Summer 2020

Effects of Online Homework on Algebra I Test Scores

Katie Muhlenkamp

SHAWNEE STATE UNIVERSITY

Effects of Online Homework on Algebra I Test Scores

A Thesis

By

Katie Muhlenkamp

Department of Mathematical Sciences

Submitted in partial fulfillment of the requirements

for the degree of

Master of Science, Mathematics

July 21, 2020

Accepted by the Graduate Department

July 23, 2020

Graduate Director, Date

The thesis entitled '**Effects of Online Homework on Algebra I Test Scores**' presented by **Katie Muhlenkamp**, a candidate for the degree of **Master of Science in Mathematics,** has been approved and is worthy of acceptance.

July 23, 2020

Date

Graduate Director

7-23-2020

Date

Katie Muhlenkamp

Student

ABSTRACT

Technology in education continues to change and evolve. More and more classrooms are integrating a variety of technology into everyday lessons but is it beneficial to student outcomes? This study looks at assigning online homework versus traditional paper-and-pencil homework. To determine the effects, a control group (n = 40) was assigned traditional homework while an experimental group (n = 29) was given online homework throughout a high school Algebra I course. Using their eighth grade End-of-Course exam to determine prior knowledge, the mean differences of each group's semester exam and final exams were analyzed. A model to predict a student's final exam score was also determined using homework type, gender, eighth grade EOC score, and semester exam score. Results showed online homework to be just as effective if not more beneficial than traditional homework. Due to a number of limitations, further research would be needed to generalize the results to a broader population.

Acknowledgements

Thank you to my parents and grandma for being so supportive and understanding throughout this process; my coworkers for being up for a store visit and getting me through some rough days; and my dog, Brewer, who came into my life in the middle of all this, had to share my attention, and reminded me what's important every day.

Table of Contents

List of Tables

List of Figures

Figure Page

Chapter I: Introduction

The purpose of this chapter is to present the motivation and purpose of the study, the background on the topic, as well as the details on what will be done to answer the research questions, namely if online homework assignments with instant feedback improve various test scores in Algebra I students.

Motivation:

Anderson & Jiang (2018) report that technology is having a profound effect on the everyday life of teenagers. As a result of their study, approximately 95% of 13-17 year olds have a smartphone or access to one. The same study found that nearly 45% of these teens are on the internet almost constantly, with double that amount on it at least several times a day. As a result, many schools have integrated technology into the classroom. This technology includes projectors, smart boards, computers, and tablets, all integrated at various levels from classroom to classroom and teacher to teacher.

Technology has also changed the way homework can be assigned. Prior to tablets and computers, students completed homework with paper-and-pencil, either from a worksheet or out of a textbook. Various websites and applications now allow students to complete homework online. Some valuable advantages of students using online homework include instant feedback and automatic grading (Mendicino, Razzaq, & Heffernan, 2009). The use of technology, specifically with assigning homework and utilizing instant feedback and automatic grading motivates the primary research question for this study: will assigning daily homework predominantly using online resources to Algebra I students improve semester exam, final exam, and end-of-course test scores?

Background:

In today's classroom, technology is changing the way teachers teach. With the number of online resources continuing to climb and improve, teachers are finding a variety of ways to integrate these resources. 63% of K-12 teachers utilize some sort of technology daily in their classrooms (The majority of K-12 teachers, n.d.). Another survey conducted by MidAmerica Nazarene University focused on the high school classroom. 82% of the teachers surveyed found the technology they have access to enhance both learning and teaching, with the majority also stating it makes students more productive and intellectually stimulated. With over 60% of the schools providing the necessary technology to students, they also found that just 42% of assignments are done by hand (Tech in the classroom, n.d.).

Schools have begun to implement one-to-one initiatives, defined as every student in a school receiving a tech device (One-to-one, 2013). This tech device could be a laptop or tablet for example. EdTech reports more than 50% of teachers have a one-to-one ratio in their classrooms as of 2017 (More than, 2017). The decreasing cost of technology and increasing use of computerized assessments have contributed to the growing number of schools implementing this one-to-one ratio into the classroom. A compilation of numerous studies found benefits to a one-to-one initiative, including improved test scores (Zheng, 2016).

The cost of textbooks is another reason schools have considered other resources. A search through the Houghton Mifflin Harcourt website, one of the few main textbook companies, revealed the staggering prices of textbooks. An Algebra I hard copy textbook costs a minimum of $129 per book. The digital version of this textbook, which is in the form of an iPad app, costs almost $55 for one 6-year license (Education and Learning, n.d.). The app, used by students in

this study, saved the small school district almost $74 per student/book, which amounts to over $3000 in all when it was originally purchased just for one set of textbooks. This was at the beginning of trying to get most textbooks on student iPads just one year after starting a one-to-one initiative to utilize the tablets as much as possible. However, this was a short term savings as the licenses have since expired.

With the push towards integrating technology, countless free learning resources have emerged and the list will very likely continue to grow. For example, elementary students can play games like *Splash Math* that can be downloaded on phones or tablets to help teach basic math facts. Different games and computer programs allow junior high students to learn how to type, *Typesy* for example. Khan Academy, a non-profit started in 2008, is available online and through an app for grades K-12. Khan Academy has videos and assessments for most topics in a variety of classes. All of their resources are free and available to both students and teachers in almost every country. Over 18 million learners and 200,000 educators around the world use Khan Academy monthly (Khan Academy, 2019).

Technology began to influence education in the 2000s, although there was a strong increase in investment in the 1990s. Technology has made students more engaged and allows learning to be individualized to a student's needs (Roden, 2011). The benefits of homework on student achievement have been studied extensively. Studies on online homework have found it to be just as effective, if not more, compared to traditional homework (Wooten & Eggers, 2013).

Is this push toward integrating technology in the classroom actually beneficial to student outcomes? As Boser (2013) points out, "there has been a growing concern around technology spending with a chorus of experts arguing that school technology is not helping students achieve

learning goals in the most effective ways." With all of the free online resources available today, are they as effective as traditional textbooks?

Details of the Study:

This research will be a quantitative study that focuses on assigning daily web-based homework. All students in the study completed a full year college-prep Algebra I course at Miller City High School in Northwest Ohio. The high school is comprised of 99% white students, with 52% female and 22% coming from low-income families. Miller City consistently achieves well above state-average EOC test scores in all subjects and a 100% 4-year graduation rate (Miller City, n.d.).

This study took place over a two-year time period with the same teacher and lessons. The control group was assigned homework out of a digital textbook, completed with paper-and-pencil assignments, which were discussed the following day. The experimental group was assigned predominantly web-based homework using Khan Academy assessments, which provide instant feedback to the student and grades student responses immediately.

Scores from the eighth-grade end-of-course test, or EOC, will be used as a covariate to control for prior knowledge. Semester exam, final exam, and Algebra I EOC scores for each student will be used to determine if there was a change in mean scores between the two groups. Gender and achievement levels, in both years, will be analyzed to see if there was a difference in scores between subgroups.

This study came about out of necessity, as the students in the experimental group were not given access to a textbook for budgetary reasons. On a small scale, the results of this study will be used by the school district as evidence to determine if purchasing a textbook in the future

is necessary. Because this school is in a consortium and works so closely with surrounding districts, this will have an effect on their textbook decisions as well. With an ever-changing budget and funding changing from year to year, schools across the country are constantly searching for more cost-effective textbooks for new ways to save money. With positive results in this study, one cost-effective measure would be to try these free resources as opposed to purchasing textbooks, either hard copy or digital.

Statement of the Problem:

The purpose of this study is to determine whether assigning daily homework predominantly using online resources to Algebra I students improves scores on semester exams, final exams, and EOC test results . The research questions are:

1. Will assigning online homework improve
    a) semester exam scores?
    b) final exam scores?
    c) EOC test results?
2. Does the type of homework assigned effect these scores differently based on
    a) gender?
    b) achievement level?

It is hypothesized that these scores will be no different compared to completing homework using paper-and-pencil. The hypothesis would be that each individual subgroup has the same mean scores for both types of homework. For example, the mean scores for males are the same when completing traditional homework as it is when completing online homework, when prior knowledge is controlled for.

The entire population of students enrolled in Algebra I over the two-year time span will be included in this study. There are 69 total participants, high school freshmen, sophomores, and juniors. This represents a variety of students, though small in number, that include a variety of socio-economic backgrounds, both males and females, lower-achieving and higher-achieving students, and students who took Pre-Algebra before taking the class. Almost all students are caucasian. All students have a school iPad supplied to them, used to complete their homework, with internet access at both school and home. The first year students completed homework from a digital textbook app, while the second year students completed homework predominantly on Khan Academy.

