The effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students: A quasi-experimental study

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ABSTRACT

This quasi-experimental design, with a mixed methods approach, examined the effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students. A sample of 150 Honors Advanced Algebra students and two teachers were the participants of the study. The purpose of the quantitative part of the design was to determine if there was a significant increase in scores on a posttest after Honors Advanced Algebra students solved homework assignments, in Brightspace, algebraically (control group) or by using strategies of reading and writing, discourse, and reflection (treatment group). It was determined that students in the treatment group performed higher on the post-test. Additional quantitative elements of this study were measured by surveys (pre and post), given to student and teacher participants, to determine student and teacher attitudes towards learning and teaching with the assignment. There were statistically significant changes in student attitudes. Specifically, students felt that the assignment helped them to better understand the lessons in the unit. Qualitative elements of this study were measured by open-ended questions on the surveys (pre and post) for students and teachers and teacher interviews. The qualitative elements determined student and teacher suggestions for improving learning and teaching with the assignment. The conclusions from this study contribute to an increasing body of research on how to implement reading, writing, discourse, and reflection in mathematical assignments.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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DEDICATION

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Chapter I

INTRODUCTION

The Georgia Department of Education, along with the Georgia Standards of Excellence in Mathematics (GSE), argue that students will use their prior knowledge and reasoning to discover new information (2015). Students are not memorizing facts, formulas, and procedures to answer questions. Using reasoning and justification, students are afforded the opportunity to use various methods to solve problems. The most appropriate way for students to understand math is to use reasoning to solve problems. The Georgia Standards of Excellence in Mathematics was implemented to ensure that students incorporate reasoning and communication.

The Georgia Standards of Excellence in Mathematics (2015) require high school students to analyze problems by explaining the meaning of the problem and look for solutions. Students then investigate the given information and relationships about the problem. In high school mathematics, it is imperative for students to be able to explain differences and give verbal descriptions about problems. While using technology students must use quantitative reasoning to construct reasonable representations to solve problems. Students must justify their conclusions and use inductive reasoning about data. The standards encourage students to continually interpret and make sense of their results.

Staats and Bateen (2009) believe writing assignments are an authentic way to explore the connections students make between mathematics and real-world problems. Writing in mathematics allows teachers to determine students' ability to synthesize various areas of knowledge. In a math classroom, writing requires students to analyze and reflect on the process of problems. Students should document their learning, questions that may arise, and write about their thought process to solving problems.

Mwei (2017) encourages students to verbally express their thinking process. Articulation is a primary tool for metacognition, particularly in solving mathematical problems. Stahl, Çakir, Weimar, Weusijana, & Ou (2010) believe that learning to discuss math and adopt the practices of mathematical reasoning help ensure a deep understanding. Stahl et al. (2010) believe that discourse in mathematics help students to truly experience math, not just memorize facts and procedures.

In mathematics classrooms, the traditional approach to teaching is that teachers inform and present material in a procedural manner. Goldsmith (2013) agrees that the traditional approach to teaching mathematics does not adequately prepare students to face challenges. Goldsmith (2013) firmly believes that those students who are talking about math are those that are learning the most. In traditional classrooms, teachers are doing most of the talking. Yet, students should be doing most of the talking for true learning to occur. Students learn how to think critically when they are involved in meaningful conversations. Classrooms must promote critical thinking and engage students in meaningful discourse (Goldsmith, 2013).

This study intends to address the effects of an assignment that incorporates reading, writing, discourse, and reflection for Honors Advanced Algebra students. Additionally, this study aims to address students' and teachers' attitudes toward learning and teaching with the assignment and their suggestions for improving the assignment. Students are expected to answer extended response and open-ended questions on assessments. However, students are not practicing answering extended response and open-ended questions on daily classroom assignments. Mathematics educators have expressed a need for students using instructional time answering extended response and open-ended questions. There is a need to enhance students' critical thinking through reading, writing, discourse, and reflection in mathematics. Teachers have expressed frustrations and concerns about the lack of effective classroom assignments. This study investigates the effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students. Additionally, this study measured students' and teachers' attitudes toward learning and teaching with the assignment and their suggestions for improving the assignment.

Statement of the Problem

While there has been research about how writing and discourse in mathematics is essential to student learning as evidenced by Staats and Bateen (2009), Mwei (2017), Stahl et al. (2010), and Goldsmith (2013), there is a lack of research addressing how to incorporate such practices in the classroom. Students are expected to answer open-ended and extended response questions on assessments. However, there is not enough known about what strategies should be implemented within the classroom. Several researchers have addressed strategies that include reading, writing, discourse, and reflection to increase student learning (Goldsmith, 2013; Singer, 2007; GSE, 2015). Yet, there is a lack of evidence supporting assignments that incorporate reading and writing, discourse, and reflection in math. The primary concern for this study was the lack of evidence supporting effective assignments that incorporate reading, writing, discourse, and reflection in math. Honors Advanced Algebra students and teachers of those students, located at a rural high school in Georgia, were the targets of the study.

The Georgia Standards of Excellence in Mathematics (2015) suggest students should be able to communicate their learning. Teachers express a need for incorporating effective strategies that require students to practice justifying their solutions to problems. Teachers have not been provided with adequate resources, training, or support for incorporating assignments that allow students to use critical thinking and mathematical communication while solving problems. Students are expected to be able to answer open-ended and extended response questions on assessments. Nevertheless, students are not practicing this type of strategy within their classroom experience. This study addressed the effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students. This study addressed students' and teachers' attitudes toward learning and teaching with the assignment and their suggestions for improving the assignment. This study could provide attainable and practical assignments for teachers to use in their daily or weekly lessons.

Theoretical Framework

The theoretical framework of the study was based on critical thinking and communication in mathematics. Sandmel and Graham (2011) found that mathematical understanding and critical thinking are associated. Writing in mathematics is significant and supports the idea that learning is more than repeating information (Sandmel & Graham, 2011). Ahn, Tamayo, and Catabagan (2013) and Steele (2007) found that the use of writing in mathematics and the use of critical thinking is effective for obtaining a deeper understanding of mathematics from encouraging students to discover new knowledge. Students will have a better understanding of concepts when they determine the mathematical reasoning behind a concept (Steele, 2007).

By becoming active participants in the learning process, students will discover their own knowledge and internalize mathematical concepts (Steele, 2007).

Keiser (2012) believed that the purpose of mathematics pedagogy is to promote students' intellectual interest in understanding mathematical concepts. Boscolo and Mason (2001) found that writing in mathematics can change the aspects of the classroom environment because it encourages students to become active participants in constructing new knowledge, rather than using remote procedures. Keiser (2012) and Rasmussen and Marrongelle (2006) agreed that writing in mathematics allows students to become less dependent on the teacher and take ownership in their mathematical thinking. Hintz (2014) found that when students are active in critical thinking then they will begin to reflect on their learning and make relevant connections to mathematical concepts. Students who were taught how to think critically and reason through their learning process outperformed students who were taught using the traditional, lecture-based way of learning mathematics (Zakaria, 2007). Critical thinking should be a crucial element of instruction because students will demonstrate a richer development of mathematical understanding (Rasmussen and Marrongelle, 2006).

The Standards for Mathematical Practice encourages educators to develop practices that require students to use justification to solve mathematical problems (GSE, 2015). The National Council of Teacher of Mathematics (NCTM) include process standards that incorporate students using reasoning and communication to make mathematical connections (NCTM, 2014). The GSE require students to understand problems by reasoning through the meaning of the problem and discover solutions to the problem. The Georgia Standards of Excellence in Mathematics state that Honors

Advanced Algebra students should be able to explain relationships between equations, tables and graphs.

Staats and Bateen (2009) addressed how writing in mathematics allows students to reason through their process and solutions to make connections about concepts. Staats and Bateen (2009) found that when students incorporate writing in mathematics, their quantitative skills increased. Mwei (2017) found that students who articulated their thinking by documenting their process for solving a problem were useful in understanding concepts. It was also found that writing in mathematics was a beneficial tool for metacognition. Like Mwei (2017), Stahl et al. (2010) believe that discussing mathematical reasoning helps ensure student understanding. Stahl et al. found that incorporating discourse in mathematics ensures student understanding and not simply memorizing facts and procedures.

Like Stahl et al. (2010), Goldsmith (2013) agreed that memorizing facts and procedures does not prepare students to face mathematical challenges. Goldsmith emphasized the traditional approach to teaching mathematics does not help students obtain a deep understanding. Goldsmith (2013) found critical thinking occurs when students have meaningful conversations in mathematics. Classrooms and classroom practices should engage students in mathematical discourse.

Singer (2007) believes that reading and writing in math classrooms are essential elements of learning. Singer suggested that these classroom practices support student success. Yet, these practices did not incorporated the concept of argumentative literacy, which is the idea that students should share ideas, listen to other student's perspectives, and construct counter-arguments to transform and influence their thinking. Discourse should be included in everyday classroom practices. Since students are expected to answer open-ended and extended response questions on assessments, they should be practicing this strategy frequently in the classroom environment. This study utilizes a form of Singer's (2007) "Discourse Time" by having students justify their reasoning to homework problems on Brightspace. Singer's (2007) "Discourse Time" includes students obtaining a deeper conceptual knowledge of math, the ability to learn and apply new information, and the benefit of engaging in mathematical conversations.

In traditional mathematics classrooms, students are not encouraged to neither reflect on their learning through writing and discourse nor become active participants in their own learning process (Belbase, 2012; Hodgen & Askew, 2007; Oguntoyinbo, 2012). The Georgia Standards of Excellence in Mathematics (2015) require students to routinely interpret their mathematical results in the context of the situation. In addition, students should reflect on whether the results make sense. It is expected that students should be able to answer open-ended and extended response questions on math assessments. However, there is a lack of research indicating how teachers should incorporate reading, writing, discourse, and reflection in mathematic classroom practices.

Research Questions

1) What are the effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students?
2) What are students' attitudes toward learning with the assignment?
3) What are teachers' attitudes toward teaching with the assignment?
4) What are their suggestions for improving the assignment?

Methodology

The study adopted a quasi-experimental design, as participants were assigned different homework assignments in the treatment and control group. A quasi-experimental design, with a mixed methods approach, using both quantitative and qualitative techniques was used to answer the research questions. The study yielded longitudinal data since the design involved repeated observations of the same variables over a brief period of time (students' and teachers' attitudes toward learning and teaching with the assignment).

There were two groups of students in this study (control/treatment) and two Honors Advanced Algebra teachers (Teacher A/Teacher B). If a student was in Teacher A's class, they were in the treatment group. If a student was in Teacher A's group, they were required to solve the weekly homework problems in Brightspace by reading the problems, writing about how to solve the problems, use discourse by responding to another student's problem, view the comment left by another student and reflect on their solution to ensure that their problem is accurate. If a student was in Teacher B's class, they were in the control group. The weekly homework problems in Brightspace required students to solve the problems algebraically.

The research took place in three phases, yielding both quantitative and qualitative data. The first phase yielded quantitative data from the pre/posttest scores. Students took a pre-test and a posttest. The pre-test scores and the post-test scores measured student achievement on the Unit 1 Test. Descriptive statistics were found to compare the means of the scores on the pre-test and post-test. SPSS (IBM CORP., 2017) was used to calculate the independent samples t-test to determine a difference in the scores of the pre-test in the treatment and control group and the post-test for the treatment and control group. A paired samples t-test was used to determine if a statistical difference in the treatment and control group's pre-test and post-test scores could be found.

