student Submission:** Karen Keene, kakeene@ncsu.edu

**Source of Funding? (required information):** *none*

**Is this research receiving federal funding?:** *No*

**If Externally funded, include sponsor name and university account number:** _____

**RANK:**
- [ ] Faculty
- [ ] Student: [ ] Undergraduate; [ ] Masters; or [ ] PhD
- [ ] Other (specify): _____

As the principal investigator, my signature testifies that I have read and understood the University Policy and Procedures for the Use of Human Subjects in Research. I assure the Committee that all procedures performed under this project will be conducted exactly as outlined in the Proposal Narrative and that any modification to this protocol will be submitted to the Committee in the form of an amendment for its approval prior to implementation.

**Principal Investigator:**

*Joshua Griffin*  
__________  
8/8/2012

(typed/printed name)  
(signature)  
(date)
As the faculty sponsor, my signature testifies that I have reviewed this application thoroughly and will oversee the research in its entirety. I hereby acknowledge my role as the principal investigator of record.

Faculty Sponsor:

Karen Keene  
(typed/printed name)  
8/28/2012  
(signature)  
(date)

*Electronic submissions to the IRB are considered signed via an electronic signature. For student submissions this means that the faculty sponsor has reviewed the proposal prior to it being submitted and is copied on the submission.

Please complete this application and email as an attachment to: debra_paxton@ncsu.edu or send by mail to: Institutional Review Board, Box 7514, NCSU Campus (Administrative Services III). Please include consent forms and other study documents with your application and submit as one document.

For SPARCS office use only

Reviewer Decision (Expedited or Exempt Review)
- Exempt  b1, b2  Approved  Approved pending modifications  Table

Expedited Review Category: 1 2 3 4 5 6 7 8a 8b 8c 9

-  
Reviewer Name  Signature  Date
Institutional Review Board for the Use of Human Subjects in Research

GUIDELINES FOR A PROPOSAL NARRATIVE

In your narrative, address each of the topics outlined below. Every application for IRB review must contain a proposal narrative, and failure to follow these directions will result in delays in reviewing/processing the protocol.

A. INTRODUCTION

1. Briefly describe in lay language the purpose of the proposed research and why it is important.

   Improving mastery of mathematical skills and understanding at all levels, and particularly the high school level, is a high priority. Some grading procedures may not support mastery to its full potential. By allowing students to have an option to replace a quiz grade with the higher test grade that is scored later, it will give the students' motivation to learn previously tested material that was not mastered. Data collected will allow me to determine if that motivation has an effect on mastery and understanding.

2. If student research, indicate whether for a course, thesis, dissertation, or independent research.

   Thesis

B. SUBJECT POPULATION

1. How many subjects will be involved in the research?

   Estimates or ranges are acceptable. Please be aware that if you recruit over 10% more participants than originally requested, you will need to submit a request to modify your recruitment numbers.

   Approximately 65-75 students will be involved in the research each semester.
1. Describe how subjects will be recruited. Please provide the IRB with any recruitment materials that will be used.

   All students enrolled in high school algebra 2 where I am the instructor will be asked to participate in the research project. Attached is the language the instructor/researcher (J. Griffin) will use to recruit (Appendix B). If they agree, they will be asked to sign an informed consent (Appendix A).

2. List specific eligibility requirements for subjects (or describe screening procedures), including those criteria that would exclude otherwise acceptable subjects.

   Any students in honors algebra 2 will be invited. There are no other requirements.

3. Explain any sampling procedure that might exclude specific populations.

4. Disclose any relationship between researcher and subjects - such as, teacher/student; employer/employee.

   The research is the instructor and the subjects are the students in high school algebra 2.

5. Check any vulnerable populations included in study:

   - ✔ minors (under age 18) - if so, have you included a line on the consent form for the parent/guardian signature
   - □ fetuses
   - □ pregnant women
   - □ persons with mental, psychiatric or emotional disabilities
   - □ persons with physical disabilities
☐ economically or educationally disadvantaged

☐ prisoners

☐ elderly

☐ students from a class taught by principal investigator

☐ other vulnerable population.

7. If any of the above are used, state the necessity for doing so. Please indicate the approximate age range of the minors to be involved.

This study will help discover new grading methods that may help increase the level of mastery and understanding for high school mathematics students. The age range will be between high school freshmen to high school juniors (14-17 years in age)

C. PROCEDURES TO BE FOLLOWED

1. In lay language, describe completely all procedures to be followed during the course of the experimentation. Provide sufficient detail so that the Committee is able to assess potential risks to human subjects. In order for the IRB to completely understand the experience of the subjects in your project, please provide a detailed outline of everything subjects will experience as a result of participating in your project. Please be specific and include information on all aspects of the research, through subject recruitment and ending when the subject’s role in the project is complete. All descriptions should include the informed consent process, interactions between the subjects and the researcher, and any tasks, tests, etc. that involve subjects. If the project involves more than one group of subjects (e.g. teachers and students, employees and supervisors), please make sure to provide descriptions for each subject group.
After the 2nd test of the semester in fall 2012, students/parents will be asked to participate in the study via two emails sent to parent/ student (see Appendix B) and sign an informed consent form (see Appendix A). The experiment will include an experimental and control class, each of which are taught by the researcher. The following data will be collected.

