

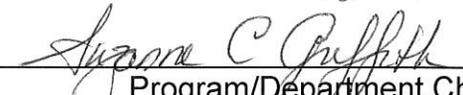
The Effects of Immediate Correctness Feedback on Student Learning, Understanding, and Achievement

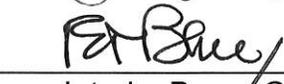
By

Kacy Johnston

A Thesis Submitted to the
Graduate Faculty in Partial Fulfillment
of
the Requirements for the Degree of
Master of Science in Education


Major Sponsor


Program/Department Chair


Interim Dean, Graduate Studies

University of Wisconsin – Superior

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Of the Requirements for the Degree

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August 2015

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Abstract

There is a national push from many directions to improve student achievement in all STEM areas. A study done by Harvard University's Program on Education Policy and Governance (HuffPost, 2012) found that the United States students are making gains at a fraction of the rate of other countries. Assistments is a free online program that allows students to submit homework online. With this program it is possible that students are able to be given hints to assist them in completing problems and then receive immediate feedback on the correctness of their answers. This study examined the effectiveness or lack of effectiveness of using an online homework submission program on student achievement in 7th grade mathematics. This study used a quantitative approach in which one class was used as a study group and three classes were used as a control group. While all classes still received the same instruction, the study group used the online homework submission program which provided hints on problems and immediate correctness feedback, and the control group submitted homework using the traditional paper and pencil method and was provided next day feedback. The researcher looked for possible relationships between student achievement and the use of the online homework submission program over the course of a full chapter in the mathematical curriculum.

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CHAPTER 1: INTRODUCTION

Middle schools, first developed in the mid 1960's, were brought about to meet student developmental needs (Meyer, 2011). Meyer refers to Alexander, Department of Education at George Peabody College for Teachers in Nashville, that Middle Schools were meant to offer students more exploratory options, freedom of movement, involvement in their learning, and resources for help with personal problems. More recently there is some debate about the effectiveness of middle schools. Meyer quotes Pierson-Yecke's 2005 study, *Mayhem in the Middle*, stating that "American middle schools have become the places 'where academic achievement goes to die'" (p. 40).

Several large studies have examined how United States students have ranked in Mathematics and Sciences among several other nations. The Programme for International Student Assessment (PISA, 2012), ranks the United States 27th of 34 Organisation for Economic Co-operation and Development (OECD) countries. PISA tested 600 students who were 15 year olds and randomly selected from 161 randomly selected schools. The Trends in International Mathematics and Sciences Study (TIMSS) by the National Center for Educational Statistics (NCES, 2011), used national samples of public and private schools drawn to represent the nation. The United States 8th graders were placed among the top 24 of 56 educational systems (2011). The Huffington Post (2012) reported that a study done by Harvard University's Program on Education Policy and Governance found that students in Latvia, Chile, and Brazil were making gains in academics three times faster than American students. Students in Portugal, Hong Kong, Germany, Poland, Leichtenstein, Slovenia, Columbia, and Lithuania were improving at twice the rate.

Given the state of student academic development, how do middle school teachers, who are always searching to find ways to improve student achievement, help students to gain better understanding of mathematics? This study intends to add new information to the already existing research focused on the effects of immediate feedback on student understanding and achievement of middle school mathematics. This study will gather, analyze, and compare student achievement in a 7th grade math class with students receiving immediate feedback and hints on homework with students who receive standard next day feedback on homework.

Problem Statement

The effects of immediate feedback have been debated over the years. In fact, there is evidence that supports that feedback within 24 hours is just as effective as immediate feedback (Cuthbert, 1982, p. 360). However, there is also evidence to support that immediate feedback does increase student achievement as “poorly conceived homework does not help learning” (Kelly, 2012). The proposed study intends to shed light on this problem through the collection, analysis, and interpretation of a limited sample of aggregate 7th grade mathematics data. Scores will be retrieved from the Aptitude Inventory Measurement Service (AIMS) Mathematics Concepts and Application (M-CAP) and Mathematics Computation (M-COMP) assessments, chapter pre-tests and post-tests, and chapter quizzes. The research intends to explore potential relationships between the use of immediate feedback and hints and student achievement.

Rationale of the Study

The purpose of this study is to explore the potential for differential achievement of students in 7th grade math classes using two different methods of homework completion (online versus traditional paper and pencil). Achievement will be measured using standardized assessments, chapter pre-tests and post-tests, and chapter quizzes. Results will be compared and analyzed to assess for the impact of immediate feedback and hints on student achievement. The study aims to contribute to and inform middle school mathematical instructional practices in the area of student homework completion.

Research Question and Hypothesis

The study asks: How would the use of an online mathematics homework program that provides hints for problems and immediate feedback on the correctness of answers affect student learning and understanding when compared to traditional homework? The hypothesis is that the inclusion of immediate feedback and hints on homework will have a positive impact on student longer term assessment achievement (M-CAP, M-COMP, chapter quizzes and tests), when compared to standard next day feedback.

Assumptions

This study assumes that the 7th grade Pre-Algebra teacher is properly administering assessments, is competent in the subject, and will not change the instruction provided to any classes. It is also assumed that the students in this class are similar to those in all other classes in the areas of gender, race, socio-economic status, and computer and internet access so that students are able to complete the study.

Limitations

This study will be limited to the specific class chosen for the study and to two chapters of mathematics. There will be no long term inferences made. However, as a pilot study, it will allow for the consideration of broader applications. Another limitation is that only one school district in northern Wisconsin is involved. While there is some diversity to the school district, the ethnic makeup of the school is predominately Caucasian (88.9+) with a very small population of students who are American Indian, Asian, Hispanic, Pacific Isle and African American (WI DPI, 2015). Therefore, the study is not a reflection of the diversity of the state of Wisconsin or of the nation and generalizability of the study findings are limited.

Delimitations

This study does not intend to evaluate the effectiveness of the teacher or evaluate the different learning styles of students. It focuses on student achievement through the use of AIMS M-CAP and M-COMP tests, chapter pre-tests and post-tests, and chapter quizzes. Ethnicity, gender, and background are not identified in this study due to the smaller number of students and the need for anonymity. There is no attempt to look at a long term impact as the focus is on the short term results (over the period of each chapter).

Definition of Terms:

AIMS: Aptitude Inventory Measurement Service. This is a web-based program adopted by the School District of Superior and the exams provided are used as standardized benchmark tests three times per school year to measure student growth and achievement.

M-CAP: Math of Concepts and Application. An AIMS test that measures students' abilities to apply mathematical concepts.

M-COMP: Math Computations. An AIMS test that measures students' computational skills.

ASSISTments: A free online website where students are able to submit answers online and receive hints created by the teacher. <https://www.assistments.org/>

Summary of the Study

Results of several large studies have shown that the United States is lacking in the area of student mathematical achievement. There are also questions about how to improve instruction and student achievement in mathematics. The focus of this quantitative study is to assess whether or not, for this group of students at this point in their mathematical education, receiving immediate feedback and hints on homework actually affects their mathematical achievement as positively measured by various types of assessments. The scores of students in this aggregate group will be compared to those of students in the control group receiving the standard next day feedback on homework. This study will attempt to contribute to and inform middle school mathematical practices and will be shared with other staff and administration at Superior Middle School.