Data Analysis:

Students will have taken the same semester and final exam after completing the same lessons beforehand. Lessons were taught by in-class lectures in a virtually identical manner. The EOC tests are not the same from year to year, but are considered equivalent and scored similarly. ANCOVAs, ANOVAs, and t-tests will be used to determine if the overall means of the semester exam, final exam, and EOC test are equivalent. The eighth grade EOC test will be used to gauge prior knowledge. Further, scores will be analyzed between males and females, as well as lower- and higher-achieving students.

Theoretical Framework:

B.F. Skinner's theory on operant conditioning provides the theoretical framework for this study. "The key to Skinner's theory is reinforcement, or anything that strengthens the desired response. This could include praise, good grades, a reward or even a feeling of accomplishment" (Hussung, 2016). In the classroom, learners should receive immediate feedback on responses.

These reinforcements condition the behavior to reoccur (Hussung, 2016). Students completing homework online not only receive immediate feedback of a correct or incorrect answer, but also the reinforcement of points towards their quarter grade when they score at least a 75%.

The rigidness of a traditional classroom is in contrast with Alfie Kohn's student directed learning theory. Ideally, students should be allowed to learn at their own pace without an emphasis on standards (Hussung, 2016). Kohn believes the extrinsic motivation, the reinforcements from Skinner's theories for example, is not effective over time; once the rewards stop, so does the behavior. This method decreases intrinsic motivation and teaches students that learning is "something that must be gotten through" (Woolfolk, 2011, p. 275). Allowing students to make mistakes, having multiple chances to do their homework assignments, does follow this theory.

"Skinner, unlike Kohn, understood that people learn best in a responsive environment... When rewards provide students with information about their growing mastery of a subject or when the rewards show appreciation for a job well done, then the rewards bolster confidence and make the task more interesting to the students, especially students who lacked the ability or interest in the task initially" (Woolfolk, 2011, p. 275).

Limitations:

Throughout the study, it is assumed that the participants involved tried their best on each test that was taken. The greatest limitation of this study was the sample size, with only 41 students in the first year and 30 students in the second. Any results from this study may be significant for the school district, but more research will be needed to generalize to other districts. Additionally, the school district has performed extremely well from year to year on the

EOC tests. Thus lower-achieving students in the study are likely to fall into a higher category at a different school or in the state/country as a whole.

Although the semester and final exams are identical, it is impossible to know how the eighth grade EOC and Algebra I EOC compare from year to year. It is assumed these tests are similar from year to year, covering the same overall topics and scored in the same format. The test is created based on the same set of learning standards. Released questions from previous years have altered the teaching of lessons in the class.

Students were taught using comparable lectures and in-class work, using the same guided notes, although not identical in wording and some questions changed. Because of differences in students, some topics were discussed more in-depth in one year or the other based on student input as well as homework and test results. The timing of the lessons also varied depending on the school schedule. This means the classes could have had a different amount of lessons before EOC testing in particular. The semester exam schedule was different from the first year to the second. The first year students completed the exam in one study block, an 80-minute class period, all taken at the same time. The second year students completed the exam in three, 40-minute periods, at different times and in a different order based on class period.

The end-of-course test, or EOC, is given by the Ohio Department of Education to various classes and grade levels each year. The test is designed to follow the Ohio Learning Standards. Question formats include extended response, fill in the blank, and multiple choice among others. Each student is given a raw score based on correct answers, a maximum of 774 for eighth-grade math and 814 for Algebra I. Scores then fall into one of five performance levels: limited, basic, proficient, accelerated, and advanced (Understanding Ohio's, 2019).

Merriam-Webster defines feedback as "the transmission of evaluative or corrective information about an action, event, or process to the original or controlling source" (Feedback, n.d.). Fyfe (2016) lists the following types of feedback: none, verification, correct-answer, elaborated, and try-again. All of these options, aside from none, are available when taking an assessment on Khan Academy.

Summary:

The purpose of this chapter was to present the motivation, background, and purpose of the study. The demand for cost-effective resources by school districts, a push towards utilizing technology in the classroom, and an increase in available online resources motivate this study, to determine if instant feedback and online homework increase test scores.

This study compared semester exam, final exam, and Algebra I end-of-course test scores across a two year time period. Using the eighth grade EOC to control for prior knowledge, scores for students completing paper-and-pencil homework were compared with those from students completing predominantly online homework. Further, this study looked at differences in scores across gender and achievement level.

Chapter II: Background and Literature Review

The purpose of this chapter is to present the prior research and statistics on the categories pertinent to this study: feedback, online homework, and technology, both in the classroom and with teens.

Feedback:

Feedback can come in a variety of ways, including a grade, comments, and a simple correct or incorrect response. In a study of students taking college courses entirely online, a large majority of students found a grade provided the most useful feedback, with most wanting to know how to improve (Jones & Blankenship, 2014). Nutbrown, Beesley, & Higgins (2016) list the following recommendations for feedback: timely, informative, reliable, consistent, clearly communicated, specific, and useful for teachers. Additionally, providing students detailed feedback and allowing them to fix and resubmit their assignments provided better work on both that assignment and future assignments (Nutbrown et al., 2016).

Fyfe (2016) conducted research on the effects of different types of feedback. Feedback, no matter the type, resulted in better scores on posttests after one assignment. Her results show extensive feedback or additional attempts do not necessarily improve results. She found an interaction between feedback and prior knowledge, with correct-answer feedback providing the best outcomes for low-knowledge students. The effectiveness of feedback may be different based on student achievement, with lower-achieving students benefiting more from feedback, but overall any feedback has a positive effect over no feedback (Fyfe, 2016).

Gjerde, Padgett, and Skinner (2017) looked at the difference in process feedback versus outcome feedback. Process feedback looks at a student's thinking process in getting their answer

while outcome feedback looks only at the student's answer. Providing two different sections of the same class with different types of feedback on the same assignments, they were able to compare quiz and exam scores. Their results showed that process feedback was more beneficial on analysis-based questions while outcome feedback was more beneficial on questions that were either correct or incorrect. Both types of feedback did provide improvements on quizzes. Although feedback has been shown to have a positive effect on student learning, they note many obstacles including the time required, determining the best type of feedback, and not knowing if the feedback is actually used appropriately (Gjerde et al., 2017).

Online Homework:

A study conducted on a college class that switched to requiring online homework to be completed before taking quizzes showed positive results. Quiz scores throughout the semester showed statistically significant higher scores for the treatment group than both of the previous two classes. The online homework class had a 3.9% higher class grade on the final exam than one of the previous classes which was determined to be statistically significant but was statistically equal with the other previous class. There was also a significant improvement in scores from the beginning of the semester to the end as well as an improvement in almost every question on the pre-test versus the post-test that was given to the treatment group (Pennington, 2013).

More positive results were shown in fifth graders when given both traditional homework and web-based homework that included feedback. Classes were separated into two groups, each set given both web-based and paper-and-pencil homework over the same information, but at opposite times. The appropriate pre-tests and post-tests were given to the groups to gauge

understanding. As noted, since many online systems take only the final answer into consideration, students are more likely to do mental math, doing less hand written work and cheating amongst students could be easier. Still, results of the study showed significantly more learning occurred when students completed the online homework with a large effect size, although improvements occurred in both cases (Mendicino et al., 2009).

One study looked into the effect of online homework choice, is there an effect of requiring homework or making it optional. It found the students who completed the online homework generally had a higher GPA and course grade as well as more motivation to study and perform well in the class. Students who did not complete the homework tended to be the lower performing college students, but those that completed it had scores closer to their GPA as opposed to those that did not. Overall, students preferred online homework as opposed to traditional homework in both the required and non-required groups, with significantly more positive responses from the required users versus the non-required users (Wooten & Eggers, 2013).

When it comes to how students perceive online homework, immediate feedback, having multiple or unlimited attempts, and easy access were listed as the biggest advantages with technical problems as the only major disadvantage (Serhan & Almeqdadi, 2020). A survey by Albelbisi (2018) also showed "a positive relationship... between performance expectancy, effort expectancy, and attitude toward the use of OHW."