The second phase yielded quantitative and qualitative data. Longitudinal data was collected to measure students' and teachers' attitudes toward learning and teaching with the assignment. The Likert-scale questions from the student and teacher surveys yielded quantitative data. The open-ended questions on the student and teacher surveys yielded qualitative data. Student and teacher surveys (pre and post) were collected. Surveys (pre and post) surveys were given to the student and teacher participants at the beginning and end of the study. The Likert-scale questions on the student surveys measured their attitudes of math, working collaboratively and privately, use of technology and Brightspace, use of homework and the assignment. Descriptive statistics (mean) were found to discuss the four attitudes on the surveys for students. The Likert-scale questions on the teacher surveys measured their attitudes of technology and Brightspace and use of homework and the assignment. The open-ended questions on the post surveys for students and teachers allowed the participants to make suggestions for improving the assignment. The third phase yielded qualitative data. Teacher interviews were used to analyze teachers' suggestions for improving the assignment.

Significance of the Study

A goal of this study was to address the effects of an assignment that incorporated reading and writing, discourse, and reflection for Honors Advanced Algebra students. Another goal of this study was to address students' and teachers' attitudes toward learning and teaching with the assignment and their suggestions for improving the assignment. The study determined if the assignment increased student achievement on the posttest. Students were surveyed at the beginning and end of the study to determine their attitudes of math, working collaboratively and privately, use of technology and Brightspace, use of homework and the assignment. Teachers were surveyed at the beginning and end of the study to determine their attitudes of technology and Brightspace and use of homework and the assignment. Teachers and students made suggestions on how to improve the assignment. Teacher interviews were conducted at the end of the study. The surveys and interviews were coded and analyzed to develop common themes.

The research could support professional practice and allow practical application for teachers and students of mathematics. The results of the study indicated if the assignment increased student achievement. The results produced students' and teachers' attitudes toward learning and teaching with the assignment. Stakeholders included parents, students, faculty, staff, and administration at the school.

Definition of Key Terms

Several key terms were defined for their meaning to be clear throughout the study. When appropriate, a source for the definition is provided.

Attitudes, as defined in the study. The Likert-scale questions on the student surveys will measure their attitudes of math, working collaboratively and privately, use of technology and Brightspace, use of homework and the assignment. The Likert-scale questions on the teacher surveys will measure their attitudes of technology and Brightspace and use of homework and the assignment.

Critical Thinking. The ability to analyze and synthesize information to obtain an answer or draw a conclusion (Hintz, 2014; Keiser, 2012).

Communication in mathematics. For this study, communication in mathematics will include a students' ability to use reading, writing, discourse, and reflection to solve problems.

Brightspace. Brightspace is an integrated learning platform where students and teachers can interact (D2L Corporation, 2018). Honors Advanced Algebra teachers, in the study, required students to solve homework problems on Brightspace.

Honors Advanced Algebra students. Typically, students in Honors Advanced Algebra are in the 11th grade. However, there are some 10th grade students who are in a "year ahead" group. Honors Advanced Algebra students have been placed in an "honors" math course since middle school. Most of the students in Honors Advanced Algebra are labeled as "gifted". Students are defined as gifted when their ability is significantly above average for their age (National Association for Gifted Children, 2018).

Reading and Writing. Writing in mathematics provides students with opportunities to think critically when solving problems by making sense of mathematics and by exchanging mathematical ideas, allows teachers to assess what students understand and how they understand the mathematics they are learning (Burns, 2012), and Schwartz and Kenney (2012) stressed that students have the ability to demonstrate what they understand when they describe, explain, or justify their thinking.

Discourse. Maguire and Neill (2006) stated that discourse can be used to determine what students are thinking and understanding to connect their previous knowledge to new knowledge. Also, discourse offers students opportunities to develop agreed-upon mathematical meanings or definitions and explore conjectures.

Reflection. Reflection requires students to use their current knowledge to create new knowledge (Bruner, 1966; Keiser, 2012), allows students to think critically and communicate mathematically, and when students' mathematical thinking is clarified when students justify their answers to solve mathematical problems (Roake and Varlas, 2013).

Limitations

The sample in this study was representative of students in an Honors Advanced Algebra class and teachers of Honors Advanced Algebra students. Therefore, the results may be limited to students and teachers at this level of mathematics. The assignment can be applied to various subjects because all students can benefit from reading, writing, and using discourse and reflection to think critically about concepts. Though the assignment could be modified to any subject, teachers may be hesitant because the assignment was specific to an Honors Advanced Algebra class. This study is limited to one school because it focused on eleventh (and some tenth) grade Honors Advanced Algebra students and Honors Advanced Algebra teachers at a Title 1 high school, located in rural Georgia. The participating mathematics teachers may not accurately represent other level mathematics teachers or other content teachers. Therefore, caution should be used when generalizing findings beyond the research site. Since students were required to record their answers to homework problems using Brightspace, a limitation could be that some students refuse to complete this strategy. Teachers will have to ensure that students completed their assignment correctly and in a timely manner.

Quasi-experimental designs can be accomplished without extensive pre-screening and randomization needing to be undertaken (Explorable, 2018). This process reduces the amount of time and resources needed for experimentation. However, a disadvantage of quasi-experimental designs is that the results may not be able to be generalized to larger populations because pre-existing factors are not considered. Yet, if these flaws are recognized in the study, a quasi-experimental design can ensure valid results.

An assumption for this study is that students do not have high achievement on math assessments that incorporate open-ended and extended response questions because they are not practicing an effective strategy in the classroom. Another assumption is that students and teachers have a negative attitude about incorporating an assignment that requires students to read, write, and use discourse and reflection in daily classroom practice.

Organization of the Study

This study measured the effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students. This study measured students' and teachers' attitudes toward learning and teaching with the assignment and their suggestions for improving the assignment. A pretest and posttest were used to measure the effectiveness of the assignment. The study determined if the assignment increases student achievement on the posttest. Students and teachers were surveyed at the beginning and end of the study to determine attitudes toward learning and teaching with the assignment. Students' and teachers' suggestions on how to improve the assignment were documented and analyzed. Lastly, teacher interviews were conducted at the end of the study.

Chapter two includes a review of the research literature on mathematical communication, reasoning and communication and its' effects on student achievement.

Chapter three consists of a discussion of the study's research design. Chapter four contains the results of the data analysis phase of the study and chapter five includes an interpretation of the findings of the study and recommendations for further research on the topic.

Chapter II

REVIEW OF THE LITERATURE

The theoretical framework for this study included the conception of critical thinking and communication in mathematics. This quasi-experimental study investigated the following research questions: What are the effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students?; What are students' attitudes toward learning with the assignment?; What are teachers' attitudes toward teaching with the assignment?; What are their suggestions for improving the assignment?. The intent for this study was to examine an assignment, for Honors Advanced Algebra students that incorporated reading, writing, discourse, and reflection. Another intent for this study was to examine students' and teachers' attitudes toward learning and teaching with the assignment.

Ahn, Tamayo, & Catabagan (2013) and Steele (2007) found that the use of critical thinking and writing in mathematics is effective for endorsing discovery and developing critical thinking skills while developing mathematical understanding. Written and verbal communication provides students with opportunities to think critically to justify their solutions (Applebee and Lagner, 2011). Written and verbal communication prompts students to discover mathematical ideas, deepen their understanding of these ideas, and make mathematical connections within and outside mathematics classrooms. The Georgia Standards of Excellence (2015), Staats and Bateen (2009), Mwei (2017), Stahl et al. (2010), Goldsmith (2013), and Singer (2007) were among several authors who emphasized the importance of the theoretical framework for this study. The Georgia Standards of Excellence in Honors Advanced Algebra were followed in this study to guide the lessons for the unit. The standards for mathematical practice encourage educators to develop practices that require students to use justification to solve mathematical problems (GSE, 2015). Staats and Bateen (2009) address the benefits of writing in mathematics. Mwei (2017), Stahl et al. (2010), and Goldsmith (2013) discussed the advantages of discourse in mathematics. Singer (2007) emphasized the importance of discourse and reflection to better understand mathematics.

GSE (2015) require students to routinely interpret their mathematical results in the context of the situation. In addition, students reflect on whether the results make sense. It is expected that students should be able to answer open-ended and extended response questions on math assessments. However, there is a lack of research indicating how teachers should incorporate reading, writing, discourse, and reflection in mathematic assignments.

Critical thinking and mathematical communication are at the forefront in the current academic standards (GSE, 2015; NCTM, 2014). National Council of Teachers of Mathematics (2014) believes that mathematical communication is a crucial part of mathematics education. The NCTM (2014) stressed that students should communicate their mathematical thinking logically to their teachers and peers. Mathematical communication allows students to clarify their thinking. When students have a deeper understanding of mathematics after clarifying their thinking to others, students will begin to create new knowledge from using their previous knowledge.

Research has indicated a connection between critical thinking and mathematical understanding, where it is indicated that learning goes beyond the reproduction of information (Sandmel and Graham, 2011) and includes students' active knowledge construction (Boscolo and Mason, 2001). The connection between critical thinking and mathematical understanding produces positive outcomes because students become less dependent on teachers and take more ownership of their mathematical thinking (Keiser, 2012; Rasmussen & Marrongelle, 2006). In measures of mathematical problem solving and achievement, Zakaria (2007) found students outperform other students who are taught the traditional lecture method because they are taught how to reason and think critically through writing, in measures of mathematical achievement and problem solving. Students have significant improvement when they are taught to use writing as an instructional strategy (Roskin, 2010). Educators should implement daily activities that require students to understand why and how something occurred in order to think critically (Rondamb, 2014). These activities could help students deepen their understanding and assist them with analyzing the situations surrounding the problem and various viewpoints for solving the problem (Adams, Bondy, & Tutak, 2011).

Mallia, Pawloski, & Daisey (2012) believe that writing contributes to students' ability to think critically and take ownership in their learning. Writing enhances students' mathematical understanding as they organize, reinforce, clarify, and explain their mathematical thinking. Teachers should create a classroom environment that requires students to participate in conversations where they think critically, share their ideas with other students, and obtain further mathematical understanding (Thompson, Kersaint, Richards, Hunsader, & Rubenstein, 2008). This type of environment provides students with opportunities to discuss their mathematical thinking and write about how they solved a problem, which allows students to clarify their thinking and obtain a deeper understanding (Burns, 2012; NCTM, 2014).

Critical thinking in Mathematics

Mathematical Communities

Mueller and Maher (2009) also stress the importance of mathematical education. Specifically, Mueller and Maher emphasize the importance of reasoning in mathematics. They believe that reasoning is critical in learning new mathematics and applying mathematical knowledge to different situations. Reasoning incorporates utilizing previous knowledge to construct and apply new knowledge. Mueller and Maher (2009) suggest that students should make their reasoning and justification public to others in a learning community because their ideas will be refined.

Mueller and Maher (2009) suggest a classroom environment and community where students are encouraged to use peers as resources. The study found that students' constructed ideas should be documented because it can be used as formal forms of reasoning. Classroom communities should be accommodating for students to share ideas and knowledge. Students should be provided with opportunities to explore critical thinking in mathematics and make mathematical connections (Fennema, Sowder, & Carpenter, 1999). Mathematical communities ensure that these opportunities take place in classrooms. Communities should have frequent interactions to communicate similar goals for effectively implementing critical thinking and writing in mathematics (Lambert, L., Walker, D., Zimmerman, D., Cooper, J., Lambert, M., Gardner, M., et al., 2002).

Cooper (2012) stated the importance of metacognition in mathematics education. According to Cooper (2012), in order for metacognition to occur, students must consider their thought process, understand their previous knowledge, and express what they do not understand. For students to obtain interaction with material and be provided with new opportunities to confidently express their knowledge, teachers must frequently look for new forms of communication. Cooper (2012) found students believed using a blog to record their writing helps them communicate more with classmates and the teacher. Teachers should create a classroom environment that allows students to feel comfortable expressing their ideas. Cooper (2012) found that there was an increase in reading and writing literacy and critical thinking.