CHAPTER 2: LITERATURE REVIEW

Introduction

“American middle schools have become the places ‘where academic achievement goes to die.’” This quote from Pierson-Yecke’s 2005 study, *Mayhem in the Middle* (p.40) in Meyer (2011) calls out the problem with academics at the middle level. Looking specifically at mathematics, there is substantial evidence showing that the United States is coming up short in mathematical achievement ranking when compared to other countries. The Programme for International Student Assessment (PISA, 2012), ranks the United States 27th of 34 Organisation for Economic Co-operation and Development (OECD) countries. The Trends in International Mathematics and Sciences Study (TIMSS) by the National Center for Educational Statistics (NCES, 2011), placed the United States among the top 24 of 56 educational systems (2011). The Huffington Post (2012) reported that a study done by Harvard University’s Program on Education Policy and Governance found that students in Latvia, Chile, and Brazil were making gains in academics three times faster than American students while students in Portugal, Hong Kong, Germany, Poland, Leichtenstein, Slovenia, Columbia, and Lithuania were improving at twice the rate.

The need for transitioning from the current practices to new practices is evident, but how do middle school educators boost student achievement in mathematics? There is some evidence that suggests that the use of immediate feedback, including hints will help to improve student learning and understanding with the intent of improving student overall achievement. This review of the literature lays out some of the research on ways that may improve middle school math learning leading to a rationale for the present study. The review is divided into two

sections; the first reviews the effects of immediate feedback on student achievement and the second reviews the effects of immediate feedback on student engagement.

The Effects of Immediate Feedback on Student Learning and Retention

The effects of immediate feedback on student learning have been examined throughout the years, with varying results. Some studies have shown the effects of immediate feedback to have a positive outcome on student learning while others have found that immediate feedback has no significant effect on student learning and achievement. The following examines the effects of immediate feedback on different age groups and subject areas when the use of immediate feedback is present.

Joseph and Maguire (1982) spent time exploring the interaction between time of feedback and student achievement and academic self-concept for students. There had been discrepancies between the effects of immediate feedback and student achievement over the years, and the author sought to find how immediate feedback really impacted student achievement and academic self-concept. It was noted that in the past, studies had been conducted to test how immediate feedback affected students' ability to retain material, but there were many different reports on its effectiveness. The authors thought this could partially be attributed to the different interpretation of immediate feedback: Some studies assumed immediate feedback meant letting students know if responses were correct or not after each question, while some others interpreted immediate feedback as responding to a complete assignment or test immediately. The authors cited and agreed with Sturges's (1969) claim that another variable, the ability to note relationships between stimulus questions, correct responses and incorrect alternatives, should be

taken into account. It was claimed that this does not happen in immediate item-per-item feedback.

Joseph and Maguire proceeded to then conduct an experiment using 236 fourth graders comparing immediate feedback after completion of a test, after being delayed 1 day, and after being delayed till the end of the study. Students were given a 26 question multiple choice arithmetic skill test. It was found that students with immediate and 1-day delayed feedback had similar results, but both of those groups did better than students who did not receive feedback until the end of the study.

Some 20 years later, Bonham, Deardorff, and Beichner (2003) looked at the use of web-based homework versus traditional paper and pencil homework in the world of College-Level Physics at North Carolina State University. Bonham et al. conducted two experiments: one on a calculus-based physics course and another on an algebra-based physics course. Over the course of a semester, two classes in each course were selected to either turn in homework using a web-based program or using the traditional paper and pencil homework method which received feedback in 1-2 weeks. Both courses received instruction from the same instructor (meaning the same instructor was used for both the algebra-based classes and the same instructor was used for both of the calculus-based courses) and had homework graded by the same graduate student. What Bonham et al. discovered in both sections was that the use of one method of homework submission did not have significant gains over the other. Rather, Bonham et al. argued that any gains in one group over the other seemed to directly correlate to factors other than the type of homework completed. These factors included student background, as measured by grade point average (GPA), Scholastic Aptitude Test math section (SATM), and the Force and Motion

Concept Exam (FMCE). These categories seemed to be significant predictors of student performance in the course, much more than the type of homework submission used.

A couple years later, Brosvic, Epstein, Cook, and Dihoff (2005) examined the role of immediate feedback on learning and retention when used in examinations. The aim was to determine if immediate corrective feedback helped students to learn and retain information better than with delayed or no feedback. 110 students enrolled in a liberal arts and sciences undergraduate course were selected on a voluntary basis. Brosvic et al. used a multi-staged process: five classes took 50-question multiple choice exams. Each class took five exams. One week after the fifth exam, students took a final 100-question multiple choice exam that consisted of 10 randomly selected questions from each of the five classroom exams as well as 50 new questions. Students were assigned to one of five feedback groups: Scantron (which received no feedback); Delayed (which received next day feedback); End-of-Test (which received feedback immediately after completing the test); Immediate/Educator (which received feedback after each question from a proctor); and Immediate/Form (which involved using the Immediate Feedback Assessment Form (IFAT)). (IFAT is used for multiple choice tests, where the correct answer is starred (*) and the incorrect answers are not. Students would answer by scratching off the corresponding letter to the assumed correct answer, much like a lottery scratch off, and if they uncovered the star, they knew they had obtained the correct answer).

What Brosvic et al. (2005) discovered was that there was no specific group that scored highest on any of the five given exams, rather it varied from week to week. However, it was then found that students who received no feedback scored lowest the final exam, while those who received delayed feedback scored higher than the no feedback group. The students that scored the highest on the final exam were those that were in the immediate feedback groups,

which led to Bosvic et al. concluding that immediate feedback enhances acquisition and retention of learned material.

In 2009, DiBattista, Gosse, Sinnige-Egger, Candale, and Sargeson built on the findings of Bosvic et al. (2005) and did another experiment on the use of immediate feedback using IFAT. The purpose of the study was to test not only whether students learned more when given immediate feedback, but also whether they were comfortable with IFAT. DiBattista et al. took a group of 157 undergraduate students ranging in ages 17-55 years in an introductory psychology course and had them complete two 30 question multiple choice tests. One group took standard multiple choice tests with grading occurring after the test was complete, and the other took the multiple choice tests using IFAT. DiBattista et al. found that on the first test both groups had about the same mean score (standard response students had a mean of 58.1 and IFAT students had a mean of 54.0). However, those students who used the standard response form of the tests did not show significant improvement from Test 1 to Test 2, raising the mean to 62.9. Students using IFAT showed significant improvement however, raising the mean to 77.7. The authors concluded then that IFAT directly contributed increased performance levels. DiBattista et al. also gave the IFAT students a questionnaire to fill out after the completion of the tests. They found that students had an overall positive reaction to the IFAT, feeling that they were being rewarded when they found that they had achieved the correct answer and liked knowing the correct answer. More than 90% of students responded that they felt they learned from their mistakes and almost 70% felt that they preferred the immediate feedback when taking tests.

Taking immediate feedback into a more technological form, Mendicino, Razzaq, and Heffernan (2009) set out to find the effect of immediate feedback focused on homework and the use of computer-based programs. Specific to this experiment was the use of the web-based

ASSISTments program. Mendicino et al. randomly selected 92 fifth grade students distributed throughout four different classes. There were two main groups involved in the experiment: one group completed the homework using paper and pencil and the other group completed the homework using the ASSISTments program. The ASSISTments program is an online free program that is able to be used for student homework completion. Hints, created by the instructor, are able to be provided to students. Upon completion of a problem, students are immediately informed of the correctness of their response.