Technology and the Classroom:

Fichten, Asuncion, and Scapin state the 1990s as the beginning of a wider use of digital technology in education. At that time, the technology used included course or learning

management systems, PowerPoint, the internet, and email. There was also an increase in electronic submissions. Today, most teachers use digital technology, including "PowerPoint and Prezi, podcasts, videos, clickers, ..., simulations, blogs, digital textbooks, and Web conferencing" (Fichten, Asuncion, & Scapin, 2014).

The decreasing cost of technology and increasing use of computerized assessments have contributed to a growing number of schools implementing a one-to-one ratio in the classroom. A meta-analysis of numerous studies found one-to-one laptop initiatives have improved test scores and "can improve educational outcomes when there is teacher buy-in, suitable technical support and professional development for teachers, and appropriate implementation with the curriculum" (Zheng, 2016).

The Education Glossary lists multiple advantages of a one-to-one initiative as well. Benefits include allowing for collaboration, interactive and innovative teaching strategies, and "can increase student motivation, engagement, and interest in learning, and that students will be able to learn more and learn in more exciting ways." Disadvantages listed include cost and technological problems (One-to-one, 2013).

Technology and Teens:

Today's teens have increasing access to cell phones and the internet. Nearly 9 in 10 adolescents have access to the internet, using it for things like social networking, playing games, and watching videos. As of 2011, 85% of teens have their own phones, with 35% being a smartphone, more than triple the percentage from 2009 (Stewart & Kaye, 2012). A similar study by the Pew Research Center found a significant increase in smartphone access in 2018, with approximately 95% of teens having a smartphone or access to one. With this increase, internet

usage has also risen with around 45% of teens using the internet on an almost constant basis and another 44% using it multiple times a day. Over half of teens report using social media sites YouTube, Instagram, Snapchat, and/or Facebook (Anderson and Jiang, 2018).

Summary:

The purpose of this chapter was to present previous studies and research that pertains to this study. Various feedback options have been proven helpful, online homework has shown positive or similar results to traditional homework, and ever-changing technology has had a significant effect on both the classroom and teens.

Chapter III: Methodology

The purpose of this study is to determine the effects, if any, assigning online math homework has on assessment scores as opposed to traditional paper-and-pencil homework. This chapter will describe the methodology that will be used to conduct this study as well as give information on the participants.

Setting and Participants:

All students in the study completed a full year college-prep Algebra I. Participants were freshmen, sophomores, or juniors, ranging from 14 to 17 years old. All students had the same teacher for Algebra I, but had different teachers prior to taking the course. Students were taught using similar lectures, during 40 minute class periods, following the same lesson progression.

There are 40 students who completed Algebra I using traditional paper-and-pencil homework out of a digital textbook, representing the control group. Students would complete homework and work/answers were discussed the following class period. There are 19 boys, 21 girls, and 9 students in the control group that completed a high school Pre-Algebra course prior to enrolling in the class.

There are 29 students who completed the course using predominantly online homework, representing the experimental group. Students completed homework in a one or two day time period, but immediately knew if their answers were correct or incorrect. Students were required to earn at least a 75% on the assignment to get full credit and could attempt the assignment as many times as necessary to achieve this score. Partial credit was given for completing the assignment but not earning the required score. There are 12 boys, 17 girls, and 5 students in the experimental group that completed a high school Pre-Algebra course prior to enrolling in the

class. Due to the coronavirus outbreak cancelling Ohio schools from March 16, 2020, for the school in this study, to the end of the school year, these students were taught/lectured all lessons during that time using online videos, but still completed homework using the same online format. This distance learning format covered material from the middle of chapter 8 through chapter 9.

The study was conducted at Miller City High School, located in Northwest Ohio. The school is comprised of 99% white students, with 52% female and 22% coming from low-income families. Miller City High School consistently achieves well above state-average EOC test scores in all subjects and a 100% 4-year graduation rate (Miller City, n.d.).

On a small scale, the results of this study will be used by the school district as evidence to determine if purchasing a textbook in the future is necessary for Algebra I. Results can be more widely used for other other math classes in the district as well, both in various grade levels and other high school classes. Because Miller City High School is in a consortium and works so closely with surrounding districts, this will have an effect on their textbook decisions as well. With an ever-changing budget and funding changing from year to year, schools across the country are constantly searching for more cost-effective textbooks for new ways to save money. With positive results in this study, one cost-effective measure would be to try these free resources as opposed to purchasing textbooks, either hard copy or digital. Further research, with a much larger sample pool, would be required before generalizing results for schools and classes across the country.

With a sample size of 40 and 29 participants for the control and experimental group, respectively, the achieved power will be 0.524 with a moderate effect size. A larger sample size would be ideal to achieve greater power, but is not feasible for the purposes of this study.

Instrumentation:

The end-of-course test, or EOC, is given in the spring by the Ohio Department of Education to various classes and grade levels each year. The test is designed to follow the Ohio Learning Standards. Question formats include extended response, fill in the blank, and multiple choice among others. Each student is given a raw score based on correct answers, a maximum of 774 for eighth-grade math and 814 for Algebra I. Scores then fall into one of five performance levels: limited, basic, proficient, accelerated, and advanced (Understanding Ohio's, 2019).

The semester exam tested students over material covered from the start of class through chapter 4, taken in December for both the control and experimental group. The exam was created by the researcher of this study. Questions on the exam were identical for the two groups and consisted of fill in the blank, matching, or multiple choice with various amounts of answer options. Each answer was worth 1 point each. Due to scheduling differences, the semester exam given to the control group was given in one 80-minute session and all students completed it at the same time. The experimental group was given the exam over three 40-minute sessions, at different times, but students could not change answers from one session to the next.

The final exam tested students over material covered immediately after the semester exam, starting with chapter 5, through chapter 9. This exam is not cumulative over the entire course, there was no information on both the semester exam and the final exam. This exam was taken in May for both the control and experimental group. Questions were identical for the two groups and were similar in format to the semester exam. The control group completed the final exam in one block session, all at the same time. Due to distance learning, the experimental group completed the exam at home at various times. Half of these students took the test while being

proctored by a teacher through video chat to ensure they were completing it honestly. The other half took it independently and were given a time limit to submit.

Procedure:

All the eighth grade EOC exams were taken prior to taking Algebra I and before this study took place. Data from these exams come from the Ohio Department of Education with access provided by Miller City High School. With schools closed because of the coronavirus pandemic, through at least April 6 at the time, the Ohio legislature waived all state testing on March 25, 2020 (Kelley, 2020). This included the Algebra I EOC that was going to be used in this study. Because of this, the experimental group in this study did not take the Algebra I EOC, and therefore that part of the study has been excluded.

The semester and final exams were administered and graded by the researcher of this study. Scores for these exams as well as the gender of the students have been provided by the researcher. No identifiable information can connect any of the scores with the students that participated.

The Shawnee State University Institutional Review Board, IRB, approved this study on December 2, 2019. The Exempt IRB Application is given in Appendix A.

Data Processing and Analysis:

Two separate independent samples t-tests will be conducted to determine if there is a difference in mean scores for both the semester exam and final exam for the control group versus the experimental group. Descriptives will include the sample size as well as the mean, standard deviation, and box-and-whisker plot of the assessment scores. The assumption of normality will

be tested by a Shapiro-Wilk test and a histogram, while independence is assured since no students are in both the control and experimental group.

Similarly, two ANCOVAs will also be conducted, one for the semester exam and one for the final exam, with the covariate being the student's eighth-grade EOC score and the two groups being the control and experimental groups. Descriptives will include the mean and standard deviation of each test score with no adjustment for the covariate as well as the sample size for each. The assumptions will be tested; homogeneity of variance by Levene's test, normality by a Shapiro-Wilk test and histogram, and independence of a student's eighth-grade EOC score over the two groups. Depending on the results, a post-hoc analysis of pairwise comparisons may be required.

Lastly, a multiple regression model will be determined with the dependent variable being the final exam scores and predictors of control/experimental group, semester exam grade, eighth grade EOC score, and gender. Assumptions of normality, by a Q-Q plot, multicollinearity, by Variance Inflation Factors, and independence will be checked. Every case will be looked at to determine if there are any extremely influential cases and what happens if an influential case is deleted. An interpretation of the coefficients from the model will be included.

The idea for and the basis of this study stems from a master's thesis completed by Kristen Ann Pennington in 2013 at the University of Akron. The goal of the thesis was to determine if there was an improvement in success rates for students who were required to complete online homework. Further, the study looked at various factors and their impact on a student's final grade (Pennington, 2013).