**Quantitative Data:** The experimental group (class A) will be told that they have an option each unit to replace their quiz grade with their test grade, if it is higher. The control group (class B) will be told that one of their quiz grades will be dropped at the end of each semester. Both groups will be made to feel like they are the “experimental” group and asked not to speak to each other about the experiment. After each quiz is graded I will pass them back to the students and review them as normal. Once it is time for the test I will ask for the students to turn in their previously graded quiz with their test in both class A and class B. At the end of each semester I will replace quiz grades with higher test grades then drop the lowest quiz for both classes. If a student declines to be a part of the study they will still receive the benefit of the replaced quiz and dropped quiz but will not be a part of my data collection. Once the data is collected I will compare the difference between the quiz and test scores. I will look at the quiz and test for each unit in both classes and compare to see if previously unmastered material is now mastered by comparing scores on similar questions from the quiz and test. After I have that data I will compare the amount of students that showed mastery of previously missed material to students that still have a topic unmastered in both classes. This will help me conclude if the replaced quiz grade has an effect in student mastery. I will also be able to compare semester grades to see how much this will impact their overall grade.

**Qualitative Data:**

Surveys: At the end of the semester I will ask all students to fill out a survey (Appendix C). Interviews. These interviews will be semi-structured with a protocol that we will develop after reading responses from the surveys, doing preliminary analysis of the surveys of the class and student work to find relevant questions. The questions will be designed to continue to find answers to the research questions as well. These questions have not been developed yet, but they will be submitted to the IRB for approval prior to implementation.

Data will be kept on the researcher’s locked computer or in a locked file cabinet in researcher’s office for 2 year and analyzed during 2012-2013.

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2. **How much time will be required of each subject?**

Students will be asked to take one survey in class. This will take about 10 minutes. All the rest of the participation will occur during the class, and will not require extra time. If the student/parent agree to interviews, they will be asked to talk with me an additional half-hour after the class has ended and grades have been turned in.
D. POTENTIAL RISKS

1. State the potential risks (psychological, social, physical, financial, legal or other) connected with the proposed procedures and explain the steps taken to minimize these risks.

   Students may feel their grade in the course may be affected either by their survey answers or their participation in the research. Care will be taken to assure the students that the interviews not be watched and the surveys will not be looked at until the course is over.

   If students are uncomfortable with the research, audio recording or doing the surveys, they can opt out of the project with no grade penalty at any time and still receive the benefit of the replaced quiz grades and one dropped quiz each semester.

2. Will there be a request for information that subjects might consider to be personal or sensitive (e.g. private behavior, economic status, sexual issues, religious beliefs, or other matters that if made public might impair their self-esteem or reputation or could reasonably place the subjects at risk of criminal or civil liability)?

   No

   a. If yes, please describe and explain the steps taken to minimize these risks.

2. Could any of the study procedures produce stress or anxiety, or be considered offensive, threatening, or degrading? If yes, please describe why they are important and what arrangements have been made for handling an emotional reaction from the subject.

   No

3. How will data be recorded and stored?

   Data will be stored on a password protected computer in a locked school room.
a. How will identifiers be used in study notes and other materials?
Students will be randomly assigned pseudonyms which will then be used to label all of their work and utterances during interviews and attached to their survey results.

b. How will reports be written, in aggregate terms, or will individual responses be described?
Primarily aggregate will be used to report results. If individuals are reported on, the pseudonyms only will be used.

4. If audio or video recordings are collected, will you retain or destroy the recordings? How will recordings be stored during the project and after, as per your destruction/retention plans?
The audios will be kept for 2 years after on a locked computer, not connected to the internet. After two years, they will be destroyed.

5. Is there any deception of the human subjects involved in this study? If yes, please describe why it is necessary and describe the debriefing procedures that have been arranged.
Yes. Both classes will be made to feel like they are the experimental group. The control group will be told that they have one quiz dropped each semester, which is normal procedure. I do not want them to be aware that the quiz will be replaced by a higher test score because if they knew then they would experience the same motivation that is being researched.

E. POTENTIAL BENEFITS
This does not include any form of compensation for participation.
1. What, if any, direct benefit is to be gained by the subject? If no direct benefit is expected, but indirect benefit may be expected (knowledge may be gained that could help others), please explain.
Students overall grade will be increased in both classes due to dropping of the lowest quiz grade and replacing quiz grades if their test score is higher.
**F. COMPENSATION**

Please keep in mind that the logistics of providing compensation to your subjects (e.g., if your business office requires names of subjects who received compensation) may compromise anonymity or complicate confidentiality protections. If, while arranging for subject compensation, you must make changes to the anonymity or confidentiality provisions for your research, you must contact the IRB office prior to implementing those changes.

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<td>Explain compensation provisions if the subject withdraws prior to completion of the study.</td>
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<td>3.</td>
<td>If class credit will be given, list the amount and alternative ways to earn the same amount of credit.</td>
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**G. COLLABORATORS**

1. If you anticipate that additional investigators (other than those named on Cover Page) may be involved in this research, list them here indicating their institution, department and phone number.

2. Will anyone besides the PI or the research team have access to the data (including completed surveys) from the moment they are collected until they are destroyed.

   Dr. Karen Keene
H. CONFLICT OF INTEREST

1. Do you have a significant financial interest or other conflict of interest in the sponsor of this project? **No**

2. Does your current conflicts of interest management plan include this relationship and is it being properly followed? **No**

I. ADDITIONAL INFORMATION

1. If a questionnaire, survey or interview instrument is to be used, attach a copy to this proposal. Attached (but one is separate). See appendix C

2. Attach a copy of the informed consent form to this proposal. See appendix A

3. Please provide any additional materials that may aid the IRB in making its decision. The original proposal as approved is attached.

J. HUMAN SUBJECT ETHICS TRAINING

*Please consider taking the [Collaborative Institutional Training Initiative](https://www.citiprograms.org) (CITI), a free, comprehensive ethics training program for researchers conducting research with human subjects. Just click on the underlined link.