According to Mendicino et al. (2009), those students who started with the web-based approach finished with the paper and pencil method and vice versa. The breakdown went as follows: Two classes started with the web-based approach, while the other two started with the paper and pencil homework completion approach. Of the two classes in the web-based homework approach, one class took a pre-test on number sense, completed the online homework problem set, and then took the post-test the following day. The second class took a mixed problem (focusing on algebra, geometry, data analysis, and probability) pre-test, completed the online homework set, and took the post-test the following day as well. The two classes then switched, taking the opposite pre-tests, completing the homework set using the traditional paper and pencil method, and taking the appropriate post-test the following day. The other two classes, in the traditional homework group, were set up in much the same way. One class took the number sense pre-test, completed the homework using the paper and pencil homework completion method, and took the next day post-test while the other class took the mixed pre-test, completed the paper and pencil homework, and completed the next day post-test. Then the two classes switched problem types and did the same process using the web-based homework completion method. Both groups were given the same two problem sets, each consisting of 10

problems. Students completing homework online were taken to a media room where they logged onto ASSISTments and worked on the problem set. Students doing traditional homework completion were given a worksheet. The students who completed the worksheet received feedback on the homework the next day in class via the instructor. They were allowed to ask questions and seek clarifications for review.

Mendicino et al. (2009) explained that the teacher involved was only able to use the exact hints that were provided to the students who completed the homework using ASSISTments. What the authors found was that the students had a mean gain of 2.32 points out of 10 when using the web-based homework completion as compared to a gain of 1.14 points out of 10 when completing homework traditionally. This led to their conclusion that students learned more with the web based immediate feedback homework approach than they did using the paper and pencil homework completion method.

Kelly et al. (2013) looked again at this idea of the effect of immediate feedback on learning but this time the authors explored the effect of correctness only feedback (students are only told if submitted answers are correct) on student achievement without the use of hints. The purpose was to find if the use of immediate correctness feedback through the ASSISTments program had any impact on student achievement when compared to traditional homework completion. Sixty three seventh grade students were selected to participate in the study. Students still participated in their regular math class and homework. While all students submitted the homework online using the ASSISTments program, some students received no feedback about the correctness of their answers (they just submitted the answers and moved on), while others immediately knew if their answers were correct or incorrect. It was noted that the students receiving correctness feedback were not able to move on until they achieved the correct

answer. There was the ability to press the “show me the last hint” button which showed students the correct answer so that they were able to move on, but teacher created hints were not available.

Each student took a pre-test, was given instruction on the current topic of negative exponents, and then completed a 20 question homework assignment. The following day, students took Post Test 1. After completing Post Test 1, the traditional homework group was given time to correct their homework and ask questions and the immediate feedback group was given the opportunity to have a discussion that was based on the item report generated by the ASSISTments program. The item report showed problems students answered correctly and incorrectly, and this was used by the teacher for the discussion. The following day both groups took Post Test 2. Homework results showed that both groups averaged almost identically on homework when the number of correct (first for the immediate feedback) responses was divided by the total number of questions: the traditional group averaged 61% while the immediate feedback group averaged 60%. The Pre-Test results also showed that students started at about the same level, with the traditional group averaging 9% correct and the immediate feedback group averaging 7% correct. However, the Post Test results showed a difference in gains. After Post Test 1, the traditional group averaged a score of 58% correct and the immediate feedback group scored an average of 69%. After Post Test 2, the traditional group averaged 68% while the immediate feedback group averaged 81%.

Finally, students were surveyed for their opinions of their methods of homework completion. When asked whether students preferred homework on ASSISTments or on a worksheet, 86% responded positive for ASSISTments and 73% responded that their time was better spent using ASSISTments for their homework than a worksheet. This followed the same

pattern of the study done by Mendicino et al. (2009) with greater gains being made by students who completed their homework online.

Singh et al. (2011) took the same ASSISTments program and focused on the role of the hints. While having implemented the same strategy seen in the research done by Kelly et al. (2013) and having all students complete the homework online, regardless of feedback, Singh et al. looked to see if having Immediate Feedback with Tutoring (IFT) available rather than correctness only feedback had a more significant impact on student learning.

Singh et al. (2011) started by comparing the effects of IFT with no feedback at all. Eight 8th grade math classrooms were used in the experiment. On the first day, all students took a pre-test consisting of 10 problems then completed a 10 problem homework assignment. Homework completion methods were divided into two groups. While all students completed the homework using ASSISTments, one group received IFT (tutoring meant that 3-4 hints were provided for each problem) while the other group received no feedback upon completion of problems. The following day students came back to class, reviewed with the teacher, and then took the 10 question post-test. The groups of students then repeated the process with the homework completion methods switched. Those who received IFT the first time received no feedback for the second round, and vice versa. After completion of the experiment, Singh et al. found that while both groups showed learning, the groups participating in the IFT method of homework completion showed higher gains than those students who did not receive any feedback. The mean gain for students using IFT was 2.4 while those who received no feedback had a mean gain of 1.63 out of 10.

Singh et al. (2011) then conducted a second experiment to compare IFT to correctness only immediate feedback. Students were assigned four homework assignments, the first two assignments were used as a pre-test and the last two were used as a post-test. What was discovered was that the mean gain score for the IFT group was 1.0 while the mean gain score for the immediate feedback without tutoring group was 0.4, indicating that the tutoring played an important role in aiding student understanding. To double check, Singh et al. decided to replicate the second experiment to see if the same sort of results were present. In doing so, it was found that the mean gain score of the IFT group was 1.16 and of the feedback without tutoring group was 0.28, reinforcing the findings found the first time around, that those students receiving IFT had greater gains than those students who did not receive any tutoring. The conclusion that the authors made was that having immediate feedback with tutoring strongly influences student learning.

In conclusion, it has been found that with different age levels and in different subject levels, the use of immediate feedback seems to have a positive impact on student achievement. Whether using IFAT or web-based programs, implementing the use of tutoring systems and hints or excluding them, the immediate feedback is found to, in a majority of the presented cases, have a beneficial impact on student learning and achievement. Immediate feedback may also have an impact on areas other than student achievement, such as student engagement. The following study examines how the use of immediate feedback effects student engagement in a class.

The Effects of Immediate Feedback on Student Engagement

In this section, the review covers the effects of immediate feedback on student engagement in an Introduction to Engineering course at the Open University of Catalonia (UOC).

Sancho-Vinuesa, Escudero-Viladoms, and Masia (2013) looked at the effect of immediate feedback on student engagement. Using 206 students in Introduction to Engineering online course at the Open University of Catalonia (UOC), Sancho-Vinuesa et al. compared the academic results and dropout rates of students using two different teaching techniques: providing immediate feedback on practice assessments and not providing immediate feedback on practice assessments. It was noted that practice assessments were very similar to the actual assessments required by students to complete and pass for the course.

To determine how these two techniques affected student engagement, Sancho-Vinuesa et al. (2013) compared student achievement and dropout rates between recent semesters when the immediate feedback was not used and the first semester of when it was used (2010/11). What was found was that the use of the immediate feedback strategy had an effect on student course completion and motivation. The dropout rates and student failure rates had somewhat declined and student engagement and academic results had increased when immediate feedback was provided. The authors concluded that using the technique of immediate feedback over the learning process did have a positive effect on student engagement and confidence and in turn, on student achievement.