Summary:

The purpose of this chapter was to lay the framework for conducting the study, the results of which will be in the next chapter. Various tests will be used to determine if there is a statistical difference in the type of homework assigned on assessment scores. Although the study can no longer test the effects of online homework on the cumulative Algebra I EOC test, it will focus on the semester and final exams.

Chapter IV: Results

This chapter will address the two main research questions. Does the type of homework, online versus traditional paper-and-pencil, have an effect on semester and final exam scores? How does type of homework, gender, EOC scores, and semester exam score predict final exam scores? The appropriate assumptions will be checked, tests conducted, and results summarized.

Participants:

All students in the study completed a full year of college-prep Algebra I. Participants were freshmen, sophomores, or juniors in high school, ranging from 14 to 17 years old. All students had the same teacher for Algebra I, but had different teachers prior to taking the course. Students were taught using similar lectures, during 40 minute class periods, following the same lesson progression.

There are 40 students total, N = 19 (47.5%) males and N = 21 (52.5%) females, who completed Algebra I using traditional paper-and-pencil homework out of a digital textbook, representing the control group. Students would complete homework, predominantly in one day. Work and answers were then discussed in the following class period, after the entire assignment had been completed. Most homework assignments were not graded but there were random completion grades to entice students to complete the work.

There are a total of 29 students, consisting of N = 12 (41.4%) boys and N = 17 (58.6%) girls, who completed the course using predominantly online homework, representing the experimental group. Students completed homework in a one or two day time period, but immediately knew if their answers to each question were correct or incorrect. Every homework assignment was graded. Students were required to earn at least a 75% on the assignment to get

full credit and could attempt the assignment as many times as necessary to achieve this score. Partial credit was given for completing the assignment but not earning the required score.

Descriptives:

The scores for each instrument used were analyzed. The eighth grade EOC had scores out of 774, the semester exam out of 65, and the final exam out of 75. Descriptives of these scores for both the control group (N = 40) and experimental group (N = 29) are included in Table 4.1. Figures 4.1-4.3 show the box-and-whisker plots across both groups for each test score.

Table 4.1: Score Descriptives

	Mean	**SD**	**Range**
Control Group			
Eighth Grade EOC	730.28	25.83	673-774
Semester Exam	48.66	8.23	34.2-65
Final Exam	52.96	15.03	23-75
Experimental Group			
Eighth Grade EOC	731.75	25.95	658-774
Semester Exam	53.61	6.75	36.25-63.4
Final Exam	57.88	12.30	29-73

Two t-tests will be conducted, one each for the semester exam and the final exam, across the traditional paper-and-pencil group and the online homework group. To control for prior knowledge, an ANCOVA will be run for each of these exams using a student's eighth grade EOC as the covariate. These tests will determine if there is a difference in mean scores between the control and experimental group.

To test for the assumption of normality, a Shapiro-Wilkes test was conducted for the semester exam, final exam, and EOC scores. The results show the population of EOC scores are not normally distributed ($W = 0.957$, $p < .05$). The semester exam scores ($W = 0.964$, $p < .05$) and final exam scores ($W = 0.936$, $p < .01$) were determined not to be normally distributed either. Histograms for EOC and semester exam scores, included in Figures 4.4 and 4.5 respectively in Tables and Figures, do not appear to show scores fall far from normal, however the final exam scores, in Figure 4.6, verify the scores do not come from a population distribution that is normally distributed. Independence is assured as no student is in both the experimental and control group. Even though the assumption of normality is not met, the t-tests and ANCOVAs will still be performed.

Mean Scores:

To examine differences in mean semester exam scores, an independent samples t-test was conducted. Results from Levene's Test for Homogeneity of Variance indicate that the equal variance assumption is met: $F(1,67) = 3.48$, $p = .07$. Results of the t-test are shown in Table 4.2.

Table 4.2: Independent Samples t-test for Semester Exam Scores

	t	df	p-value	Mean Difference	95% Confidence Interval Lower	Upper
Exam Scores	2.74	65.92	< .01	4.95	1.34	8.56

The difference in the means was significant, $t(65.92) = 2.74$, $p < .01$, indicating that the experimental group, who completed their homework online, had a mean difference (1.34, 8.56) points higher than the control group, who completed their homework with paper-and-pencil. With scores out of 65, this would represent an increase of between 2% and 13% on the semester

exam. The effect size is r = .320, representing a moderate effect, with a high achieved power, 75.7%.

To examine mean differences in the means for the final exam scores, an independent samples t-test was conducted. Results from Levene's Test for Homogeneity of Variance indicate that the equal variance assumption is met: $F(1,67) = 3.73$, $p = .06$. Results of the t-test are shown in Table 4.3.

Table 4.3: Independent Samples t-test for Final Exam Scores

	t	df	p-value	Mean Difference	95% Confidence Interval Lower	Upper
Exam Scores	1.49	65.95	.14	4.92	-1.66	11.50

The difference in the means was not statistically significant, $t(65.95) = 1.49$, $p = .14$. This indicates that the experimental group had a mean difference (-1.66, 11.50) points higher than the control group, and therefore mean scores for the two groups should be considered equal. The effect size is r = .180, representing a small effect, with a low achieved power, 30.5%.

An ANCOVA was conducted to control for the influence of the eighth grade EOC scores on both the semester exam and final exam scores. To run an ANCOVA, two further assumptions needed to be tested. Independence of EOC scores across the control and experimental groups was confirmed, $F(1,66) = 0.05$, $p = .82$. For the semester exam, there was homogeneity of regression slopes, $F(1,64) = 0.20$, $p = .66$. However, there was a violation of this homogeneity for the final exam scores, $F(1,64) = 6.38$, $p < .05$, but the ANCOVA will still be run.

The ANCOVA results for the semester exam scores are shown in Table 4.4. A student's eighth grade EOC score was used as a covariate and the two groups were the control and experimental group.

Table 4.4: Semester Exam ANCOVA with EOC as Covariate

	SS	df	F	p
Intercept	1018.15	1	36.73	< .001
Group	343.86	1	12.41	< .001
EOC	2111.60	1	76.19	< .001
Residuals	1801.58	65		

The results show that when the effect of the EOC is removed, the effect of homework type on the semester exam score is statistically significant, $F(1,65) = 12.41$, $p < .001$, $\eta^2 = .160$. Further, a student's semester exam score is predicted or influenced by their EOC score, $F(1,65) = 76.19$, $p < .001$, $\eta^2 = .540$. A Tukey post-hoc analysis was conducted and shown in Table 4.5. The results show the experimental group had a mean difference 4.57 points higher on the semester exam than the control group when controlling for a student's EOC score, with a 95% confidence interval between 1.98 and 7.16 points higher.

Table 4.5: Semester Exam ANCOVA Post-Hoc Analysis

	Estimate	SE	t	p	95% Confidence Interval	
					Lower	Upper
E - C	4.57	1.30	3.52	< .001	1.98	7.16

The ANCOVA results for the final exam scores are shown in Table 4.6. A student's eighth grade EOC score was used as a covariate and the two groups were the control and experimental group.

Table 4.6: Final Exam ANCOVA with EOC as Covariate

	SS	df	F	p
Intercept	2059.5	1	14.30	< .001
Group	320.8	1	2.23	.14
EOC	3681.7	1	25.57	< .001
Residuals	9359.0	65		

The results show when the effect of the EOC is removed, the effect of homework type on the final exam is not statistically significant, $F(1,65) = 2.23$, $p = .14$, $\eta^2 = .033$. However, a student's final exam score is influenced by their EOC score, $F(1,65) = 25.57$, $p < .001$, $\eta^2 = .282$.

Predicting Final Exam Scores:

In order to run a multiple regression model to predict a student's final exam score, the control group participants were coded with 0's while the experimental group was coded with 1's. Similarly, females were coded with 0's and males were coded with 1's. A model for determining a student's final exam score was created using group, gender, EOC score, and semester exam score. The Q-Q Plot for this model is included in Figure 4.7 in Tables and Figures. Although there are violations at the lower and upper level, it does not appear to be severe, indicating that the assumption of normality is not violated. Variance Inflation Factors were determined for each of the predictors. Each VIF is included in Table 4.7 in Tables and Figures. EOC and Semester exam scores show slight collinearity, but it is not high enough to be excluded from the model.