Mueller, Yankelwitz, and Maher (2014) developed four themes that create a mathematical community that promotes reasoning and justification. The four themes created were teacher interventions, posing strategic questions, creating a community that allows students to reason and construct new ideas, and social mathematical norms that are established in the creation of the mathematical community. Teacher interventions are critical in creating a mathematical community where students feel comfortable constructing and sharing ideas. In this mathematical community, students take ownership of their learning. Teachers should pose questions that require students to reason mathematically. When students reason and justify their answers to solutions, they will have a deeper and more meaningful understanding.

Jia (2010) stated that teachers should create a welcoming and favorable classroom environment. Students should focus on the exploration of learning and cooperative learning, using previous knowledge and former experiences, and use interactions to build and create new knowledge. Teachers should offer a positive atmosphere, allowing students to feel safe. Mueller et al. (2014) emphasized the importance of a teacher when establishing a mathematical community. Social norms should be established to ensure a learning community where students use reasoning and justification. Teachers should give students meaningful and challenging tasks, listen to student's ideas, and utilize skillful questioning. Mueller et al. (2014) study was conducted in a low-income and urban community. The results of their study could be generalized to teachers of elementary mathematics. Though their research developed several themes, it was noted that there is still a lack of research regarding the ways in which teacher's classroom strategies can impact certain student mathematical behaviors and sense-making in the classroom. However, it was found that three certain teacher moves helped create the establishment of social norms. The three moves included students making their ideas public, extending student ideas, and encouraging student explanations and justifications.

Teachers plan tasks that require students to use their previous knowledge in order to construct new knowledge (Mueller et al., 2014). Teachers should observe and listen to the student's justification to solutions. Teachers should incorporate questioning that monitors student problem solving, ideas, and help advance mathematical growth and success. The questioning requires students to explain their thinking using justification and use prior knowledge to solve the task. Teachers invite students to share their ideas and justification with others by asking appropriate questions. By posing skillful questions, a classroom community is created where students build their ideas and conjectures.

Mueller and Maher (2009) offered suggestions for mathematical communities. Mathematical communities incorporate collaboration where learners support one another by offering missing pieces of information that is required to solve a problem. Collaborative work entails group members relying on each other to generate, challenge, refine, and pursue new ideas. In this collaboration, students construct new ideas and ways to think as a group. Mueller and Maher (2009) referred to this group effort as collaborative mathematical understanding. Learning is facilitated when students are dependent on the actions of others in a group.

Constructivism

Hennessey, Higley, & Chesnut (2012) discussed the relationship between constructivism and the National Council of Teachers of Mathematics (NCTM). The principal and standards of the NCTM align with constructivist teaching. Constructivism and the standards emphasized that math classrooms should incorporate meaningful interactions with real problems and students should provide reasoning for their solutions to problems. Most students construct knowledge and meaning when they are required to communicate their ideas. Students should use prior knowledge to construct new meaning, which is critical in the teaching and learning process. In constructivism, teachers must refute the assumption that they can passively tell information to students and expect understanding to occur (Dewey, 1987; Joldersma, 2011).

Central ideas to the theory of constructivism include knowledge, learning, students, and teachers (Jia, 2010). Knowledge is based upon students' previous knowledge and experiences. Learning is acquired when student construct their cognitive structures. Students must code, process, and construct their own learning, based on past experiences. Students must use past experiences and previous knowledge to gain new knowledge. Teachers should create a teaching environment that guides students and then serve as a consultant for students. The traditional model of teaching is disregarded allowing students to be the center of receiving knowledge.

Mueller and Maher (2009) found that the use of manipulatives help students construct their own knowledge. Manipulatives are imperative tools that allow students to construct physical models in problem solving. Manipulatives promote exploration, representation, and communication of mathematical ideas. Various representations and justifications of ideas can be represented by manipulatives. Manipulatives also aid in students being able to develop their reasoning skills.

Jia (2010) wrote about the teaching theory of constructivism. Jia (2010) implied that constructivism occurs when learners construct their own knowledge using their own initiative. Jia's (2010) study was used as a theoretical base for teaching theory in China's educational reform. Jia (2010) stated that the first to contribute to constructivism and how it applies to students' learning and development were Dewey (1933), Piaget (1959), and Vygotsky (1978). Hennessey et al. (2012) described constructivist teaching and its importance in mathematical communication. Constructivist teaching promotes reflection from teachers and students. Constructivist teaching promotes interactive mathematical communication by allowing students to construct their own knowledge through discourse.

Hennessey et al. (2012) addressed radical constructivism, social constructivism, and practices of constructivism in the mathematics classroom. Radical constructivists believe that mathematical abstractions of students are more important than teachers.

Social constructivists, in contrast to radical constructivists, explain the influence that a shared reality has on learning. In social constructivism, students need to be able to explain their justification to other students and teachers as a part of the normal classroom procedures. Discussion of concepts increased students' mathematical development. Social constructivism promotes student discussion in order to enable better learning. Practices of constructivism in mathematics classrooms consist of creating an environment built on the interaction between students. In a mathematics classroom, ideas and shared experiences should be allowed in implying mathematical rules. In constructivism, learning is dependent upon the activity and involvement of the learner (Confrey, 2006; Oguntoyinbo, 2012)

Barret and Long (2012) stated that the belief of constructivists is that mathematical learning includes the active manipulation of meaning and understanding and not memorizing formulas and procedures. This type of routine learning does not create understanding (Keiser, 2012). In fact, students may begin to reject their own mathematical thinking when they learn in this repetitive manner (Hintz, 2014; Keiser, 2012). To avoid misconceptions, educators and teachers should no longer require students to demonstrate their learning by using rote formulas and procedures (Thompson et al., 2008). A harmful effect to learning would be that students continue learning with an incorrect way of thinking (Burns, 2012).

Persuasive Pedagogy

The persuasive pedagogy that Hennessey et al. (2012) mentioned is beneficial on other content areas. Hennessey et al. (2012) indicated that teachers should incorporate persuasive practices to teach students how to address misconceptions in learning mathematics. The authors found that using a persuasive pedagogy is an option for replacing the constructivist framework.

Hennessey et al. (2012) wrote about the persuasive pedagogy that facilitates learning experiences to promote problem solving, reasoning and proof, communication, utilizes previous knowledge to construct new meaning. The theoretical framework emphasized that educators should require reasoning and proof to justify beliefs and allow students the opportunity to create and evaluate conjectures about mathematics. Hennessey et al. (2012) indicated that students should connect their prior knowledge to strengthen learning experiences. Practices of justification, argumentation, and discourse are crucial components of the teaching, persuasive pedagogy in mathematics classrooms.

Persuasive pedagogy is a method of teaching that fosters critical thinking by helping students considers alternative perspectives and using some of those perspectives (Hennessey et al., 2012). Another teaching method in persuasive pedagogy is the practice of explanatory inquiry. This strategy has students to try and obtain correct knowledge through discourse with their peers. Teachers should help students correct their misconceptions. Hennessey et al. (2012) concluded that teaching mathematics should evolve.

Communication in Mathematics

Reading and Writing

Singer (2007) believes that a person who is numerically educated is one that can read, write, and argue with numbers and mathematical ideas and concepts. However, there is a lack of math communication in classrooms. In traditional math classrooms, students solve most problems for the students, while students simply observe the teacher.

Writing allows students to make sense of what they are learning and it stimulates their mathematical thinking (Schwartz & Kenney, 2012). Mathematics teachers must promote writing as a way to develop students' critical thinking in mathematical literacy (Vu & Hall, 2012). Paul (2004) emphasized that the use of written justifications of answers has helped mathematics teachers to improve their critical thinking instructional practices and make necessary modifications. Critical thinking has directed students to monitor and assess their own mathematical knowledge and make necessary revisions in their mathematical understanding.

Stahl et al. (2010) researched Virtual Math Teams (VMT) and found there are many resources related to mathematics available for middle-school and high-school students. Stahl et al. (2010) stated that traditional classrooms in mathematics relies heavily on one teacher, one text book, and a set of routine procedures on how to solve problems. VMT allows students to participate in a forum that offers a different view of mathematics.

In traditional math classes, students simply solve math problems by algorithms and remote procedures (Staats and Batteen, 2009) and emphasize the importance of writing in mathematics. Writing in mathematics allows teachers to synthesize student's knowledge. Staats and Batteen (2009) believed that writing assignments in mathematics will be important components in classrooms and learning communities. In math classrooms, students were not writing to learn but to create meaning. Staats and Batteen (2009) created a rubric for grading writing assignments. Students should be informed of the rubric prior to an assignment. The open-ended task allowed students many options when creating a position statement. Students should be allowed to incorporate multiple sources to draw mathematical conclusions in order to support their calculations for their argument. Staats and Batteen (2009) emphasized students should attend to context in their math writing because it will make their quantitative skills and ability to express the relevance of mathematics in the real-world more precise.

Writing in mathematics provides students with opportunities to think critically when solving problems by making sense of mathematics and by exchanging mathematical ideas (Burns, 2012). Burns encouraged teachers to provide students with opportunities to think critically by justifying answers to problems through writing, assess what students understand and how they understand the mathematics they are learning. Schwartz and Kenney (2012) stressed that students have the ability to demonstrate what they understand when they describe, explain, or justify their thinking.

While writing is used frequently in education, the writing process is rarely used in mathematics classrooms (Cooper, 2012). In the past, mathematics has primarily focused on routine procedures and formulas. These rote procedures do not afford students an opportunity to gain a deep insight of concepts. Typically, when students solve a problem, they are not required to use justification to reason through their thought process. In traditional math classrooms, the time spent learning is limited. However, using technology to record students' writing, allows students to have unlimited access to their learning.

Lardner (2008) emphasized that students need frequent opportunities to strengthen their skills in writing and critical thinking. Students should be familiar with how writing is utilized as a process for thinking about problems and sharing ideas with other students. Writing should not be an abstract set of routine behaviors but more of a way to clarify thinking across content areas in multiple formats.

Peterson (2007) discussed how writing is recognized as a way for learners to have a deeper understanding of concepts. Peterson (2007) suggested two forms of writing; staccato writing and discovery writing. Staccato writing is a short writing assignment, such as copying notes, that does not allow students to construct a deep understanding of concepts. Discovery writing requires students to make sense of ideas.

Mwei (2017) stressed the importance of problem solving in mathematics. Students should be exposed to solving mathematical problems in familiar and unfamiliar situations. Mwei (2017) suggested that mathematical problem solving as a process to find solutions to non-routine or non-standard tasks. After a solution is found, the solver should interpret the solution in a real-world aspect. Mwei (2017) believed that teachers of mathematics have a responsibility to provide students with authentic and challenging problems. Mwei (2017) found that there was disconnect between students using their previous knowledge to solve new problems. All the participants in Mwei's (2017) study were able to articulate their thinking by writing down their thought process while solving a problem. Mwei (2017) made several suggestions for future mathematical writing assignments. First, students should examine keywords in mathematical problems. Next, students should have previous knowledge of mathematical concepts that will be needed to solve new problems. Students should be encouraged to articulate their thinking process during problem solving. Lastly, students should be exposed to several strategies to solve problems.

Peterson (2007) emphasized certain strategies that teachers must enforce when teaching writing in the classroom. When students utilize writing in the classroom, they have the opportunity to investigate the content knowledge they have learned and make connections with their own experiences. Writing should be used in all content areas. In mathematics, students should be writing about their thought process while solving a problem. Peterson (2007) suggested writing should be scheduled and should be utilized frequently. It was suggested that the writing done in all content areas should be applied to student's language arts/English grade. Writing assignments can be done outside of school. Peterson (2007) stated that students could include writing assignments online. The documentation of writing provides students with an opportunity to reflect on their learning process.

Peterson (2007) shared thoughts on how to assess writing assignments and offered suggestions about how to provide students with feedback. Writing assignments offer teachers a clear image of how well students understand concepts and how well students can communicate their learning. Prior to grading students' writing assignments, teachers and peers should offer feedback. Writing requires students to have a deeper understanding of concepts. This strategy can be applied across content areas and is applicable in real-life situations.