Conclusion

The United States has fallen behind many countries in its ranking of student achievement in mathematics. Educators are always looking for ways to improve their instruction so as to better meet the needs of students and help them achieve a higher standard of mathematical achievement. The literature review provides evidence that the use of immediate feedback has a positive impact on student learning and achievement. Even more so, the use of immediate feedback and hints on problem solving produced an even greater impact on student achievement. Whether used with 4th grade students studying basic arithmetic, high school students studying higher levels of mathematics, or college students studying general courses, the implementation of immediate feedback, especially with tutoring or hints, appeared to have had a related increase in student achievement.

CHAPTER 3: METHODOLOGY

The purpose of this study is to evaluate the impact of online homework submission which provides hints on problems and immediate feedback on answers on student achievement in middle school mathematics. The hypothesis is that the use of the ASSISTments program, or another online program similar to it, may have an impact on student learning and achievement. The current study intended to answer the following question: How would the use of an online mathematics homework program that provides hints for problems and immediate feedback on the correctness of answers affect student learning and understanding when compared to traditional homework?

Participants

Participants in this study included one aggregate class of seventh grade students participating in the use of the ASSISTments program for homework submission, and three control group classes, where students submitted homework using traditional paper and pencil method. The ASSISTments group was able to receive hints on problems and immediate feedback on answers while the control group received next day feedback. Each group was provided the same in-class instruction, homework problems, quizzes, and tests.

Superior Middle School (SMS) is located in Superior, WI. There were 917 enrolled at SMS students during the 2013-14 school year. The table below displays the student demographics of SMS for the 2013-2014 year as provided by the Wisconsin Department of Public Instruction (2015):

Superior Middle School

American Indian	4.0%
Asian	1.0%
Hispanic	1.4%
Black	3.0%
White	88.9%
Two or more Races/Ethnicities	1.7%
Female	46.2%
Male	53.8%
Economically Disadvantaged	49.0%

Instrumentation

This study focused on a quantitative approach in which the researcher sought to find potential relationships between the use of an online homework submission program that provides hints on problems and immediate feedback on the correctness of answers and student achievement. These potential relationships were based on student data collected throughout the chapter. The use of multiple data collection was used to increase reliability. The study provided a descriptive comparison between the aggregate class using ASSISTments and the control classes using traditional paper and pencil homework submission. The study attempted to contribute to and inform middle school mathematical practices and will be shared with other staff and administration at Superior Middle School.

Student achievement was measured through a variety of assessment techniques. Assessment techniques included the use of chapter pre-tests and post-tests, two chapter quizzes,

and the use of the AIMS assessments M-CAP and M-COMP, which were given prior to and after the conclusion of the chapter. Data collected compared the achievement of the aggregate group to the control classes.

Procedure

Before any data was collected, approval for the study was sought from the UW-Superior Institutional Review Board (IRB) and from the Building Principal. Once approved, a memo about the study was provided to the students and a separate memo sent home to parents, providing information about the program and stating that the only change happening in students' education is the manner in which homework is submitted. All classroom instruction and routines remained unchanged.

The chapter in which the ASSISTments program was used was Chapter 8 of the Big Ideas Red book. This chapter is 4 sections in length – 8.1 Circles and Circumference, 8.2 Perimeters of Composite Figures, 8.3 Areas of Circles, 8.4 Areas of Composite Figures. Prior to the beginning of the chapter, the M-CAP, M-COMP, and the chapter pre-test was given to all groups. After two sections a quiz was given on the perimeter and circumference of composite figures and circles. After the remaining two sections a second quiz on area of composite figures and circles was given. Then the chapter post-test, which is the same as the pre-test, was given as well as another M-CAP and M-COMP. Upon completion of the chapter, the points earned on all of the assessments were averaged between groups to look for a possible relationship between the use of the online homework submission, which provides hints and immediate feedback, and student achievement. It was estimated that the entire study should take about three weeks to complete.

Data Analysis

Utilizing information gathered from chapter assessments, data collection and analysis consisted of four parts. First, data from the chapter pre-test was compared to data collected from the chapter post-test to gain perspective on student growth throughout the chapter. Second, data collected from the first round of M-CAP and M-COMP was collected and compared to data collected from a second round of M-CAP and M-COMP assessments to determine if there was any student growth on general standardized mathematical knowledge throughout the chapter. Third, student achievement data on quizzes was collected throughout the chapter to determine understanding of concepts. Finally, the data collected throughout the chapter was compared between the aggregate and control groups to see if there was any difference between the two and to help determine if the use of the online homework submission showed a positive effect on student achievement.

CHAPTER 4: RESULTS

The purpose of this study was to evaluate the impact of online homework submission which provides hints on problems and immediate feedback on the correctness of answers on student achievement in middle school mathematics. The quantitative research study focused on the comparison of student achievement on a variety of assessment techniques including the chapter Pre-Test and Post-Test, two chapter quizzes, Pre and Post M-CAP, and Pre and Post M-COMP scores of 7th grade students at Superior Middle School during the 2014-2015 school year. The study sought to contribute to and inform middle school mathematical instructional practices in the area of student homework completion. The study aimed to examine possible relationships between the use of an online mathematics homework program that provides hints for problems and immediate feedback on the correctness of answers and student learning and understanding when compared to traditional homework completion. In order to achieve this goal, information regarding student scores was first collected.

Results

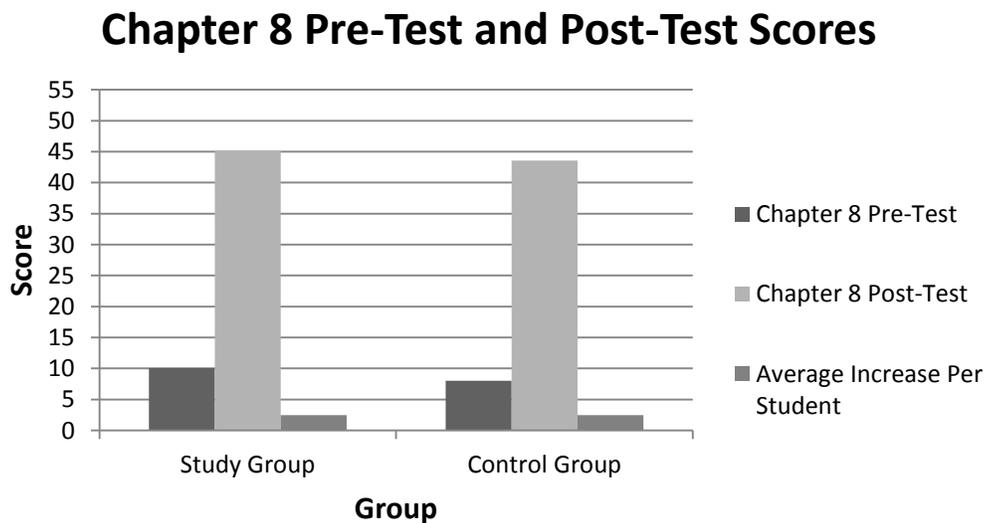
The participants of this study consisted of four 7th grade math classes at Superior Middle School. Of the four classes, one was selected as the Study Group which submitted homework using ASSISTments, an online homework submission website that provided teacher made hints and immediate feedback on the correctness of answers. The other three classes were used as a Control Group participating in traditional paper and pencil homework submission with next day feedback on correctness of problems. All classes had the same instructor and received the same instruction. The study examined student growth over the course of a single chapter, Chapter 8 of the Big Ideas Red Book (Larson, 2014).