Results are shown in Table 4.8. The model is statistically significant, $F(4,63) = 24.69$, $p < .001$; 58.6% of the variance in final exam scores is explained by the regression on the predictors of group, gender, EOC score, and semester exam score. The residual standard error of the model is 9.11 on 63 degrees of freedom.

Table 4.8: Multiple Regression Model to Predict Final Exam Score

	Estimate	SE	t	p	95% Confidence Interval Lower	Upper
Intercept	5.64	39.79	0.14	.89	-73.88	85.16
Group	-2.37	2.45	-0.97	.34	-7.27	2.53
Gender	-2.02	2.27	-0.89	.38	-6.54	2.51
EOC	-0.03	0.06	-0.49	.63	-0.16	0.10
Semester	1.46	0.22	6.68	< .001	1.03	1.90

With all four predictors in the model, there is not enough evidence to support the coefficients for group, gender, and EOC score to be other than 0 with the coefficient for semester exam score being the only one statistically significant. When controlling for homework type, gender, and EOC score, semester exam score was a significant predictor for final exam score, $t(65) = 6.68$, $p < .001$. The results indicate the predicted final exam score will increase by 1.46 points for each point increase in a student's semester exam score. There is a .95 probability a student's predicted final exam score will increase between 1.03 and 1.90 points for every point increase in their semester exam score.

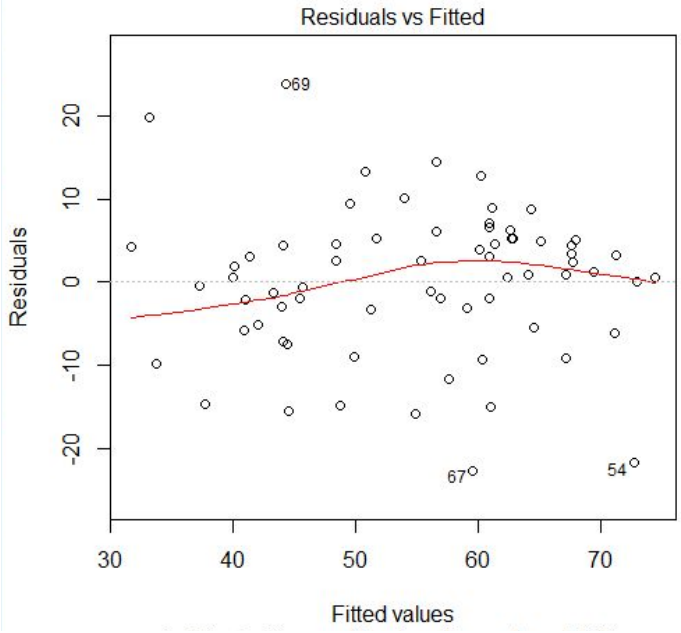
To determine if there were any extremely influential cases in determining the model, Cook's Distance was calculated for each case. These distances were plotted and included in Figure 4.8 in Tables and Figures. Case 69 was determined to be the most influential, with a distance of 0.45. Since this is less than 0.5, it was determined that it is not influential enough to be deleted. Additionally, using:

$$\frac{3(k+1)}{n} = \frac{3(4+1)}{69} \approx 0.217$$

as a cutoff, the hat matrix revealed no extremely influential cases.

Figure 4.9 shows the plot of Residuals vs. Fitted for the four predictor multiple regression model. Linearity does not appear to be violated. Based on the spread at each level, there does not appear to be unequal variance of the error terms. There does appear to be two or three residuals that stand out from the rest.

Figure 4.9: Residuals vs Fitted for Multiple Regression



Summary:

The purpose of this chapter was to determine if there was a difference in mean scores for the semester and final exams between the control group, completing traditional homework, and the experimental group, completing online homework. This was accomplished using t-tests to compare scores and with ANCOVAs using a student's eighth grade EOC score as a covariate to gauge prior knowledge. Additionally, a model was created to predict a student's final exam score based on the homework type, gender, semester exam score, and EOC score.

Both the t-test and ANCOVA determined there was a difference in mean semester exam scores between the two groups. The t-test showed completing online homework resulted in

semester exam scores (1.34, 8.56) points higher than completing traditional paper-and-pencil homework. When the effects of a student's EOC score were removed, the online homework group scored (1.98, 7.16) points higher than the traditional homework group. Final exam scores for the two groups were found to be statistically equal with and without using EOC scores as a covariate.

A multiple regression model was found to predict a student's final exam score using group, gender, EOC score, and semester exam score. The semester exam score was the only one statistically significant, with enough evidence to support it is not zero. When controlling for the type of homework, gender, and EOC score, the predicted final exam score increased by 1.46 points for each point increase in their semester exam score.

Chapter V: Conclusion

The increase of technology in the classroom motivated this study. More and more schools are adopting one-to-one initiatives and recommending the use of free online resources. The purpose of this study was to determine the effects, if any, of assigning online homework as opposed to traditional paper-and-pencil homework to Algebra I students.

B.F. Skinner's theory on operant conditioning provided the main theoretical framework for this study. "The key to Skinner's theory is reinforcement, or anything that strengthens the desired response. This could include praise, good grades, a reward or even a feeling of accomplishment" (Hussung, 2016). In the classroom, learners should receive immediate feedback on responses. These reinforcements condition the behavior to reoccur (Hussung, 2016). Students who completed homework online not only received immediate feedback of a correct or incorrect answer, but also the reinforcement of points towards their quarter grade when they scored at least a 75%.

The rigidness of a traditional classroom is in contrast with Alfie Kohn's student directed learning theory. Ideally, students should be allowed to learn at their own pace without an emphasis on standards (Hussung, 2016). Kohn believes the extrinsic motivation, the reinforcements from Skinner's theories for example, is not effective over time; once the rewards stop, so does the behavior. This method decreases intrinsic motivation and teaches students that learning is "something that must be gotten through" (Woolfolk, 2011, p. 275). Students being allowed to make mistakes, giving them multiple chances to do their online assignments, did follow this theory.

Summary of Research:

Technology in the classroom has grown from email and PowerPoints to individual devices for every student and a variety of courses delivered entirely online. The decreasing cost of technology and increasing use of computerized assessments have contributed to the growing number of schools implementing a one-to-one ratio into the classroom. A compilation of numerous studies found benefits to a one-to-one initiative, including improved test scores (Zheng, 2016). The rise in the cost of textbooks has also contributed to this change. Online resources, such as Khan Academy, offer additional benefits not available out of a textbook. This includes automatic grading and instant feedback, beneficial to teachers and students alike.

Numerous previous studies have shown the benefits of feedback for student improvement. Fyfe (2016) found improved scores even without extensive feedback which can be time consuming for teachers, although the best type of feedback may vary based on student achievement levels. Gjerde, Padgett, and Skinner (2017) found benefits to both process and outcome feedback depending on the type of questions being asked. Nutbrown, Beesley, & Higgins (2016) list the following recommendations for feedback: timely, informative, reliable, consistent, clearly communicated, specific, and useful for teachers. Additionally, providing students detailed feedback and allowing them to fix and resubmit their assignments provided better work on both that assignment and future assignments (Nutbrown et al., 2016).

This study included a total of 69 participants. Each participant completed a full year of high school level Algebra I. 40 of these participants were given traditional paper-and-pencil homework assignments throughout the year while 29 were given predominantly online homework, mainly through Khan Academy assignments. The in-class portion remained consistent between the two groups, with similar lectures and lesson progressions throughout

most of the school year. All participants were given identical semester and final exams. The eighth grade EOC tests given to participants prior to taking Algebra I were not identical, but should be considered equivalent as it covered the same state standards.

Due to the coronavirus pandemic, the research questions needed to be adjusted. Namely, there was no Algebra I EOC to analyze and therefore had to be excluded. To determine if online homework improves semester exam and final exam scores a t-test and ANCOVA using a student's eighth grade EOC as a covariate was conducted. The control group was assigned traditional paper-and-pencil homework while the experimental group was given online homework. The results of the t-test and ANCOVA showed a statistically significant difference in mean semester exam scores but not final exam scores. The t-test showed completing homework online improved semester exam scores by (1.34, 8.56) compared to traditional paper-and-pencil. The ANCOVA showed the group that completed online homework had a mean difference 4.57 points higher on the semester exam than the group completing traditional homework when controlling for a student's EOC score, with a 95% confidence interval between 1.98 and 7.16 points higher.