Cooper (2012) wrote about the use of internet-based chats, forums, and blogs as a way of incorporating writing in mathematics. It was found that student engagement enhances a cooperative environment for writing. The purpose of writing in classrooms should be clear and students should take ownership of their learning. Writing allows opportunities for students to express their reasoning for problems, well beyond the rote procedures that were used to solve a problem.

Cooper (2012) addressed several strategies for implementing writing through technology. Forums, chats, and blogs provide an authentic writing environment for deeper understandings of mathematical knowledge. Students incorporate these tools as a way to communicate with other students. Students are required to use previous knowledge to construct new mathematical knowledge. Students take ownership of their learning when they are aware that their writing is made public. These writing assignments create real-life situations and students acknowledge that their work is meaningful and applicable in the real world. The results of the study indicated that the strategies encouraged reflection and metacognition. In order for students to effectively write in mathematics using technology, teachers must clearly explain how the technology is useful, practice using the technology, and collaborate with other teachers about the use of technology.

Discourse

Social activities that are important for learning include mathematical discussions (Pytash & Morgan, 2013). As students begin to make sense of their mathematical experiences, discussions help students to build critical thinking skills and increase their mathematical knowledge (Bruner, 1966, Butera et al., 2014). Goldsmith (2013) mentioned that teachers traditionally do most of the talking in mathematics classrooms. Teachers most often think they are presenting content to students in a lecture type format and in a formal, didactic manner. However, Goldsmith (2013) emphasized that this is not the way students learn best. Teachers must create an environment that prepares students for unforeseeable circumstances. The best way to create this environment is by ensuring students are engaged in meaningful academic conversations.

Goldsmith (2013) found that when students are held accountable for participating in class discussions they feel safe to do so because they understand why the discourse is important. In the past, questions were simply right or wrong. Most importantly, discussions must have students explain their thinking, learn from one another, reason through problems, and justify their thinking process. Class meetings should be a time where students share their learning and be accountable for sharing their learning with others.

Goldsmith (2013) emphasized that educators are responsible for helping students engage in significant discourse. Students should be afforded the opportunity to practice communicating their ideas across content areas. Students must be held accountable for their conversations and teachers should serve as facilitators. Students should be more successful when they are required to take ownership of their learning. In order to accomplish this, students must be able to find their own voice, even if that requires teachers to use less of their voice.

Stahl et al. (2010) believe that math discourse promotes knowledge and understanding. Mathematics is more than just memorizing facts and procedures. Historically, math has incorporated discourse, a common vocabulary, and various ways of representing procedures and ideas for defending certain claims. Stahl et al. (2010) indicated that discussing math objects, appreciate arguments about those objects, and adopt the practices of mathematical reasoning can create an education in mathematics.

Mueller and Maher (2009) found that students should be encouraged to participate in mathematical discourse. Mathematical discourse should involve students proposing and defending arguments and responding to other student's conjectures. In these communities, teachers should develop norms and expectations of desirable behaviors and guide students through meaningful tasks.

Hansen-Thomas (2009) examined discourse used by teachers to promote discourse in students in the classroom. The study implemented a math project that demonstrated how teachers should model and elicit student practice by encouraging mathematical discourse and content knowledge. Discourse was measured by oral interactions of students focused and engaged participation in group activities. The study found that mathematical discourse utilizes a math language, which is a shared vocabulary. Mathematical discourse requires students to use social language for problem solving and an interaction with the teacher and texts.

Hennessey et al. (2012) emphasized that discourse should be a significant component in the teaching process. Discourse allows teachers to continually assess students' knowledge. Students learn more and participate in required reflection needed for students to have ownership of their learning.

Stahl (2006) first developed the VMT project to develop and analyze group cognition. Similar to Brightspace, the VMT project created an online community, where mathematical discourse is utilized and saved automatically. The VMT project analyzed how students worked collaboratively to solve and discuss mathematics. Stahl et al. (2010) conducted a study on mathematical communication for VMT. VMT is a Math Forum that creates a web-based environment for people to discuss math and work collaboratively others in mathematics. Similar to VMT, this study utilized Brightspace as an online forum for students to communicate mathematically with other students and teachers. Like Brightspace, VMT creates an environment that supports online math discourse. Stahl et al. (2010) suggests that students learn best if they are actively engaged in talking about math. Students develop a deep understanding and expertise when students explain their thinking to other students and the teacher, if they make their ideas and thoughts visible, if they communicate math concepts, and if they help other students.

Stahl et al. (2010) suggested that when students solve problems in the chat environment, such as through VMT, they work collaboratively to solve and discuss math problems. When students work collaboratively, Stahl et al. (2010) refer to this effort as group cognition. Students are solving problems with advanced levels of cognition in a group discourse.

Singer (2007) found that discourse is crucial in math classrooms. Singer (2007) suggested teachers must support and encourage students to share their voice. In the classroom, students should use discourse while working collaboratively to solve a problem. Singer (2007) suggested that teachers should serve as more of a coach and that students should be doing the work. Teachers should become a facilitator of learning, while students take ownership of their learning. In a traditional mathematics classroom, discourse is frequently used informally. Singer (2007) advocates for teachers using discourse as a formative assessment, by examining what the students know and are able to do.

Singer (2007) emphasized that students must feel the classroom environment is conducive for students to feel comfortable to take mathematical risks. Students must be familiar with the rubric and expectations of discourse or assignments involving discourse. Singer (2007) has outlined a set of expectations that are crucial for the success of discourse. The student must state an opinion related to the problem, include another student in their discussion, make a connection, support their opinion with factual evidence, ask another student a clarifying question about their problem, answer that other student's question with evidence, then understand the value of the discourse. His guidelines have been adapted for this project for a rubric for grading in Brightspace.

Throughout the discourse process, teachers must ensure student's progress, documenting what is seen and heard from the students (Singer, 2007). These notes should then help guide upcoming instructional decisions and could serve as evidence of student teaching. If these guidelines are followed correctly, students will gain a more in-depth conceptual knowledge of mathematics, the capability to learn and relate new information, increased resourcefulness, the exposure of challenging each other's thinking, the skill of deciding what a question is asking, the experience of listening to another student's opinion and synthesizing it with their own, the ability to collaborate effectively, and the benefit of engaging in mathematical conversations.

Mueller and Maher (2009) explained that teachers play a crucial role in requiring students to explain their reasoning and provide evidence to their claims. Teachers should have high expectations for students to have success in engaging in meaningful mathematical activity and discourse. If teachers underestimate students in these conditions they will miss opportunities to learn from each other in constructing justification to problems.

Teachers should act as facilitators that promote justification and reasoning (Mueller and Maher, 2009). Teachers should encourage students to interact with one another and provide justification for their ideas. Classrooms should emphasize student discourse and allow time to share ideas and representations. Students should be allowed to revisit their ideas and make connections to new ideas.

Hansen-Thomas (2009) found two linguistic practices that elicited student practice in discourse and focus on modeling mathematical discourse. Teachers exposed the students to classroom practice that prompted the application of mathematical concepts and acknowledge student's contributions to the correct use of language use and responses. Hansen-Thomas (2009) emphasized that teachers should model mathematical discourse by reading the text, calculating or solving problems verbally, and repeat algorithms, concepts, formulas, and definitions. Students are successful in math when teachers modelled standard mathematical language.

Herbel-Eisenmann and Wagner (2010) stated that mathematical discourse allows for critical reflection. Mathematical classroom practices allow educators to become aware and reflect on activities that would be the most appropriate for developing students' mathematical knowledge and social agency. Herbel-Eisenmann and Wagner (2010) found that discourse practices created awareness and support for reflection.

Justification and accuracy in teaching and learning mathematics allows comparison in other subject areas (Herbel-Eisenmann and Wagner, 2010). Teachers' directions in mathematics have implications for social and mathematical significance.

Teachers should create and control the agenda for mathematical discourse. Teachers should require students to understand and engage in conversations with other students. Students should trust the teacher to make good decisions on what should be accomplished in the classroom.

Reflection

Cooper (2012) addressed how NCTM encouraged writing in mathematics because it leads students to reflect and clarify their ideas. Writing allows students to justify their own ideas and analyze the ideas of other students. Writing in mathematics allows students to understand the operations they use to solve problems and their reason for performing those operations. Writing allows students to understand the overall picture of mathematics. Cooper (2012) described that writing should be an essential part of the mathematics classroom and can be implemented easily through technology. In addition to students reflecting on their learning process, Hennessey et al. (2012) discussed how teachers should spend time reflecting on student knowledge.

Reflection requires students to use their current knowledge to create new knowledge (Bruner, 1966; Keiser, 2012). Reflection allows students to think critically and communicate mathematically. Roake and Varlas (2013) discussed how reflection incorporates how justifying an answer to solving mathematical problems helps students to clarify their mathematical thinking. Checkley (2006) and Hintz (2014) believed that students become critical thinkers when they make sense of the strategies they use to solve problems. In Bloom's (1956) upper level for cognitive demand, justifying answers to solve mathematical problems is important because students must synthesize their thinking. Students are required to demonstrate each step of their mathematical process, explain their reasoning for each step, check for computational mistakes, and analyze any errors during their justification for solving problems. When students revise their thoughts, students clarify their misconceptions and improve their mathematical thinking skills (Schwartz and Kenney, 2012).

Kaune, Cohors-Fresenborg, and Nowinska (2011) conducted a study in secondary math classrooms. Kaune et al. (2011) found that there is a relationship between metacognition and learning success. Learning mathematics is accomplished when students expand their mathematical reality. Kaune et al. (2011) suggested that students have a deeper understanding of problems when they reflect on the results. Students should reflect on mathematical approaches to conceptions and misconceptions. Kaune et al. (2011) stated that students will have a deeper understanding of concepts when they monitor and reflect on the discourse that is used in class. Kaune et al. (2011) proved that metacognition and discursive activities should be interwoven in the classroom. Students should be able to reason and articulate what has been presented in classroom discourse.

Classroom settings should promote mathematical reasoning (Mueller & Maher, 2009). Students should become actively engaged in mathematical discussion, within a setting that is conducive to learning, where their ideas are public, shared, modified, and agreed upon. Classroom environments should incorporate mathematical activity where students have ownership of their learning and use justification to find solutions to problems. Mathematical activities should be tasks where students are engaged in problem solving and promote mathematical reasoning. Mathematical reasoning is stimulated when tasks are complex rather than simple, routine tasks. Problems within each task should incorporate problems in which students can revisit at a later time. These tasks should also allow students to reflect on their own reasoning.

Mueller and Maher (2009) offered suggestions on how to create a supportive environment. They suggested that students should be seated in small, heterogeneous groups because it allows students the opportunity to build ideas together. Students are afforded the opportunity to internalize their ideas and modify those ideas after considering other student's alternative theories. Allowing students ample time to formulate their own understanding and consider other perspectives will give the students accountable for their learning.

Mueller and Maher (2009) concluded that students used various types of arguments when justifying their solutions to problem solving tasks. Different types of reasoning include direct reasoning, reasoning by contradiction, upper and lower bounds, and case-based reasoning correctly to support their solutions. In a mathematical community, students use sense-making to construct alternate forms of reasoning and students feel comfortable sharing their ideas. At times, a student's incorrect argument can promote a deeper understanding. When students listen to other student's arguments, they are prompted to revisit their previous misconceptions.

Soares, Moro, and Spinillo (2012) examined a teaching process geared towards students' reflection and understanding. Soares et al. (2012) sought to determine if students documented their explanations for their reasoning when looking for solutions to problems would help improve their own thinking and reflection when approaching new problems. Their results indicated that public school students demonstrated difficulty in providing explanations for how they solved problems. Contrary to public school students, private school students provided descriptive and explicative justifications to problems. Soares et al. (2012) found that students who provided reasoning and justifications for their solutions were the students who correctly solved the problems.