Analysis of Data

In order to examine the differences of achievements among the study group and control groups, the average scores of the different assessments were calculated as shown in Graphs 1–3. However, not all students in the Study Group chose, or were able, to complete all of the assigned homework online. Therefore, included are Graphs 4-6, comparing those students from the Study Group who completed all assignments online to the Control Groups.

To begin, Graph 1 shows the average scores for each of the Study and Control Group on the Chapter 8 Pre-Test and Post-Test, as well as the average score increase per student. The Pre-Test and Post-Test averages for the Study Group were 10.1 and 45.1 with an average student increase of 2.5. The Pre-Test and Post-Test averages for the Control Group were 8 and 43.58 with an average increase of 2.48 per student. The data shows that the Study Group had a higher average increase per student by 0.02 point.

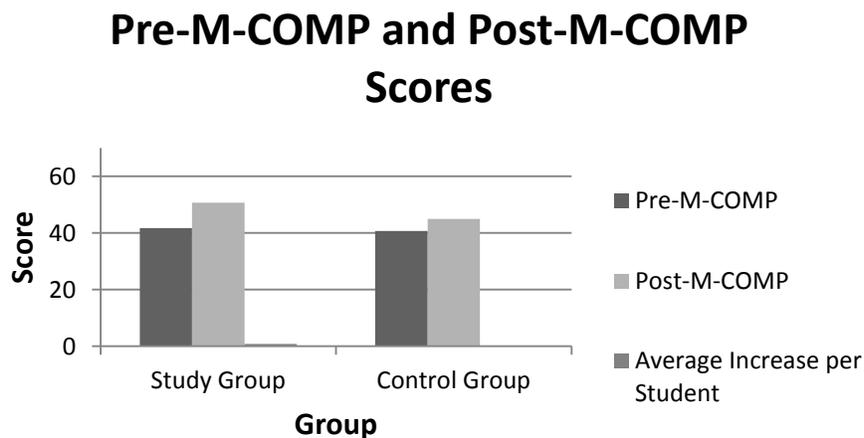
Graph 1: Results of the average scores for Chapter 8 Pre-Test and Post-Test as well as the average increase per student for the Study and Control Group.



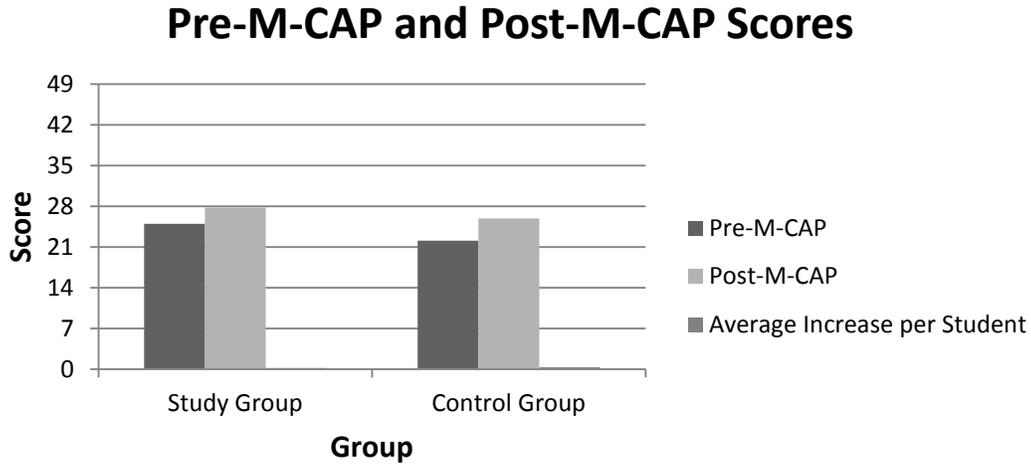
In addition to the Chapter 8 Pre-Test and Post-Test, students were given a Pre-M-CAP and Post M-CAP standardized assessment as well. Graph 2 shows the average scores for each of the Study and Control Group as well as the average score increase per student. For the Study Group, the average Pre-M-CAP and Post M-CAP scores were 25 and 27.79 respectively with an average increase per student of 0.2. The Control Group had average scores of 22.07 and 25.9 with an average increase of 0.29 per student. The data reveal that the Control Group improved by an average of 0.09 point more than the Study Group on this assessment.

Also given to the students were Pre-M-COMP and Post-M-COMP assessments. Graph 4 reveals the average scores for each of the Study and Control Group on both the Pre-M-COMP and Post-M-COMP assessments as well as the average increase in score per student. The Study Group had average Pre-M-COMP and Post-M-COMP scores of 41.77 and 50.77 with an average increase of 0.77 per student. The Control Group had average scores of 40.69 and 44.95 with the average student increase being 0.27, showing that the Study Group increased by an average of 0.5 point more than the Control Group. The results for both sets of assessments may be seen in Graphs 2 and 3 respectively.

Graph 2: Results of the average scores for Pre-M-CAP and Post-M-CAP as well as the average increase per student for the Study and Control Group.

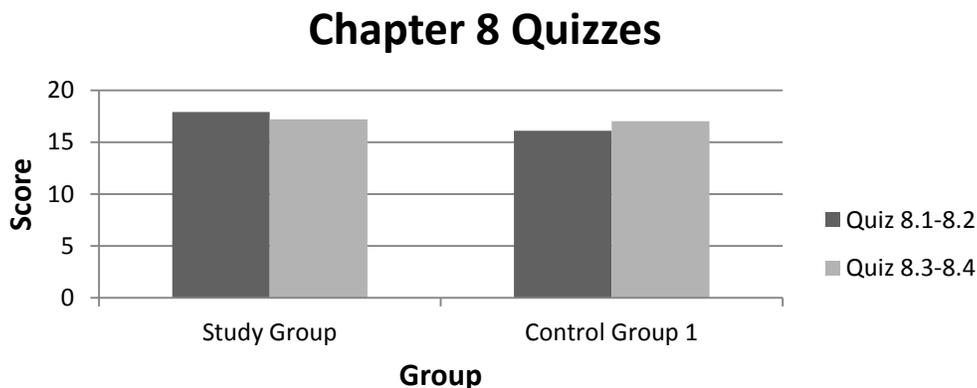


Graph3: Results of the average scores for Pre-M-COMP and Post-M-COMP as well as the average increase per student for the Study and Control Group.



The last type of assessment given to students was in the form of two Chapter 8 Quizzes. One quiz was given in the middle of the chapter covering sections 8.1-8.2, and the other given at the end of the chapter covering sections 8.3-8.4. Graph 4 shows the achievement of each of the Study and Control Group on both Chapter 8 Quizzes. As seen in Graph 4, the Study Group averaged 17.9 and 17.2 on Quiz 8.1-8.2 and Quiz 8.3-8.4 respectively. The Control Group averaged 16.1 and 17 on the two quizzes. The Study Group averaged 0.7 points higher on Quiz 8.1-8.2 and 0.9 points higher on Quiz 8.3-8.4.