Without an Algebra I EOC for the experimental group, a model was determined to predict a student's final exam score using the predictors of homework group, gender, eighth grade EOC, and semester exam score. In this four predictor model, a student's semester exam score was the only one found to be statistically significant. Controlling for homework group, gender, and EOC score, for each point increase in a student's semester exam score, their predicted final exam score would increase by (1.03, 1.90) points. Though not statistically significant, when controlling for homework group, gender, and semester exam score, each point

increase in a student's EOC score would change their predicted final exam score by (-0.16, 0.10) points, virtually no change at all.

Limitations:

The main limitation of this study was the sample size. With 40 and 29 students in the control and experimental group respectively, it was impossible to achieve a large effect size. The participants included did not represent a diverse student body. Most participants were caucasion from similar backgrounds, and an above average math ability based on their eighth grade EOC scores. The results of this study can be generalized to the school district where it took place, as well as those with similar demographics. Based on the small, relatively homogeneous sample size, it is impossible to generalize these results to a broader population.

There were a variety of differences between the control group and the experimental group, mostly due to the disruption to the school year because of the coronavirus pandemic, that could have had an effect on the results of this study. The last nine weeks for the experimental group was given entirely online through distance learning. This included video lectures over new material as well as continuing online homework assignments. Both groups were given similar reviews in the days leading up to the semester exam. This included various group work and homework assignments. However, these reviews leading up to the final exam varied. The control group was given reviews similar to the semester exam. The experimental group had an optional review posted online and given numerous opportunities to ask additional questions on a video chat or by message followed by a video example. Few students took advantage of these review options but still could have prepared independently. Although each exam was given in a similar manner within each group, the two groups were not given either exam in the same format. The

control group had to complete each exam in one block session. The experimental group had the semester exam broken up into three days and the final exam was given remotely, either completed on video chat or on a time limit. The final exam weight on a student's final grade was adjusted due to distance learning as well. The exam was worth 10% of a student's final grade for the control group, whereas it was less than 7% of the student's quarter grade, or approximately 1.5% of their final grade, for the experimental group. It is unknown if this adjustment had an effect on the effort put forth by the students. Lastly, given a year long time gap between groups, it is almost certain there were grading inconsistencies between groups, especially for questions where partial credit was awarded.

Another limitation is based on the differences in grading policy for the two types of homework assignments. The traditional homework group rarely had their assignments graded. There was always a possibility of a completion grade, but these were worth minimal points and therefore would not drastically change a student's grade. The online homework group had every assignment graded. Although each assignment was worth only a handful of points, cumulatively they amounted to approximately 20-30% of a student's quarter grade. Because students could attempt these assignments as many times as necessary to achieve the required score, it is almost guaranteed that students spent more time completing online assignments than their counterparts completing traditional homework. It is unknown how much of an effect this additional time on task and effort to achieve correct answers had on the results of the study.

This study could have been improved in a number of ways. The biggest improvement would be with greatly increasing the sample size. Though most tests performed showed statistically insignificant results, having a larger sample size would make significant findings

more notable. All information from the control group in this study was collected after the fact. Because of this, there was a limited amount of data that was able to be used. This also relied on using assessments that were already created instead of determining one or more that would have been better suited for this study. With the Algebra I EOC being cancelled for the experimental group, there was no cumulative assessment that covered the entire year. These scores would have been more representative of the overall knowledge learned in the course.

Future Research:

Aside from a much larger sample size, future research needs to include a more diverse population. Specifically, this should include numerous participants from each general ability category, from low to high performing math students. This would help determine if the effect of online homework, if any, varies between performance levels. Does completing online homework improve test scores more for lower performing students compared to higher performing students?

Looking at the effects of online homework could be broadened to any subject matter as well. Keeping the same model, this study could be conducted in any classroom that is considering converting to online homework. Are there benefits in English classes that do not show up in science classes for example? This study focused on Algebra I, would the results be different in more advanced math classes like Calculus or in college courses? Are there different results with elementary students versus high school students?

Summary:

With technology continuing to evolve and be further implemented in the classroom, the need for research on potential benefits of non-traditional resources will continue to grow as school districts and teachers look to improve student achievement. This study looked at online

homework specifically. The results showed differences in mean semester exam scores, but not final exam scores when compared to traditional paper-and-pencil homework. When determining a model to predict a student's final exam score, their semester exam score was the only statistically significant predictor, showing a positive correlation. Additional research would be needed in order to generalize the results to the education community as a whole.

References

Albelbisi, N. A., & Yusop, F. D. (2018). Secondary School Students' Use of and Attitudes Toward Online Mathematics Homework. *The Turkish Online Journal of Educational Technology*, *17*(1). Retrieved from https://eric.ed.gov/?

Anderson, M., & Jiang, J. (2018, May 31). Teens, social media & technology 2018. *Pew Research Center.* Retrieved November 24, 2019, from https://www.pewresearch.org/internet/2018/05/31/teens-social-media-technology-2018/.

Boser, U. (2013, June 14). Are Schools Getting a Big Enough Bang for Their Education Technology Buck? *Center for American Progress.* Retrieved from https://eric.ed.gov/?

Education and Learning Resources: Houghton Mifflin Harcourt. (n.d.). Retrieved December 8, 2019, from https://www.hmhco.com/.

Feedback. In *The Merriam-Webster.com Dictionary*. Retrieved December 15, 2019, from https://www.merriam-webster.com/dictionary/feedback

Fichten, C. S., Asuncion, J., & Scapin, R. (2014). Digital Technology, Learning, and Postsecondary Students with Disabilities: Where We've Been and Where We're Going. *Journal of Postsecondary Education and Disability, 27(4)*, 369–379. Retrieved from https://eric.ed.gov/?

Fyfe, E. R. (2016). The Benefits of Feedback on Computer-Based Algebra Homework. Tucson, AZ: North American Chapter of the International Group for the Psychology of Mathematics Education. Retrieved from https://eric.ed.gov/?

Gjerde, K. P., Padgett, M. Y., & Skinner, D. (2017). The Impact of Process vs. Outcome Feedback on Student Performance and Perceptions. *Journal of Learning in Higher Education*, *13*(1), 73–82. Retrieved from https://eric.ed.gov/?

Hussung, T. (2016, May 31). Understanding Three Key Classroom Management Theories. Retrieved February 5, 2020, from https://online.husson.edu/classroom-management-theories

Jones, I. S., & Blankenship, D. (2014). What do you Mean you Never got any Feedback? *Research in Higher Education Journal*, *24*. Retrieved from https://eric.ed.gov/?

Kelley, Jeremy P. "Ohio Cancels School Testing, Sets Graduation and Voucher Rules: 7 Things to Know about Changes." *Dayton Daily News*, 27 Mar. 2020, www.daytondailynews.com/news/local-education/coronavirus-state-cancels-school-testing-sets-graduation-and-

voucher-rules/oc2iW7BtkruLPlxF9z8OMO/.

Khan Academy. (2019). *Khan Academy.* Retrieved December 10, 2019, from http://www.khanacademy.org/.

The majority of K-12 teachers are assigning fewer hours of homework, yet 77 percent think homework is beneficial to students. (n.d.). *The University of Phoenix,* Retrieved from https://www.phoenix.edu/about_us/media-center/news/majority-of-teachers-think-homework-is-beneficial.html.

Mendicino, M., Razzaq, L., & Heffernan, N. T. (2009). A Comparison of Traditional Homework to Computer-Supported Homework. *Journal of Research on Technology in Education*, *41*(3), 331–359. doi: 10.1080/15391523.2009.10782534

Miller City High School. (n.d.). *GreatSchools*, Retrieved February 4, 2020, from https://www.greatschools.org/ohio/leipsic/4122-Miller-City-High-School/

More Than 50 Percent of Teachers Report 1:1 Computing. (2017, February 1). *EdTech.* Retrieved December 8, 2019, from https://edtechmagazine.com/k12/article/2017/02/more-50-percent-teachers-report-11-computing.

Nutbrown, S., Higgins, C., Beesley, S. (2016) Measuring the Impact of High Quality Instant Feedback on Learning. Practitioner Research in *Higher Education Journal*, Special Assessment issue, 10(1), pp.130-139. Retrieved from https://eric.ed.gov/?

One-to-one. (2013, August 29). *Great Schools Partnership*, Retrieved November 21, 2019, from https://www.edglossary.org/one-to-one/.

Pennington, K. (2013). *Improving College Algebra Grades Using Online Homework Completion as a Prerequisite for Quizzes.* (Electronic Thesis or Dissertation). Retrieved from https://etd.ohiolink.edu/

Roden, K. (2011, July 13). *Technology in Education.* Retrieved from https://eric.ed.gov/?