Implications for Mathematics Instruction

GSE

The Georgia Department of Education and the Georgia Standards of Excellence in Mathematics, in particular the Algebra II/Advanced Algebra course, express eight processes students must incorporate within their course (GSE, 2015). The eight processes are; make sense of problems and persevere in solving them, reason abstractly and quantitatively, construct viable arguments and critique the reasoning of others, model with mathematics, use appropriate tools strategically, attend to precision, look for and make use of structure, and look for and express regularity in repeated reasoning.

First, students must make sense of problems and persevere in solving them (GSE, 2015). High school math students should begin solving problems by examining the problem, explain the meaning of the problem to them, and plan a solution process to the problem. If students need to change their thought process of solving a problem, they would do that at this time. Students should express their ideas to solving a problem and listen to other student's ideas, then consider different approaches to solving problems.

The second step for students to solve a problem is to reason abstractly and quantitatively (GSE, 2015). Students should make sense of the problem at hand (GSE, 2015). Next, students should construct viable arguments for their solutions to problems and analyze the reasoning of other students. Students should justify their conclusions, communicate their reasoning to others, and respond to the arguments of others. Students should be able to model with mathematics. Students should apply their knowledge to real-world scenarios. Students should use their previous knowledge to construct new ideas, make revisions to their thought process, and draw conclusions from their results. Students should reflect on their results and determine if the solution makes sense.

GSE (2015) stated that there has been a shift in the mathematics classroom. Students should no longer learn specific procedures to solve problems. Students should apply previous mathematical knowledge to construct a deeper understanding of concepts. Currently, in math classes, students should learn to think critically and realize there are numerous ways to solve problems. Students should discover new mathematical knowledge by reasoning, making logical connections.

Students must use appropriate tools to solve problems (GSE, 2015). Students should determine what tool is necessary to solve problems. Students should be familiar with numerous tools. High school math students should communicate to others their reasoning and attend to precision. In high school, students should be able to look for and make use of structure. Lastly, students should look for and express regularity in repeated reasoning. Students should notice if calculations are repeated, if general formulas can be derived, make generalizations, maintain an oversight to the process, attend to details, and constantly evaluate the reasonableness of their results.

Mathematics educators should provide students with a variety of expertise practices (GSE, 2015). The National Council of Teaching Mathematics (NCTM) addresses the following process standards: problem solving, reasoning and proof, communication, representation, and connections. The National Research Council's report, *Adding It Up*, include the following strands of mathematical proficiency: adaptive reasoning, strategic competence, conceptual understanding, procedural fluency, and productive disposition.

The Standards for Mathematical Practice are connected to the Standards for Mathematical Content (GSE, 2015). The Standards of Mathematical Practice expressed ways for creating student practitioners of the discipline of mathematics, as they grow in mathematical maturity. Those who design professional development, assessments, and curricula should attend to the need to connect the mathematical practices to mathematical content in mathematics instruction. Students will not obtain an understanding of a topic if they rely too heavily on routine procedures. If this occurs, students will not be able to represent problems coherently, justify their results, apply their knowledge to real-world situations, use appropriate technology, communicate to other students, and analyze and revise their results. Students cannot actively engage in mathematical practices without having a deeper understanding of mathematics.

Traditional Mathematics Instructions

Traditional mathematics instruction emphasizes that students should memorize facts with repetitive skills and procedures (Barrett & Long, 2012). In addition to Barrett and Long's (2012) findings, Jia (2010) found that teachers use direct instruction in traditional teaching. Teachers initiate, explain, and analyze for the students, which results in teachers completing the math for the students. Allen (2011) and Jia (2010) discussed that teachers are fundamental in organizing and guiding the whole teaching process founded on operational knowledge, which results in teachers completing the math for the students instead of the students completing the math. After instruction, teachers assign numerous problems to students that reinforce the same routines and procedures for solving math problems, which does not require critical thinking or allow for a deeper understanding of mathematics.

Sriraman and English (2010) described traditional mathematics instruction as instruction that requires students to memorize basic math rules, procedures, and facts and only obtain adequate mathematical knowledge for making informed decisions. In traditional mathematics instruction, Marshall (2006) found that students are learning mathematics through rote learning, following specific routines, and exercising memory without understanding or reflecting on their knowledge. In this instruction, teachers model procedures and students mimic the procedures, while solving similar problems in classwork and homework. Allen (2011) and Keiser (2012) stated that assigning students limitless worksheets or textbook pages with drills is not effective for communicating mathematical understanding. In this type of instruction, Jia (2010) explained that teachers do not address why or how certain procedures work for solving problems.

Jia (2010) explained that traditionally teachers explain, analyze, and introduce. Students received knowledge passively. Students do not have enough time and space for thinking. Teaching should entail using students' previous knowledge as the growth point of new knowledge and introduce students to generating new knowledge. Traditional teaching neglects students' practicing process, which resulted in students being able to think independently. Therefore, students do not meet their potential. When students do not take the initiative to participate, then the learning is worthless. Students should be required to respect other student's ideas and opinions. Jia (2010) explained that modern cognitive psychology occurs when learning is an interactive process and communication plays a critical role. Teaching should be changed to an equal association and communication. When students use previous knowledge to construct new knowledge, they will be more successful in solving real-world problems.

Marshall (2006) believed that the traditional style of teaching required students to memorize and apply formulas and procedures, without understanding how the formula relates to concepts. Marshall (2006) found that this traditional approach to teaching mathematics failed to engage students' minds. Marshall (2006) suggested a different style of teaching that allows students to use the concepts they learned and apply them to new situations.

In traditional mathematics instruction, teachers teach mathematics based on their views of mathematics and how students should learn because that is how they were taught and learned mathematics (Barrett and Long, 2012). When teachers were taught mathematics as a set of remote rules and procedures that is how they will teach students to learn mathematics. Students may seem to master routine procedures and memorize facts but the students' mathematical understanding of why the procedures are used is not apparent (Hennessey, Higley, & Chesnut, 2012; Jia, 2010). Students should be able to demonstrate the mathematical understanding and reasoning behind the procedures (Jia, 2010). When students are taught to memorize procedures, they may not know how to handle real-life problems (Sriraman & English, 2010). Mathematical literacy goes beyond performing mathematical procedures (Clark, 2013). Mathematical literacy incorporates applying those procedures in numerous contexts in real-life situations that are meaningful and reflective. Mathematics literacy emphasizes that students should communicate their mathematical ideas (Barlow & Drake, 2008). Communicating their ideas requires students to think critically and sharpen their understanding of mathematical concepts they experience.

Applying Teaching Practices in Mathematical Communication

Teachers should view students as learners who actively construct their own knowledge and communicate their thoughts verbally and in written format daily (Ahn et al., 2013; Dewey, 1987). Mueller et al. (2014) discussed the important role of a teacher. Teachers should promote student mathematical reasoning. Mueller et al. (2014) discussed conditions that promote mathematical learning. The conditions included challenging actively engaged students, teachers who are observant and help students create ideas, mathematical tasks that require students to extend their learning and provide justification to their reasoning, and a classroom environment that encourages group collaboration for students to share their ideas. Mueller et al. (2014) stated that these conditions influenced student discussion and reasoning about mathematics because students were comfortable in sharing their ideas and justifications to their solutions.

Critical thinking and mathematical literacy should be evident in classrooms so that students may develop competence and assurance in their mathematical thinking (Sammons, 2011). Writing about mathematics in daily classroom practices helps deepen student's conceptual thinking and they become proficient at expressing their mathematical thinking clearly and concisely. Soares et al. (2012) clearly indicated that students do not have a realization of their learning process when they cannot provide a clear justification to their solutions to problems. Their analysis confirmed that the content of students' justifications demonstrated a grasp of consciousness of the calculation procedures that were utilized. Explanations were an indication that specific procedures and relations of the concepts in questions, at a descriptive level. Writing justification to problems allowed competency to problems and solutions and resulted in a grasp of consciousness. Soares et al. (2012) emphasized that public schools need to contain a teaching-learning process where students should reflect and provide justifications for solving mathematical problems. Mathematical education should value students' capabilities of thinking about their own thoughts and encourage students to reflect on their solutions and thought process.

Improving Mathematics Instruction

Teachers should lead students to think about their learning process, so they can create understanding and transform their knowledge (Soares et al., 2012). To go beyond procedural knowledge, students should participate in learning experiences that create a conceptual understanding (Thompson et al., 2008). To create conceptual understandings, students should explore new concepts, make conjectures, and explain their reasoning for their thought process. Rothman (2012) and Steffe (2010) believe that students should be promoted to develop a deeper understanding of mathematics by creating their own ways of thinking and learning.

Burns (2012) wrote about the Common Core State Standards for Mathematical Practice. Burns (2012) emphasized that teachers must help strengthen student's mental math and numerical reasoning skills. Burns (2012) indicated mental math computation helps create adeptness with many common core standards, such as constructing a viable argument, reasoning quantitatively, and making use of structure. Reasoning and understanding should be a critical component of the classroom environment. The Common Core State Standards Initiative suggested that mathematics educators should move away from rote teaching (Dickey, 2013). Teachers should create learning environments that foster critical thinking for conceptual understanding. This type of environment encourages students to think about the processes they use to solve a mathematical problem and justify their answers in writing (Dickey, 2013).

Teachers should produce open-ended tasks and reflective listening (Mueller et al., 2014). Students obtained increased mathematical autonomy when they obtained ownership and had confidence in their learning. In the mathematical community, students would evaluate other student's solutions to problems by listening to their ideas and justification. Teachers must receive high-quality professional development so that they can understand mathematics and their thoughts about mathematics and understand what their students are trying to accomplish, and understand their thoughts about mathematics (Kinzer et al., 2011).

Mathematically literate students are developed when they participate in experiences that allow them to behave as mathematicians (Ben-Hur, 2006). Teachers should generate these experiences by creating tasks that require written communication (Soares et al., 2012). Teachers can foster rich conversations in the classroom through addressing their misconceptions (Burns, 2012). Rich conversations address cognitive demands that students experience through discourse, listening, and making mistakes (Hintz, 2014). Hintz suggested that if student's misconceptions were not addressed then they will continue learn incorrectly.

Constructivists encourage classroom environments that require students to use communication and reflection (Allen, 2011; Phillips & Wong, 2012). Barrett and Long (2012) and Soares et al. (2012) suggested that classrooms should promote and construct understanding by requiring students to actively engage in mathematical conversations, reflect on problems, use their previous knowledge to construct new knowledge, and articulate their thoughts and learning process. Allen (2011) found that students take ownership in their learning when they construct their knowledge, reflect on their knowledge, and discuss their understanding.

While it is encouraged that students use reflection, reflective practices help teachers understand the association between how they teach and how to improve their teaching (Ghaye, 2011). Ghave (2011) discussed how reflective practices provide teachers with opportunities and ideas for high-quality teaching. Reflective teachers explain pedagogical knowledge into their own teaching practice (Zwozdiak-Myers, 2012). Teachers are effective when they know how to make quick decisions and reflect on their teaching practices (Danielson, 2009). Teacher reflective practices associate with teacher pedagogical skill improvement, which has a direct effect on student accomplishment (Marzano, 2012). Teachers are encouraged to learn effective practices and interpret elements of those practices (Doerr & Lesh, 2003; Faulkner, 2013).

Marshall (2006) stated that teaching mathematics should incorporate students creating experiences, where interconnections can be constructed. Without these experiences, the learning process would be unclear and unsystematic. Low retention in fragmented knowledge does not allow students to use previous knowledge to construct new information. Students should be exposed to various and multiple models on how to approach new concepts. Marshall (2006) encouraged teachers to utilize their knowledge of mathematics and how students learn. Administration should give teachers guidelines and support that create and advocate an understanding approach and updated materials that foster the learning process. Teachers should create a positive classroom environment, where students feel comfortable making mistakes and their making sense of mathematics should be supported (Hintz, 2014; Larson et al., 2012).