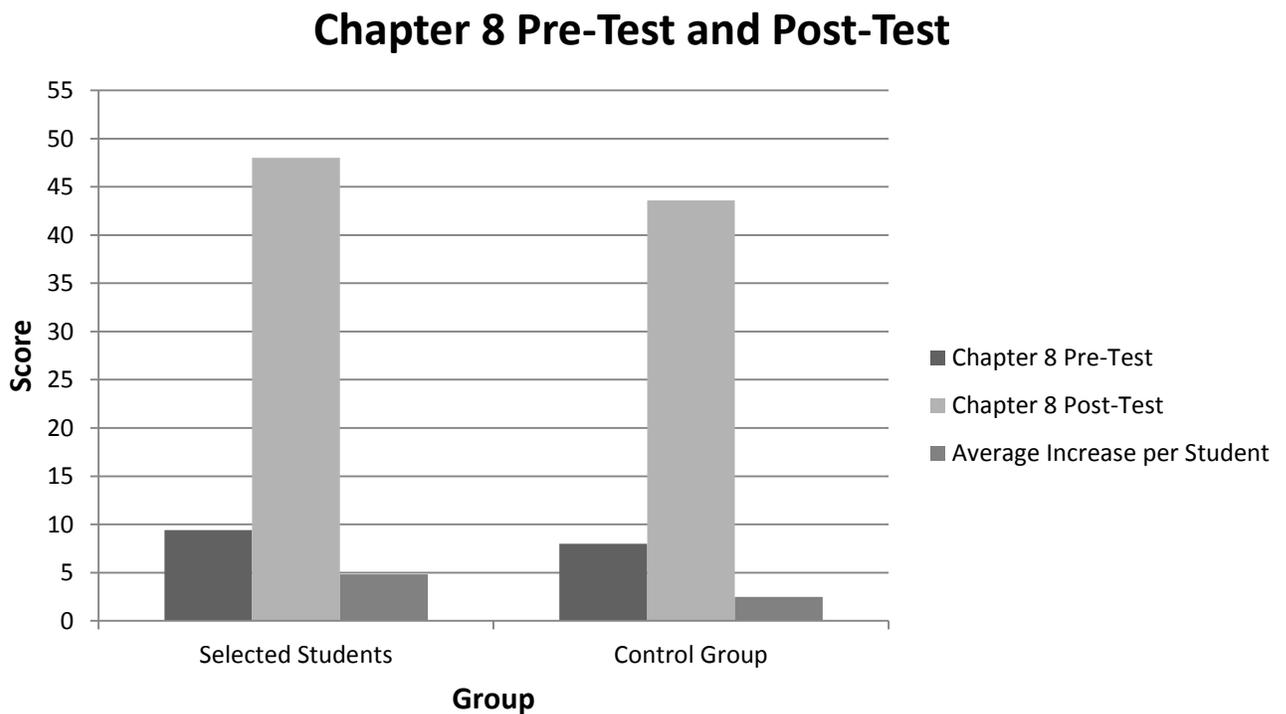
Graph 4: Results of the average scores for Quiz 8.1-8.2 and Quiz 8.3-8.4 for the Study and Control Group.



Of the 14 students in the Study Group, only eight students completed all of the assigned homework online. Due to this fact, a separate analysis was completed using only the students from the Study Group, called Selected Students, who were able to complete all assigned homework using the online ASSISTments program.

Graph 5 compares the average Chapter 8 Pre-Test and Post-Test scores of Selected Students to the Control Group. As the graph shows, the Selected Students averaged 9.4 and 48 on the Chapter 8 Pre-Test and Post-Test with an average increase of 4.83 per student. The Control Group averaged 8 and 43.58 with an average increase of 2.48. The Selected Students increased their average score by 2.35 more points than the Control Group.

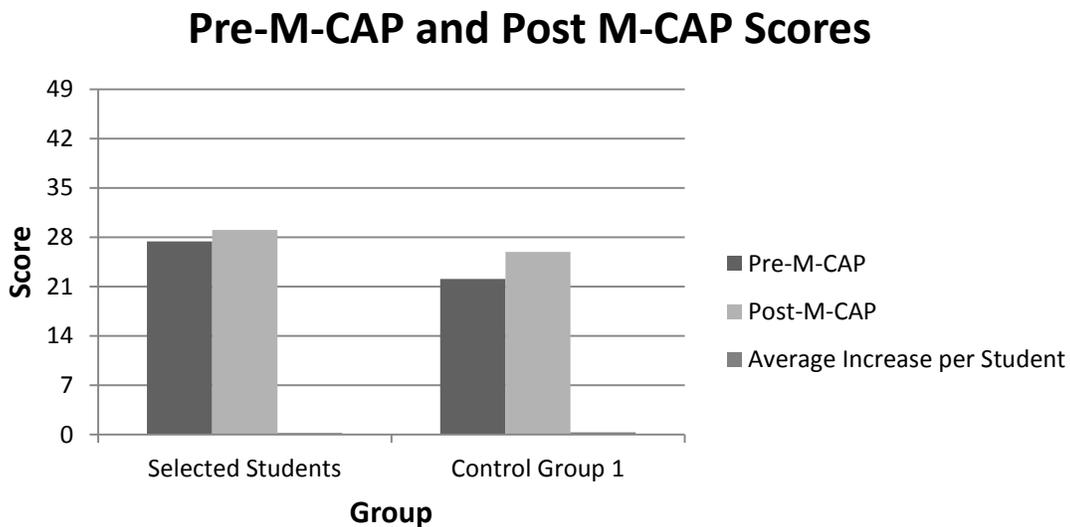
Graph 5: Results of the average scores for Quiz 8.1-8.2 and Quiz 8.3-8.4 as well as the average increase per student for the Selected Students and Control Group.



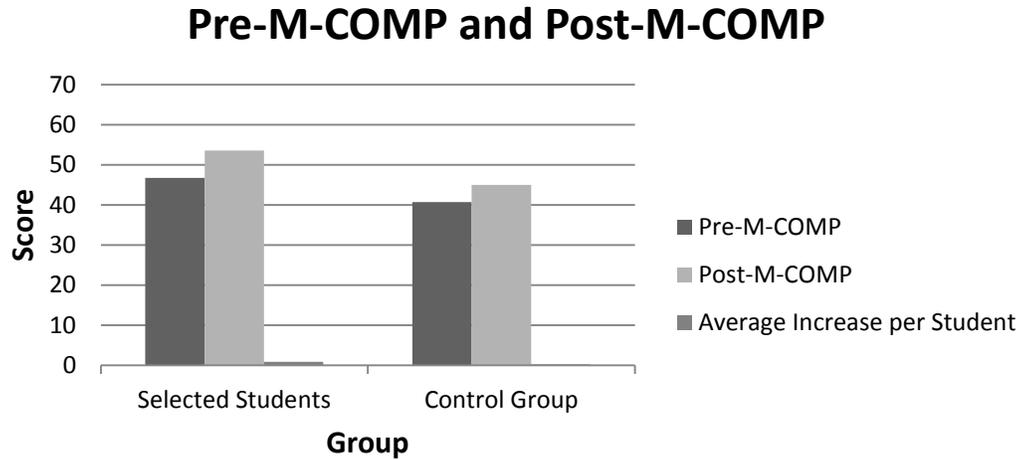
Graph 6 reveals the average scores on the Pre-M-CAP and Post-M-CAP scores for the Selected Students and Control Group. The average Pre-M-CAP and Post M-CAP scores for the Selected Students were 27.38 and 29 respectively, with an average increase of 0.2 per student. The Control Group had averages of 22.07 and 25.9 with an average increase of 0.29 per student, showing that the Control Group averaged an increase of 0.09 point more than the Selected Students.