Serhan, D. & Almeqdadi, F. (2020). Students' Perceptions of Using MyMathLab and WebAssign in Mathematics Classroom. *International Journal of Technology in Education and Science*, 4(1), 12-17. Retrieved from https://eric.ed.gov/?

Stewart, A., & Kaye, K (2012). Freeze Frame 2012: A Snapshot of America's Teens. Washington DC. *National Campaign to Prevent Teen and Unplanned Pregnancy.* Retrieved from https://eric.ed.gov/?

Tech in the classroom. (n.d.). *MidAmerica Nazarene University*, Retrieved from https://www.mnu.edu/graduate/blogs-ideas/tech-in-the-classroom

Understanding Ohio's State Tests Score Reports. (2019, October 18). *Ohio Department of Education*

Woolfolk, A. (2011). *Educational psychology: active learning edition*. Boston: Pearson/Allyn and Bacon Publishers.

Wooten, T., & Dillard-Eggers, J. (2013). An Investigation of Online Homework: Required or Not Required? *Contemporary Issues in Education Research*, *6*(2). doi: 10.19030/cier.v6i2.7728

Zheng, B., & Henion, A. (2016, April 26). Does learning improve when every student gets a laptop? Retrieved November 20, 2019, from https://msutoday.msu.edu/news/2016/

Tables and Figures

Figure 4.1: Box-and-Whisker Plot for EOC Scores

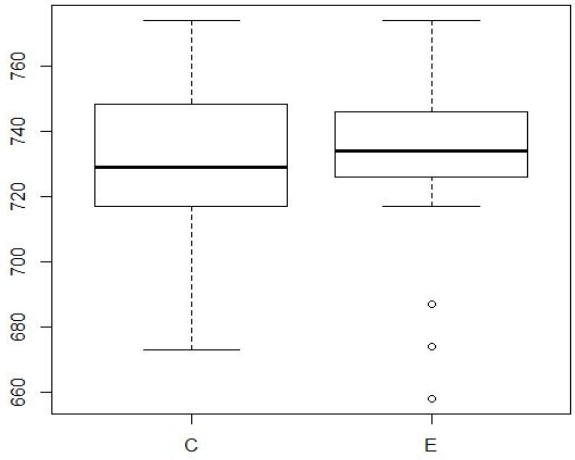


Figure 4.2: Box-and-Whisker Plot for Semester Exam Scores

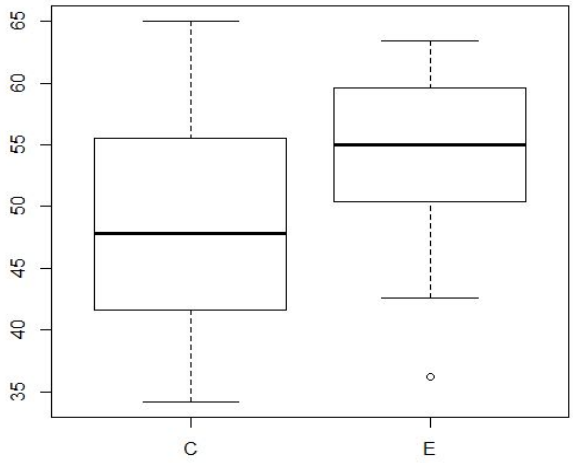


Figure 4.3: Box-and-Whisker Plot for Final Exam Scores

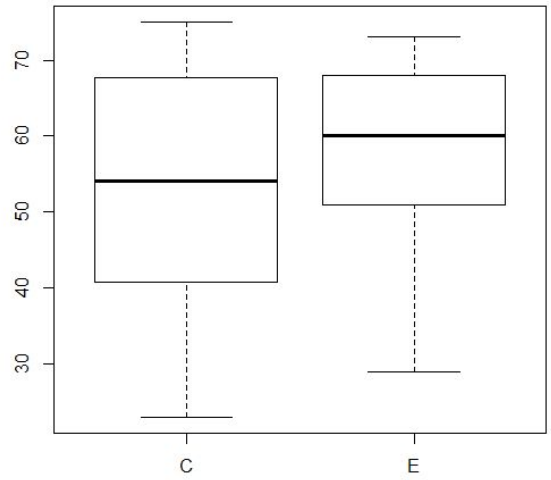


Figure 4.4: Histogram for EOC Scores

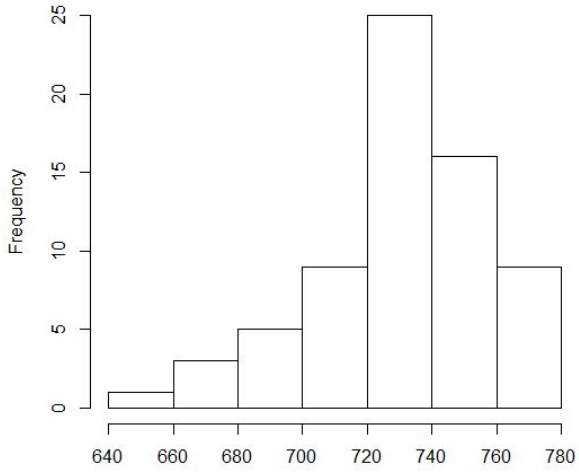


Figure 4.5: Histogram for Semester Exam Scores

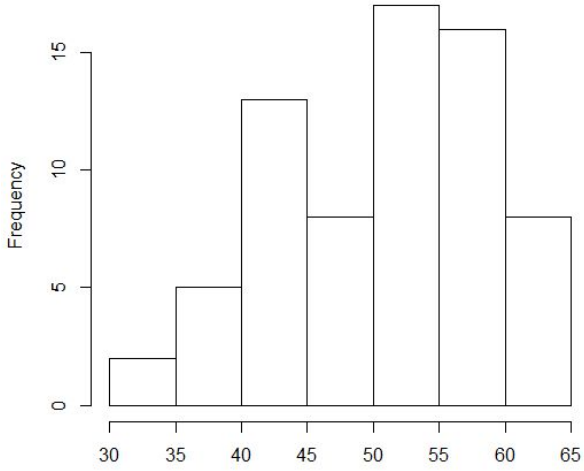


Figure 4.6: Histogram for Final Exam Scores

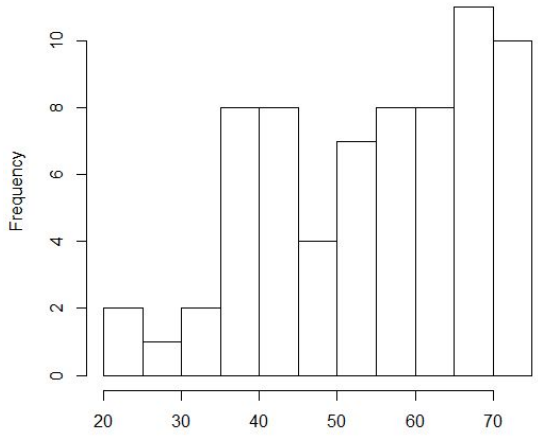


Figure 4.7: Q-Q Plot for Multiple Regression

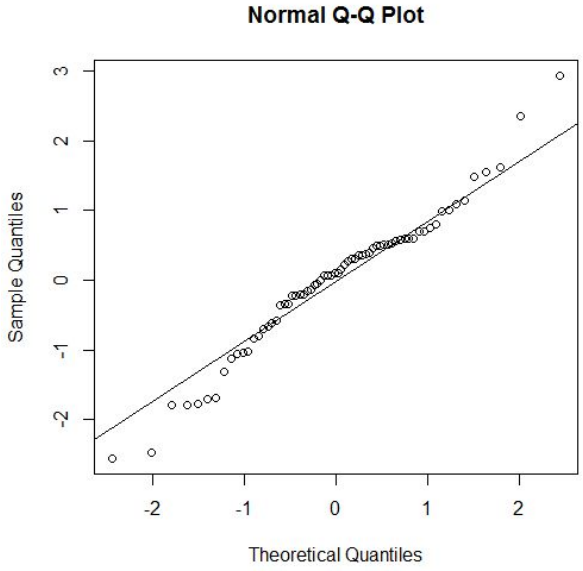
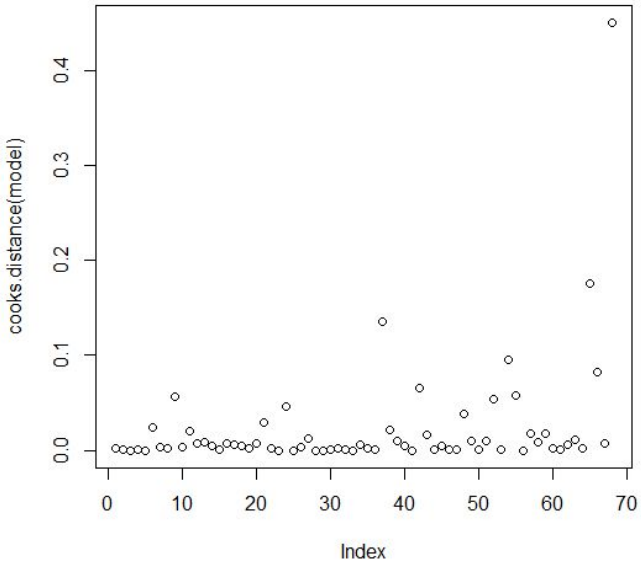