Summary

The extensive review of literature found three common themes to help organize the structure of the study. Reading, writing, and using discourse and reflection help create a classroom environment that is conducive for students to obtain a deeper understanding of mathematics. Writing helps students to clarify and express their ideas and thought processes to others (Cooper, 2012; Lardner, 2008; Peterson, 2007). Discourse incorporates a common vocabulary and numerous ways to represent procedures and ideas for defending claims (Stahl et al., 2010; Hansen-Thomas, 2009; Hennessey et al., 2012). In addition to reading, writing, and using discourse, students should reflect on mathematical approaches to conceptions and misconceptions (Kaune et al., 2011). Chapter three includes a description of the mixed-methods research design that will be used to analyze homework assignments that required students to solve mathematical problems by using reading, writing, discourse, and reflection. Chapter three explains how the mixed-methods research design will be used to analyze the effects of the assignment, students' and teachers' attitudes toward learning and teaching with the assignment their suggestions for improving the assignment.

Chapter III

METHODOLOGY

The purpose of this quasi-experimental design, with mixed methods approach, was to analyze the effects of an assignment that requires students to solve mathematical problems while using reading, writing, discourse, and reflection. Another purpose of this study was to analyze students' and teachers' attitudes toward learning and teaching with the assignment and their suggestions for improving the assignment. There have been numerous studies that have indicated that reading, writing, discourse, and reflection should frequently be implemented in mathematics classrooms (Staats and Bateen, 2009; Mwei, 2017; Singer, 2007). There is a lack of evidence addressing how educators should implement an effective assignment that requires students to read, write, and use discourse and reflection in mathematics. In addition, there is inadequate research addressing students' and teachers' attitudes toward assignments that require students to read, write, discourse and reflection in mathematics.

The following research questions will help guide the study:

Research Questions

1) What are the effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students?
2) What are students' attitudes toward learning with the assignment?
3) What are teachers' attitudes toward teaching with the assignment?
4) What are their suggestions for improving the assignment?

Methodology

To determine the effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students, students' and teachers' attitudes toward learning and teaching with the assignment and their suggestions for improving the assignment, a quasi-experimental, with mixed-methods, research design was employed. A quasi-experimental design involves selecting groups, where a variable is tested, without having to use a random selection process (Explorable, 2018). A quasi-experimental design, with mixed methods approach, using both quantitative and qualitative techniques was used to answer the research questions. Longitudinal data was collected from the student and teacher surveys to determine if there is a change in attitudes over a short period of time. The quasi-experimental design compared a variable between different groups, over a period of time.

A quasi-experimental design, using mixed-methods approach, using both quantitative and qualitative techniques was used to answer the research questions. Creswell (2009) defined mixed methods research as by "an approach to inquiry that combines or associates both qualitative and quantitative forms" (p. 4). Creswell (2009) suggested that determining the timing of each data collection component, the weighting of the quantitative and qualitative pieces, the way in which the data are mixed, and the approach to theorizing should be used when planning a mixed methods design. In this study, the timing for data collection consisted of quantitative data being collected first, followed by qualitative data. Both quantitative and qualitative data will be equally weighted. Creswell (2009) referred to the mixing of data as a connected approach where the analysis of the data from one form is linked to the data collection of another form. The scores of students on the pretest and posttest will be used as quantitative data. SPSS (IBM CORP., 2017) will be used to analyze the statistical differences between the means of the two groups (Kent State University Libraries, 2018).

Longitudinal analysis can be used in quasi-experimental studies. Longitudinal data was collected from the surveys (pre and post) for students and teachers, which measured students' and teachers' attitudes toward learning and teaching with the assignment. Berbaum (2018) defined longitudinal analysis at the study of short serious of observation obtained from many respondents over a period of time. According to Creswell (2009), theorizing in mixed method studies can be done either explicitly or implicitly. Creswell (2009) described explicit theorizing as stating the theory on which the study is based and implicit theorizing as not stating the theory on which the study is based. Implicit theorizing was used in this study.

Considering timing, weighting, mixing, and theorizing approaches planned for this study, the sequential explanatory strategy was used. This strategy consisted of performing the quantitative and qualitative data collection sequentially where the initial quantitative results inform the secondary qualitative data collection (Creswell, 2009). This approach usually results in the qualitative element being used to follow-up with the participants from the quantitative phase. According to Fraenkel and Wallen (2009), the ability to study a topic more deeply is an advantage in mixed methods studies. An overview of the multiple methods used in the research study is described in Table 1.

Table 1

Overview of multiple methods used in the research study

Research Questions	*Quantitative*	*Qualitative*
1) What are the effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students?	Pre/Post-test scores	
2) What are students' attitudes toward learning with the assignment?	Likert-scale questions from the pre/post surveys for students	Open-ended questions on the post student survey
3) What are teachers' attitudes toward teaching with the assignment?	Likert-scale questions from the pre/post surveys for teachers	Open-ended questions on the post teacher survey Data from the teacher interviews
4) What are their suggestions for improving the assignment?		

Population and Sample

The study took place at a Title I, charter system in a Georgia public high school in the southeastern region of the United States. There are approximately 9600 students served by the district's ten elementary schools, one middle school (grades 6-7), one junior high school (grades 8-9), and one high school (grades 10-12). The ethnic demographics of the school system include approximately 49% white, 27% black, 19% Hispanic, and 5% other or multi ethnicity. Seventy-four percent of the school system received free and reduced lunch for the 2012 to 2013 school year. The high school in the study serves tenth to twelfth grade students. There are approximately 121 teachers and 1,812 students. Thirty-five percent of students passed the Geometry End of Course assessment and thirty-four percent of students passed the Algebra I End of Course assessment.

The participant population included 6 classes of Honors Advanced Algebra students (approximately 150 students) and 2 teachers of those students (Teacher A and

Teacher B). Students have been enrolled in Honors level math courses throughout their schooling experience. Teachers A and B are gifted endorsed, have more than ten years of teaching experience, and have previously taught the Honors Advanced Algebra course. The method for selecting participants include that there are 6 classes of Honors Advanced Algebra students at the high school and there are two teachers of those classes. Teacher A and teacher B both have 3 classes of Honors Advanced Algebra. The students and the parents of the students signed a consent form for participation in the study. Additionally, information was provided in all participant outreach correspondences identifying the researcher and explaining the purpose of the study. Furthermore, to ensure participants met the selection criteria of being certified teachers, participants confirmed they were certified teachers before progressing through the survey. To obtain access to the students, the researcher contacted the Board of Education and administrators to explain the purpose of the research study and to provide a letter of cooperation explaining the extent of the research study and the process utilized.

Participants were 150 students taking Honors Advanced Algebra. The students were in tenth and eleventh grade. All students in Honors Advanced Algebra have consistently taken honors math courses throughout their schooling experience. Ages of the students ranged from fifteen to seventeen years old. There were two groups in this study (treatment/control) and two Honors Advanced Algebra teachers (Teacher A/Teacher B). There were approximately 75 students in both the control and treatment groups. Student participants in Teacher A’s classes were in the treatment group and were required to solve the problems in Brightspace by reading the problems, writing about how to solve the problems, use discourse by responding to another student’s problem, and view the comment left by another student and reflect on their solution to ensure that their problem was accurate. Student participants in Teacher B's classes were in the control group and were required to solve the homework assignments algebraically.

A convenience sample is composed of participants easily and readily accessible to the researcher (Etikan, Musa, & Alkassim, 2016). Convenience sampling was utilized in this study because the participants were students enrolled in Honors Advanced Algebra and teachers of those students. The selection was convenient because it caused little disruption in the education setting (Explorable, 2018). Additionally, the researcher was identified and the purpose of the study was explained to all participants.

Instrumentation

The research took place in three phases, yielding both quantitative and qualitative data. The first phase yielded quantitative data and was used to answer the first research question (What are the effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students?). Students took one pre-test and one posttest at the beginning and end of the study. The name of the first and second instrument was "Honors Advanced Algebra Unit 1 Test (PRE/POST-TEST)" (Appendix C). The test was administered prior to assigning the homework assignments for Honors Advanced Algebra students in the study. The two teachers in the study administered the test on the second day of the study. The test was on a paper copy. The pre-test was administered Honors Advanced Algebra students at the beginning of the study. All of the items on the instrument applied to the first research question. Items 1 through 10 are constructed response questions. Answers were assessed using the point value system provided on the test and scores were calculated accordingly. The scores from the pre-test were compared to the scores from the posttest. Percentage gain or loss for each item from pre- to posttest was calculated for the learners as a group. The pre-test and post-test scores measured student achievement on the Unit 1 Test (Appendix C).

Longitudinal data was collected during the second phase to determine students' and teachers' attitudes toward learning and teaching with the assignment. The second phase yielded quantitative and qualitative data and was used to answer the second, third, and fourth research questions. The Likert-scale questions from the student (Appendix D and Appendix E) and teacher (Appendix F and Appendix G) surveys yielded quantitative data and the open-ended questions on the surveys yielded qualitative data. The Likert-scale categories were: "Strongly Disagree (0)", "Disagree (1)", "Neutral/Undecided (2)", "Agree (3)", and "Strongly Agree (4)". The surveys were modified from Walker's dissertation (2017) and from the Student Attitude Survey (Brookstein, Hegedus, Dalton, Moniz, &Tapper, 2011). The pre-surveys were administered by the third-party individual at the beginning of the study. The post-surveys were administered by the third-party individual at the end of the study. Once the surveys were completed, the third-party individual returned the surveys to the researcher. The surveys were on a paper copy.

There were two instruments used to answer the second research question (What are students' attitudes toward learning with the assignment?). "Attitudes of Students (Pre) Survey" was the name of the first instrument (Appendix D). The Likert-scale questions on the student surveys measured their attitudes of math, working collaboratively and privately, use of technology and Brightspace, use of homework and the assignment. The following breakdown of questions was used on the survey for students (pre): questions 1 through 5 measured students' attitudes toward learning math, questions 6 through 10 measured students' attitudes toward working collaboratively and privately, questions 11 through 15 measured students' attitudes toward their use of technology and Brightspace, and questions 16 through 18 measured students' attitudes toward their use of homework and learning with the assignment (Appendix D). The instrument was administered prior to the assignment and pre-test. The survey was on a paper copy.

The second instrument that was utilized to answer the second research question was the "Attitudes of Students (Post) Survey" (Appendix E). The post survey (Appendix E) for students was the same as the pre- survey for students but there were two additional Likert-scale questions that asked about the effectiveness of the assignment (questions 19 and 20). The survey was administered after the assignment and the posttest to the student participants in the study.

Two instruments were used to answer the third research question (What are teachers' attitudes toward teaching with the assignment?). "Attitudes of Teachers (Pre) Survey" was the first instrument that was administered (Appendix F). The Likert-scale questions on the teacher surveys measured their attitudes of technology, Brightspace, homework, and the assignment. The following breakdown of questions was used on the survey for teachers (pre): questions 1 through 5 measured teachers' attitudes toward their use of technology and Brightspace and questions 6 through 8 measured teachers' attitudes toward their use of homework and the teaching with assignment. The survey was administered, prior to teaching with the assignment, to the teacher participants. The teacher participants completed the survey on the first day of the study. The survey was on a paper copy.

"Attitudes of Teachers (Post) Survey" was the second instrument to answer the third research question (Appendix G). The post survey for teachers was the same as the pre- survey for teachers but there were two additional Likert-scale questions that asked about the effectiveness of the assignment (questions 9 and 10). The surveys were administered after the assignment to the Honors Advanced Algebra teachers in the study. The teacher participants in the study completed the survey at the end of the study. The survey was on a paper copy. The teacher participants completed the survey on the last day of the study. The survey was on a paper copy.