Similarly, Graph 7 demonstrates the average scores on the Pre-C-COMP and Post-M-COMP assessments for the Selected Students and Control Group. As shown in the graph, the Selected Students averaged 46.71 on the Pre-M-COMP and 53.57 on the Post-M-COMP increasing their scores by an average of 0.86 per student. The Control Group averaged 40.69 and 44.95 on the Pre-M-COMP and Post-M-COMP raising their scores by an average of 0.27 per student. The data shows that the Selected Students had an average increase of 0.59 point more than the Control Group.

Graph 6: Results of average scores for the Pre-M-CAP and Post-M-CAP assessments as well as the average increase per student for the Selected Students and Control Group.

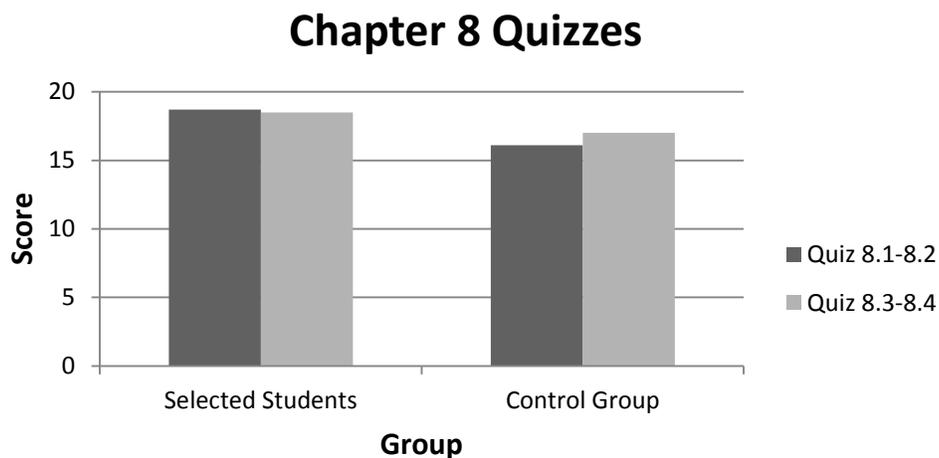


Graph 7: Results of average scores for the Pre-M-COMP and Post-M-COMP assessments as well as the average increase per student for the Selected Students and Control Group.



Finally, Graph 8 shows the achievement of the Selected Students and Control Group on both Chapter 8 Quizzes. The Selected Students averaged 18.7 on Quiz 8.-8.2 and 18.5 on Quiz 8.3-8.4. The Control Group had an average of 16.1 and 17 on Quiz 8.1-8.2 and on Quiz 8.3-8.4 respectively. The Selected Students averaged 2.6 points higher on Quiz 8.1-8.2 and 0.9 points higher on Quiz 8.3-8.4.

Graph 8: Results of the average scores for Quiz 8.1-8.2 and Quiz 8.3-8.4 for the Selected Students and Control Group.



Summary

As the data reveal, those students who participated in the ASSISTments online homework submission method had greater gains and outscored those students in the Control Group. While the Selected Students had more substantial gains than the Study Group, the use of ASSISTments for this chapter showed greater improvement and learning than those students in the Control Group who used traditional paper and pencil homework completion with next day feedback on most assessments.

CHAPTER 5: DISCUSSION

Discussion

The purpose of this study was to evaluate the impact of online homework submission which provides hints on problems and immediate feedback toward the correctness of answers on student achievement in middle school mathematics. This study sought to contribute to and inform middle school mathematical instructional practices in the area of student homework completion. The study aimed to examine a possible relationship between the use of an online mathematics homework program, which provides hints on how to complete problems and immediate correctness feedback on submitted answers, and student learning and understanding when compared to traditional homework completion with next day feedback.

The participants of the study consisted of four 7th grade math classes at Superior Middle School during the 2014-2015 school year. Of the four classes, one was selected as the Study Group, which submitted homework using the online ASSISTments program, while the other three classes were used as the Control Group, which participated in traditional paper and pencil homework submission with next day feedback on correctness of problems. All classes received the same instruction from the same instructor.

The results of the quantitative research, when comparing the Study Group to the Control Group, did not show much greater growth in student achievement throughout the course of the chapter. Of the five assessments provided to students, the Study Group showed gains greater than the Control Group on four of the assessments. The Study Group increased an average of 0.02 point more than the Control Group from the chapter pre-test to post-test, which was worth 55 points. On the Pre-M-COMP to Post-M-COMP exam, worth 70 points, the Study Group

increased 0.5 point more than the Control Group. The Study Group also averaged 0.7 points higher than the Control Group on the first chapter quiz worth 20 points, and 0.9 points higher than the Control Group on the second chapter quiz also worth 20 points. Where the Study Group did not have a higher increase than the Control Group was the Pre-M-CAP to Post-M-CAP. On this 49 point exam, the Control Group increased 0.09 point more than the Study Group. It is worthwhile to note, however, that the Study Group started at an average of 25 when the Control Group started at an average of 22.07, which could contribute to lesser increase.

Another noteworthy factor is that not all of the participants in the Study Group chose, or were able, to submit all of the assignments for the chapter using the ASSISTments program. Of the 14 students in the Study Group, eight submitted all assigned homework using ASSISTments. These eight students, known as the Selected Students, did show a more substantial improvement overall. Of the five assessments provided, the Selected Students also had greater gains than the Control Group on four of the assessments. On the 55 point Pre-Test to Post-Test, the student group increased higher than the Control Group by an average of 2.35 points or about 4.3%. On the 70 point Pre-M-COMP to Post-M-COMP, the Study Group increased 0.59 point more than the Control Group. On both of the Chapter 8 Quizzes, each of which were worth 20 points, the Selected Students averaged 2.6 points higher on the 8.1-8.3 Quiz than the Control Group, and 0.9 points higher on the 8.4-8.5 Quiz. The Control Group did average a higher increase than the Selected Students on the 49 point Pre-M-CAP to Post-M-CAP exam, averaging a higher increase of 0.09. Here it must also be noted that the Selected Students tested at an average of 27.38 to start whereas the Control Group averaged at a 22.07.

Mendicino et al. (2009) found that when students were given the task of completing homework using the online homework submission program ASSISTments, they averaged about

1.18 points higher on a 10 point assessment than the students completing homework using the traditional paper and pencil method with next day feedback. While the experiment done by Mendicino et al. was only conducted over the course of two days, the conclusions are in alignment with the conclusions of this study in that the students using the online homework submission technique with hints and immediate correctness feedback outperformed the students participating in traditional homework submission with next day feedback.

Kelly et al. (2013), who focused on the immediate correctness feedback portion of the ASSISTments program, came up with a similar conclusion when comparing the online homework submission with immediate feedback to next day feedback. Kelly et al. did not use traditional paper and pencil homework submission, but rather online submission regardless. The difference was that one group received immediate feedback on each problem while the other received feedback the next day. It was discovered that the students receiving immediate feedback scored higher than students receiving next day feedback. This study, while not just looking at the role of immediate feedback, does also produce a similar conclusion.