Table 4.7 Variance Inflation Factors for Multiple Regression

	Group	Gender	EOC	Semester
VIF	1.19	1.04	2.22	2.49

Figure 4.8 Cook's Distance for Multiple Regression



Appendix A

For Office Use Only

Protocol #

Shawnee State University

Exempt Review Application

Title of Research Project: Does requiring students to complete online homework with instant feedback have an impact on test scores?

Name(s) of Principal Investigators:	Email address:	Faculty	Student	Other
Katie Muhlenkamp	muhlenkamp_k@roadrunner.com	☐	■	☐
Douglas Darbro	ddarbro@shawnee.edu	■	☐	☐
		☐	☐	☐
		☐	☐	☐
		☐	☐	☐
		☐	☐	☐

*Please place an asterisk by the investigator name(s) whose NIH certificate(s) is/are already on file with the IRB, if the certificate is less than 3 years old.

Contact Name: Katie Muhlenkamp Contact Phone Number: (419)953-2989

Department(s)/Division/Agency: Math Department

Please place a check mark next to the category that best describes your research. You may check more than one category.

■ Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (a) research on regular and special education instructional strategies, or (b) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

☐ Research involving the use of educational tests (e.g., cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (a) data obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (b) any disclosure of the human subjects' responses outside the research could reasonably place the participants at risk of criminal or civil liability or be damaging to the participants' financial standing, employability, or reputation. No videotaping or photography is allowed for data collection. You may not collect data from appointed public officials or candidate for public office.

☐ Research involving the collection or study of existing information, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a

manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

- ☐ Research and demonstration projects that are conducted by or subject to the approval of supporting agencies, and which are designed to study, evaluate, or otherwise examine: (a) public benefit or service programs; (b) procedures for obtaining benefits or services under those programs; (c) possible changes in or alternatives to those programs or procedures; or (d) possible changes in methods or levels of payment for benefits or services under those programs.
- ☐ Taste and food quality evaluation and consumer acceptance studies, (a) if wholesome foods without additives are consumed or (b) if a food is consumed that contains a food ingredient at or below the level, and for a use, found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the Food and Drug Administration and approved by the Environmental Protection Agency or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

If at least one of these categories does NOT describe your research, then you should complete the "Expedited and Full Review Application" instead of this one.

1. Describe the key demographics (age, SES, ethnicity, geographic locations, gender, etc.) of the sample that you wish to obtain. __High school Algebra I students, age 14-17, almost entirely white, at a very small rural school in northwest Ohio, both males and females, from a variety of socio-economic backgrounds. _____

1a. What is the greatest number of participants that will be recruited? _30 from this year's class, 41 from last year's class (includes 1 student in both years)_____

1b. How will participants be recruited? _All students currently enrolled in Algebra I and all students from last year's class will be recruited. A letter will be sent home describing the research topic. _____

2. Will participants be remunerated for their participation? Yes (No)

2a. If so, how will participants be remunerated? Please indicate the type of remuneration and the amount. For instance, the participants will be given a $10 Amazon Gift Card for participation or the participants will receive 3% of their final grade in extra credit in their Introduction course. _No. All of the data for the research is required for the class.

2b. If participants do not complete the study, will partial or full remuneration be given? Please describe how that will be determined. ___No _____

3. What direct benefits (other than remuneration) exist for the participants who participate?

There are no other direct benefits to participating.

4. What direct risks could the participants potentially face? Check all that apply.

_____ Risk of breach of confidentiality or privacy

_____ Risk of coercion by researcher(s)

_____ Risk of psychological harm

_____ Risk of physical harm

_____ Other potential risk: _____

If you checked any direct risks in Item 4, then you should complete the "Expedited and Full Review Application."

5. Will the participants be informed of the risks and benefits of the study? Yes (No)

5a. If so, how will the participants be informed?

5b. Please check each box if the following criteria match your research.

- ■ The research involves no greater than minimal risk.
- ☐ It is not practicable to conduct the research without a waiver of informed consent or alteration to informed consent.
- ■ Waiving or altering the informed consent will not adversely affect the subjects' rights and welfare.
- ■ The consent document would be the only record linking the subject and the research, and the principal risk would come from a breach of confidentiality.

5c. Do you wish to waive the signed informed consent? (Yes) No

Shawnee State University | Protocol #

In submitting this form and the corresponding documents, I acknowledge that I have completed Human Research Participants training and that I understand and will uphold the rights of human participants. I also verify that all information contained in this form and any other corresponding documentation is correct based on my knowledge. I understand that I may not have contact with any research participants until the Shawnee State University IRB has given me their approval.

Katie McMahon

Signature of Principal Investigator 1

Signature of Principal Investigator 2

Signature of Principal Investigator 3

Signature of Principal Investigator 4

Signature of Principal Investigator 5

Signature of Principal Investigator 6

Date of Submission: 11-22-19

I. The main research question is "Does requiring students to complete online homework with instant feedback have an impact on test scores?" To determine if there is a difference in test scores, I will look at the difference between last year's Algebra I class and this year's class. Some previous studies that are directly related to this include the research on requiring students to complete online homework before taking quizzes in class (Kristen Ann Pennington, 2013), an analysis of a variety of different homework research (R. Paschal, T. Weinstein, and H.J. Walberg, 1984), and comparing web-based homework to paper and pencil homework (A. Cunningham, O. Diaz, N. Angulo, 2011).

II. This research will compare the success of the Algebra I class of 2019 with the Algebra I class of 2020. I will be comparing their final exam scores and the state end-of-course test. I will be using all of the student's eighth-grade state end-of-course test results as their baseline score, or beginning knowledge score, so I can compare similar students and determine knowledge growth. This year's class will take a final exam that I create and administer that is identical and/or comparable to last year's class. The class of 2019 had almost entirely paper and pencil homework out of a textbook. The class of 2020 has had almost all of their homework assignments online since the beginning of the school year, with most of the assignments giving instant feedback if the answer is correct and hints to help fix incorrect answers.

III. Each subject will have an eighth grade EOC test score, a final exam score, and an Algebra I EOC score. The means of the final exam and Algebra I EOC of the 2019 class vs. the 2020 class will be compared using an independent samples t test to determine if the differences are significant. ANOVAs will be performed to compare the final exam scores and Algebra I EOC

scores based on a student's eighth grade EOC score. No names will be used in any summary of results, but results may include subject numbers to follow the scores of each student.

IV. Data collection will begin with past test results, continue throughout the spring semester of2020 (namely the final exam) and end when the end-of-course test results come back to the school. These are generally posted at the beginning to middle of June, 2020.

CERTIFICATE

OF COMPLETION

PHRP Online Training, LLC certifies that

Katie Muhlenkamp

has successfully completed the web-based course
"Protecting Human Research Participants Online Training."

Date Completed: **09/10/2019**
Certification Number: **2839272**

PHRP
Protecting Human
Research Participants
Online Training

Bibliography

Katie Muhlenkamp

Candidate for the Degree of

Master of Science Mathematics

Thesis: EFFECTS OF ONLINE HOMEWORK ON ALGEBRA I TEST SCORES

Major Field: Mathematics

Education: Bachelor of Arts in Mathematics, Bluffton University, May 2012

Completed the requirements for the Master of Science in Mathematics, Portsmouth, Ohio in August 2020.

ADVISER'S APPROVAL: Douglas G. Darbro, Ph.D.

Douglas G. Darbro July 24, 2020