The second phase yielded qualitative data from the open-ended questions on the students' and teachers' post surveys and were used to answer the fourth research question (What are their suggestions for improving the assignment?). The first instrument (Appendix E) was two open-ended questions on the post survey for students. The open-ended questions asked for students' suggestions for improving learning with the assignment (questions 21 and 22). The items were coded, themed, and analyzed to yield qualitative data. The students' responses were recorded in the treatment group (Appendix K) and the control group (Appendix L). After all of the student responses were documented, the researcher highlighted common responses in certain colors to determine common themes. The themes were analyzed and discussed to make comparisons between suggestions made by students in the treatment and control group. Percentages were calculated to determine how many students had similar suggestions for improving the study. The survey was administered, by the third-party individual, after the posttest and at the end of the study. The survey was on a paper copy.

The second instrument (Appendix G) was two open-ended questions on the post survey for teachers. The open-ended questions asked for teachers' suggestions for improving teaching with the assignment (questions 11 and 12). The survey was administered, by a third-party individual, after the posttest and at the end of the study. The survey was on a paper copy. The items were coded, themed, and analyzed to yield qualitative data. Teachers' responses were recorded (Appendix M). After all of the teacher responses were documented, the researcher highlighted common responses in certain colors to determine common themes.

During the third phase of data collection, teacher interviews were conducted by the researcher. The "Teacher Interview Guide" was used to collect additional data to answer the fourth research question (Appendix H). The instrument contained six open-ended interview questions that were asked of the teacher participants. All items yielded qualitative data. The researcher recorded teacher responses from the interviews by typing their responses in a word document. Answers from the interviews were coded, themed, and analyzed to determine suggestions for improving the assignment. Interviews took place at the end of the study and after the "Attitudes of Teachers (Post) Survey". The interview questions were on a paper copy and the researcher read the questions from the interview guide. Teacher participants were able to read their typed responses and make revisions. The teacher interview guide was modified from Angelique Brown's Dissertation (2016).

Validity

Validity is accomplished when instruments measures what it is intended to measure. Creswell (2013) identifies three traditional forms of validity for quantitative studies. According to Creswell (2013), the three forms are content validity (items measure the content they were intended to measure), concurrent or predictive validity (scores predict a conditioned measure and the results correlate with other results, and construct validity (items measure theoretical concepts). Committee members, teacher and student participants, and Valdosta State University's Institutional Review Board (IRB) checked all of the instruments and determined that the instruments would measure the content that was intended to measure.

Reliability

The instruments were piloted and checked by students, teachers, and committee members to ensure that the questions were clear and easy to understand. Physical and Biological scientists regard a quasi-experimental design as unreliable (Explorable, 2018). However, quasi-experimental designs do not undermine the validity of the data, as long as the data weaknesses are recognized and allowed for during the whole experimental process. Quasi-experimental designs resemble quantitative and qualitative experiments, but lack random allocation of groups or proper controls, so firm statistical analysis can be very difficult. The unit of material that the students learned is a review from their previous course that most students took in ninth grade (GSE Algebra I). Therefore, the material was not new to students. The material was not new to the teachers in the study because both teachers have taught Honors Advanced Algebra. The students were familiar with the homework assignments because all students practiced the process by completing a practice homework assignment. The level of participation was measured by the teachers by ensuring that each student completed each homework assignment. A homework rubric was utilized for each homework assignment.

No information was gathered from the participants that contained identifiable, personal information. The third-party individual administered the surveys to the students and teachers. Students and teachers were required to write their names on the pre-test and post-test and the survey. This was required to help identify students and teachers and assign them a code from the formula, provided by the researcher. This code was used for collecting data. Once the code was assigned, the code was used in place of the participants' names. Participants' rights were protected by removing all names from materials used as part of the study. Once the third-party individual collected the completed surveys from students and teachers, the researcher placed codes over the participants' names. Then, the researcher analyzed the data, stored the data, and will destroy all the data at the appropriate time.

Data Collection

Data collection was acquired in three phases. Permission for collecting data was sought from the Valdosta State University Institutional Review Board (IRB). Permission was sought of the school systems' superintendent and administrators at the high school. Using the format prescribed by the IRB, a consent form (Appendix I), a parental consent form (Appendix J), and a student assent form was developed and given to all participants. Consent forms were collected before data collection began.

Valdosta State University and the researcher kept information confidential to the extent allowed by law. Members of the Institutional Review Board (IRB), a university committee charged with reviewing research to ensure the rights and welfare of research participants, may be given access to participants' confidential information. Students' and teachers' information, for research purposes, were identified only by a pre-assigned identification number placed on the pre-test and post-test, surveys, and interviews. The researcher compiled the instruments, removing all student and teacher identity, so that the researcher had no knowledge of the identity of the participants, when analyzing the data. Participants were not identified; therefore, the study did not place participants at risk for privacy or confidentiality risks. The researcher administered the pre-tests and post-tests and conducted teacher interviews. The pre-tests were administered at the beginning of the study. The post-tests were administered at the end of the study. Teacher interviews were conducted at the end of the study. Teacher responses from the interviews were typed in a word document to determine their suggestions for improving the homework assignments. Teacher participants were able to read their typed responses and make revisions. A third-party individual administered the surveys. Only the researcher had access to the compiled data. No actual names were used. The signed parental consent forms were placed in a sealed envelope that the researcher provided. A label on the envelope with instructions was provided by the researcher. The researcher collected the sealed parental consent forms. Participants returned the sealed parental consent forms into the researcher. The completed instruments will be stored in a locked cabinet and will only be shared with members of the dissertation committee. The data from the study were reported in combination with information from other participants, not associated with participants by name, and not individually identifiable.

Once the proposal defense of Chapters one through three was accepted on June 20, 2018, IRB with the final proposal and other documents were submitted. This process took approximately 4 weeks and was granted on August 7, 2018.

After initial contact for securing participants for the study, an informed consent was collected from the teacher participants in the study (Appendix I). Parental consent forms were collected from the student participants in the study (Appendix J). The students were required to bring back the signed consent forms two days after it was given. A Remind account was created so that the student participants, teacher participants, and guardians of the participants could be sent reminders and updates for the study.

The participants were involved in the study for three weeks. The qualitative phase, consisting of teacher and student surveys was administered at the beginning of the study, prior to the quantitative phase. The surveys were completed in one day. The quantitative phase (pre-test) began on the same day of the surveys. The quantitative phase lasted for three weeks. At the end of the quantitative phase (post-test), the last part of the quantitative and qualitative phases was administered (post- surveys and teacher interviews). Data collection was completely administered within four weeks. On August 6, 2018, consent forms were administered and collected by August 8, 2018. Student and teacher surveys (pre) and the pre-test were administered on August 8, 2018. The posttest and student and teacher surveys (post) were administered on August 24, 2018. Teacher interviews were conducted on August 25, 2018.

Data Analysis

Students are expected to answer extended response and open-ended questions on assessments. However, students do not practice answering extended response and open-ended questions on daily classroom assignments. Mathematics educators have expressed a need for students using instructional time answering extended response and open-ended questions. There is a need to enhance students' critical thinking through reading, writing, discourse, and reflection in mathematics. Teachers have expressed frustrations and concerns on the lack of effective classroom assignments. This study investigated assignments that required students to read, write, and use discourse and reflection to solve mathematical problems on an online forum (via Brightspace). A pretest and posttest were used to measure the effectiveness of the assignment. The study aimed to determine if the assignments increased student achievement on the posttest. Students and teachers were surveyed at the beginning and end of the study to determine attitudes toward learning and teaching with the assignment. Students' and teachers' suggestions on how to improve the assignment were documented and analyzed. Lastly, teacher interviews were conducted at the end of the study.

A pretest and posttest were used to measure the effectiveness of the assignment. The study aimed to determine if the assignment increases student achievement on the posttest. Students and teachers were surveyed at the beginning and end of the study to determine attitudes toward learning and teaching with the assignment. Students' and teachers' suggestions on how to improve the assignment were documented and analyzed. Lastly, teacher interviews were conducted at the end of the study.

In addition to the pre-tests, posttest, surveys, and teacher interviews during the three-week study, the students completed four weekly homework assignments in Brightspace (Appendices E and F). The homework assignments were problems from original weekly homework sheets, given in Honors Advanced Algebra. Weekly homework problems consist of problems that students are required to solve in lessons for Unit 1 (7 lessons). The homework assignments were assigned weekly in Brightspace and the students were notified of due dates. Parents had the option of requesting their child's login for Brightspace to see all homework assignments and due dates. Due dates for the weekly homework assignments and Unit-test were located on the calendar on the first page of the student's Unit 1 booklet. Solving the homework problems algebraically in Brightspace and the posttest were required for course completion and academic credit. The activities that were part of the research project, and therefore voluntary, included the surveys and solving the homework problems by using reading, writing, discourse, and reflection. The surveys and weekly homework assignments in Teacher A's classes were the procedures that are experimental. An alternative procedure for Teacher A's homework assignments was to solve the homework problems algebraically. If student participants chose not to use reading, writing, discourse, and reflection to solve the homework problems in Brightspace, then their average in the course was not altered. If student participants chose not to participate in the surveys, then their average in the course was not altered.

According to Creswell (2013), quantitative designs have numerous variables: independent, dependent, intervening (or mediating), moderating, control, and confounding. This study utilized one dependent variable and three independent variables. Creswell (2013) defined an independent variable as causing, influencing, or affecting outcomes. Creswell (2013) defined dependent variables as variables that depend on the independent variable and are the result of the influence of the independent variables. SPSS (IBM CORP., 2017) was used to find an independent samples *t*-test to compare the pre-test scores and pre-survey scores in the treatment and control group and compare the post-test scores and post-survey scores in the treatment and control group. Then, a paired samples *t*-test was used to compare the pre-test scores to the post-test scores in the treatment group and control group. A paired samples *t*-test was used to compare the pre-survey scores to the post-survey scores in the treatment group and control group.

The independent variable utilized during the quantitative phase of this study was the homework assignments. The dependent variable utilized during the quantitative phase of this study was the student's pretest and posttest scores on the assessment. The scores from these items were used to inform the independent variables. Surveys were transcribed, coded, themed, and analyzed to inform the qualitative phase of the study. Quantitative and qualitative data was collected during this quasi-experimental to answer the four research questions. Therefore, both data analysis methods were employed to evaluate, analyze, and interpret the findings and draw conclusions.

SPSS (IBM CORP., 2017) was used to calculate descriptive statistics, independent samples *t*-test and paired samples *t*-test for the pre-test and post-test scores. Descriptive statistics were calculated to determine the means of scores on the pre-test and post-test. An independent samples *t*-test was calculated, using SPSS (IBM CORP., 2017), to compare the means of scores on the pre-tests for the treatment and control group. An independent samples *t*-test was used to inform the researcher on how the student's prior knowledge of the unit compared in the treatment to control group, at the beginning of the study. The results of the independent samples *t*-test helped compare how students performed on the pre-test in the treatment group to how students performed on the pre-test in the control group. At the end of the study, an independent samples *t*-test was calculated, using SPSS (IBM CORP., 2017), to compare the means of scores on the post-tests for the treatment and control group. These results informed the researcher about how students performed in the treatment group when compared to the control group. Performing an independent samples *t*-test was useful to provide evidence on how students performed in the treatment group when compared to how students performed in the control group. The results indicated if there was a significant difference in student's performance on the pre-test and post-test, in both groups.

A paired samples *t*-test was performed at the end of the study, after the pre-test and post-test were administered. A paired samples *t*-test was used to determine if there was a significant difference between the scores on the pre-test and post-test. A paired samples *t*-test was used to compare pre-test and post-test scores for the treatment and the control group. The results of the paired samples *t*-test provided evidence on the growth of scores that occurred before and after the homework assignments were implemented. Also, the results provided evidence that allowed comparison, in pre-test and post-test scores, between the treatment and control group.