Another study by Singh et al. (2011) used the ASSISTments program to compare the results of student achievement when comparing the use of hints and immediate feedback to next day feedback without hints. Singh et al. also used online homework submission for both groups of students, whether or not they received the hints and immediate feedback. The experiment was done over the course of a couple days and discovered that both groups did show learning, but the group receiving the hints and immediate feedback progressed further than the group only receiving next day feedback. This study also showed similar results. All groups, the Study Group, Control Group, and Selected Students, showed learning over the course of the chapter.

However, it was those students in the Selected Students group that showed the greatest increase over the course of the chapter.

Conclusions

The purpose of this study was to evaluate the impact of online homework submission, which provides hints on problems and immediate feedback toward the correctness of answers, on student achievement in middle school mathematics. This study sought to contribute to and inform middle school mathematical instructional practices in the area of student homework completion. The study aimed to examine a possible relationship between the use of an online mathematics homework program, which provides hints on how to complete problems and immediate correctness feedback on submitted answers, and student learning and understanding when compared to traditional homework completion with next day feedback.

Results of this study support the hypothesis that the use of an online homework submission program such as ASSISTments or one similar, which provides hints on problems and immediate feedback on the correctness of answers, may have an impact on student learning and achievement. Students that used ASSISTments throughout the entire chapter, Selected Students, averaged the highest scores on all provided assessments.

Mendicino et al. (2009), Kelly et al. (2013), and Singh et al. (2011) all concluded that the use of ASSISTments, whether focusing on just immediate feedback, just the role of hints, or both immediate feedback and the role of hints, brought higher achievement when compared to students that received no hints and next day feedback. This study builds on those studies, and expands them as well. The studies of Mendicino et al., Kelly et al., and Singh et al. all were done over the course of 2 or 3 days focusing on a single topic, while this study was conducted

over an entire chapter that included five different sections all focusing on the topic of circles. The previously mentioned studies also focus on one pre-test and post-test as a means of measuring growth and understanding, while this study uses multiple assessments to measure student learning.

Students in the Study Group were asked, upon completion of the chapter, whether or not they would prefer to continue to use ASSISTments. A majority of the class voted that having the ASSISTments program available was their preference. Students noted that knowing right away whether or not they were correct was beneficial when completing homework and understanding the topic. Students also liked the ability to ask for help and use hints, however they did not like that a problem was automatically marked incorrect if a hint was requested.

Limitations and Summary of Research

As results from this study contribute to present and past literature focusing on the use of online homework submission which provided hints and immediate feedback, considerations of the current sample and data limitations are necessary. Specifically, it should be noted that the current study was based on certain assessments chosen by the instructor. The use of additional measures could potentially produce varying results. This study may include distinct aspects of classroom processes, practices, and management that may differ from teacher to teacher and makes it difficult to distinguish additional factors (other than the type of homework submission) that may affect students learning. Although both groups represented in the study received the same mathematical curriculum, not all factors remain constant in each classroom (teacher experience, parental involvement, and etcetera). A related point follows from the absence of specific student details as far as age, race, gender, socioeconomic status, and educational

background. As a result, it is unclear whether some unmeasured factors may also explain the higher increased average scores for students using ASSISTments. Had this data been presented, the increase in scores and understanding of the Study Group and Selected Students may have been interpreted differently. Although the aforementioned limitations suggest a need for additional research on use of online homework submission programs, the current study does present evidence concerning the academic benefits of using a program that provides hints and immediate correctness feedback.

This study confirms what other studies have found: the use of an online homework submission program such as ASSISTments has an overall positive impact on student learning and achievement. This research used this alternative approach across a full chapter lasting four weeks and it also used several other assessment measures. What it was not able to do was to see if this apparent improved learning held over time. Further research is needed. The present research may be used by current middle school educators to contribute to and inform middle school mathematical instructional practices in the area of student homework completion.

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School District of Superior

SUPERIOR MIDDLE SCHOOL

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Attendance

Blue Wing 715-394-8749
Green Wing 715-394-8751
Red Wing 715-394-8750



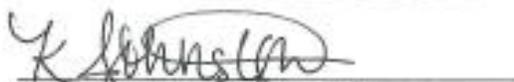
*"Provide all children with the relevant tools to develop
a foundation for living, learning, and working successfully"*

Ms. Kacy Johnston has described to me her plan to study students' math progress using the Assistments method in her class. I understand that the only modification to what she is doing in this one class is how students turn in their homework. I also understand that this is a study that she will use as part of her Master's Program/Thesis and that the study will keep anonymous and private all specific student information and outcomes. This study has the potential for learning about the program's ability to improve student learning, retention, and assessment in mathematics.

As principal of Superior Middle School I, Rick Flaherty, give Ms. Kacy Johnston permission to use Assistments in her classes as part of her Master's Program research. I also request that the outcome be shared with the administration, staff, and parents.


Rick Flaherty - SMS Principal

1-26-15
Date


Kacy Johnston - SMS Math

1/26/15
Date

Dear Parent /Guardian,

As educators, we are always looking for better ways to support our students' understanding of and success in mathematics. For that reason I want to let you know about something I am trying in one of the 7th grade math classes. Instruction will be the same in all classes and the homework assignments will be the same, but in your student's class we ask that homework be submitted on-line through a free program. Students doing their homework on this site will receive immediate feedback on whether it was done correctly. If he or she is unsure how to do it there is also a way to receive 'hints' as to how to proceed. As the teacher, I also receive a report on how each student is doing when answering the homework.

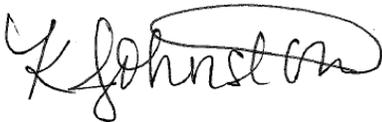
I will use this approach for two chapters and then study the results.

The homework assignment is accessible on any iPhone, tablet, or computer connected to the internet. My understanding is that your student has access to such a device. If this is not possible the homework can be done using traditional paper and pencil assignments or at a computer at the library or at school before the next class.

I am trying this as a pilot in just one 7th grade Math class and just for two chapters. Upon completion I will study student progress. While I am trying this because I think it will be helpful, I won't know until after students try. Assuming that this is effective, it will be tried in more classes. I have read many educational articles regarding this program and all have stated positive results.

If you have any questions or concerns please contact me or the Principal, Rick Flaherty (715.394.8740). You may check out the site by going to: <https://www.assistments.org/>

Sincerely,

A handwritten signature in black ink that reads "Kacy Johnston". The signature is written in a cursive style with a large, looping initial "K".

Kacy Johnston

Red 7 Math

Students, I want to tell you about a project I want us to try:

What is involved:

For the next two chapters I am asking just this class to turn in homework using Assistments. This free on-line approach will give you feedback right away to let you know whether you are correct in your answers. You can also ask it for hints if you do not understand how to work a problem or need reminders. It will let me know before class where we need to review and what you understand.

The pre-test and post-test, the quizzes, what I do in each class, and the homework assigned will be the **same as what the other math classes** receive. The only difference will be how you do your homework.

Purpose of this:

I want to see if this way of doing homework influences your understanding and learning of the math that we cover in class.

Your rights:

You can choose not to use this technique but you can not choose to NOT do your homework [you still must do your homework]. You will still be graded on your homework and not doing it will still result in a zero. If you do not use Assistments you must do your homework the traditional paper and pencil way. If you start out using Assistments you can stop but I hope you will stay with it for the chapters we use. (If there is some power or technology problem then do your homework the same old way.)

Any questions?