SPSS (IBM CORP., 2017) was used to calculate descriptive statistics, independent samples *t*-test, and paired samples *t*-test. Descriptive statistics calculated the means of scores on the surveys for students. The results provided evidence of student's attitudes at the beginning of the study (prior to assigning the homework assignments) and at the end of the study (after the students completed the homework assignments). An independent samples *t*-test was used to compare student's attitudes in the treatment group to student's attitudes in the control group, at the beginning and end of the study. The importance of finding these results was to analyze the difference in attitudes between both groups. A paired samples *t*-test was used to compare student attitudes, in the treatment group, at the beginning of the study and at the end of the study. Another paired samples *t*-test was used to compare student attitudes, in the control group, at the beginning of the study and at the end of the study. The results were important because the test determined if there was a change in attitudes from the beginning of the study to their attitudes at the end of the study. SPSS (IBM CORP., 2017) was not used to calculate the independent samples *t*-test and the paired samples *t*-test for the teacher surveys because the sample size was too small (N = 2). The means for each question were found and discussed and compared to the results of the pre-survey.

Protection of Human Subjects

The researcher completed the required IRB form and obtained permission to complete the study (Appendices I and J). This form was used to provide the context and purpose of the study. This page included human-rights compliance information and confidentiality information about the nature of the study. Participants were informed of identifiable characteristics that will be utilized for statistical purposes only. Statistical data was used for whole group reporting analysis. The researchers maintained the privacy rights of all participants in the study. All efforts were made to ensure respondents' anonymity was protected.

Participants' rights were protected by removing all names from materials used as part of the study. The participants' information, for research purposes, was identified only by a pre-assigned identification number placed on the surveys, pre/posttests, and the interview guide. Student and teacher participants in the study were not identified; therefore, the study did place them at risk for privacy or confidentiality risks. No actual names were identified by the researcher. The completed instruments will be stored in a locked cabinet and were shared with members of the dissertation committee. Once the code was assigned, the code was used in place of the participants' names. All paper documents containing student and teacher responses will be kept in a locked filing cabinet in the researcher's office for three years. All data collected will be destroyed at the appropriate time using a paper shredding machine by the researcher. No other persons were a part of analyzing data. The data from the study was reported in combination with information from other participants, not associated with participants by name, and not individually identifiable.

Summary

A quasi-experimental design, with mixed methods approach, using both quantitative and qualitative techniques, was used to answer the research questions. The purpose of the quantitative part of the design was determine if there is a significant difference on an Honors Advanced Algebra posttest after the implementation of an assignment that requires students to use reading, writing, discourse and reflection while solving mathematical problems and algebraically solving mathematical problems on homework assignments in Brightspace (Appendices E and F). The results were analyzed to determine if the assignment increased student achievement on the posttest. SPSS (IBM CORP., 2017) was used to determine if the mean of the students' scores on the pretest was significantly different from the mean of the student scores on the posttest (Appendix C).

Another purpose of the quantitative elements of the study was to determine students' and teachers' attitudes toward learning and teaching with the assignment and will be measured by the Likert-scale questions on the surveys (pre and post) for students and teachers. These quantitative elements were measured by two student surveys and two teacher surveys, given at the beginning and end of the study (Appendixes D-G). On the post surveys for students and teachers, given at the end of the study, there were two open-ended questions asking students and teachers to make suggestions for improving learning and teaching with the assignment. Lastly, teacher interviews were conducted to measure teachers' suggestions for improving teaching with the assignment (Appendix H).

Chapter IV

RESULTS

Chapter 4 is organized by the demographics of participants, presentation and analysis of data, and the summary. The presentation and analysis of the data incorporates data from the three phases of the study. Phase I addressed the first research question and yielded quantitative data collected by analyzing the pre-test and post-test scores. Phase II addressed the second and third research questions and yielded quantitative and qualitative data that was collected from the surveys. Phase III answered the fourth research question by analyzing data from the interviews with teachers. Four research questions for which data were collected are as follows:

1. What are the effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students?
2. What are students' attitudes toward learning with the assignment?
3. What are teachers' attitudes toward teaching with the assignment?
4. What are their suggestions for improving the assignment?

This quasi-experimental study, with mixed-methods approach, investigated the effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students. The first purpose of the study was to determine if there was a significant difference on an Honors Advanced Algebra posttest after the implementation of an assignment that required students to use reading, writing, discourse and reflection while solving mathematical problems and algebraically solving mathematical problems on homework assignments in Brightspace. The second purpose of the study was to determine students' and teachers' attitudes toward learning and teaching with the assignment and their suggestions for improving the assignment. Quantitative elements of the design included pre- and posttests for students and Likert-scale questions from the student and teacher surveys. SPSS (IBM CORP., 2017) was used to calculate an independent samples *t*-test and paired samples *t*-test to determine if there was a significant difference on the pre-tests, post-tests, pre-surveys, and post-surveys. Qualitative elements of the design included open-ended questions from the student and teacher surveys and teacher interviews. The qualitative elements were coded, themed, and then analyzed to measure students' and teachers' suggestions for improving learning and teaching with the assignment. The findings will begin with an overview of the demographic data followed by analyses and results summary presented in the order of the four research questions.

Participants

The participant population included six classes of Honors Advanced Algebra students (approximately 150 students) and two teachers of those students (Teacher A and Teacher B). A special characteristic of the students was that those students have been enrolled in Honors level math courses throughout their schooling experience. Special characteristics about the teacher participants was that they are both gifted endorsed, have 10 or more years of teaching experience, and have previously taught the Honors Advanced Algebra course. There were 180 students enrolled in Honors Advanced Algebra at the designated school, at the beginning of the 2018 school year. The two participating teachers each had 90 students in their classes. One-hundred and eighty consent forms were sent out to all students. Of those 180 consent forms that were sent out, both teachers had at least 75 returned. In the treatment group, 4.67% were male students in the tenth grade, 16.67% were male students in the eleventh grade, 6.67% were female students in the tenth grade, and 22% were female students in the eleventh grade. In the control group, 5.33% were male students in the tenth grade, 18% were male students in the eleventh grade, 7.33% were female students in the tenth grade, and 19.33% were female students in the eleventh grade. This guaranteed that there were enough participants for the study. Both teachers agreed to participate. Both teachers have ten or more years of teaching experience, gifted endorsed, have experience teaching honors level math courses, and are female. The student participants' demographics are described in Table 2.

Table 2

Student participants' demographics (N = 150)

	Treatment Group	Control Group	Total
Male (grade 10)	7	8	15
Male (grade 11)	25	27	52
Female (grade 10)	10	11	21
Female (grade 11)	33	29	62
Total	75	75	150

Presentation and Analysis of Data

There were three phases to the data analysis for this quasi-experimental with mixed-method approach study. The first phase yielded quantitative data from the pre/posttest scores. Students took one pre-test and one posttest. The pre- and post-tests measured student achievement on the Unit 1 Test. The second phase yielded quantitative and qualitative data. Longitudinal data was collected to measure students' and teachers' attitudes toward learning and teaching with the assignment. The Likert-scale questions from the student and teacher surveys yielded quantitative data. The open-ended questions on the student and teacher surveys yielded qualitative data. The third phase yielded qualitative data. Teacher interviews were used to analyze teachers' suggestions for improving the assignment.

Phase 1: Pre/Post-test (Quantitative)

Research Question 1.

What are the effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students?

The pre-test and post-test was completed by 150 student participants. Descriptive statistics were analyzed, using SPSS (IBM CORP., 2017), for the student scores on the pre/posttest in the control and treatment group. Then, an independent samples t-test was analyzed, using SPSS (IBM CORP., 2017), by comparing the means of the pre-test scores in the treatment group to the pre-test scores in the control group and the post-test scores in the treatment group to the post-test scores in the control group. Lastly, a paired samples t-test was analyzed using SPSS (IBM CORP., 2017), by comparing the means of the pre-test scores to the post-test scores in both the treatment and control groups.

Descriptive Statistics for the mean on the pre-test and post-test for the treatment and control group is presented in Table 3.

Table 3

Descriptive Statistics for the means and differences of the pre-test and post-test scores in the treatment and control group (N = 75 in each group)

	Treatment Group (Students A)		Control Group (Students B)	
	Mean	SD	Mean	SD
Pre-test	10.11	.76	14.63	1.21
Post-test	87.25	.94	78.68	1.61
Difference	77.14	1.04	64.05	2.16

The students in the control group (M = 14.63, SD = 1.21) performed higher on the pre-test compared to the students in the treatment group (M = 10.11, SD = .76). The students in the treatment group (M = 87.25, SD = .94) performed higher on the post-test compared to the students in the control group (M = 78.68, SD = 1.61).

The researcher chose to calculate an independent samples t-test for the pre-test scores to determine if student's ability at the beginning of the study was different, when comparing the treatment and control group. An independent samples t-test was used to compare the means of the pre-test scores in the treatment group and the means of the pre-test scores in the control group. Results indicate that students in the control group had a significantly higher mean on the pre-test than the students in the treatment group: $t(75) = -3.17$, $p < .05$. This finding implies that students in the control group had more prior knowledge about the unit than the students in the treatment group. This result was important to keep in mind when comparing the results to the post-test scores.

An independent samples t-test was used to compare the means of the post-test scores in the treatment group and the means of the post-test scores in the control group. Results indicate that students in the treatment group had a significantly higher mean than the students in the control group: $t(75) = 4.60$, $p < .05$. The results have a deeper meaning when comparing the results of the post-test scores to the pre-test scores because at the end of the study, the treatment group performed significantly higher than the control group. These results imply more growth with the students in the treatment group. The *t* value and 2-tailed significance is reported in Table 4.

Table 4

Independent samples t-test for comparing pre-test and post-test scores in the treatment and control group (N = 75 in each group)

	t	Sig. (2-tailed)
Pre-test	-3.173	.002*
Post-test	4.600	.000*

* Indicates significance at $p < .05$

A paired samples *t*-test was used to compare the means of the pre-test scores to the means of the post-test scores in the treatment group. Results indicate that students, in the treatment group, had a significantly higher mean on the post-test than the pre-test: $t(75) = -73.865$, $p < .05$. A paired samples t-test was used to compare the means of the pre-test scores to the means of the post-test scores in the control group. Results indicate that students, in the control group, had a significantly higher mean on the post-test than the pre-test: $t(75) = -29.677$, $p < .05$. Calculating a paired samples t-test was important to signify the growth that students had from the beginning of the study to the end of the study. The *t* value and 2-tailed significance was reported in Table 5.

Table 5

Paired samples t-test for comparing pre-test and post-test scores in the Treatment Group and Control Group (N = 75 in each group)

	t	Sig (2-tailed)
Treatment Group	-73.865	.000*
Control Group	-29.677	.000*

* Indicates significance at $p < .05$

Phase 2: Pre/Post Student and Teacher Surveys (Quantitative and Qualitative)

Research Question 2.

What are students' attitudes toward learning with the assignment?

Quantitative data

The student pre-survey and the student post-survey were completed by 75 student participants. The Likert-scale questions on the surveys were measure by using the following scale: 0 for strongly disagree, 1 for disagree, 2 for neutral/undecided, 3 for agree, and 4 for strongly agree. Descriptive statistics were analyzed, by using SPSS (IBM CORP., 2017), to compare the student scores on the pre-survey and the post-survey for each question, in the control and treatment group. Then, an independent samples *t*-test was analyzed, by using SPSS (IBM CORP., 2017), to compare the means of each question on the pre-survey and the post-survey, in the control and treatment group. Lastly, a paired samples *t*-test was analyzed, by using SPSS (IBM CORP., 2017), to compare the means of each question on the pre-survey to the post-survey, in the treatment and control group. There were four attitudes defined on the surveys for students. Questions 1 through 5 analyzed Attitude 1, "Deep affect: Positivity towards learning mathematics and school"; questions 6 through 10 analyzed Attitude 2, "Working collaboratively and related effect and working privately"; questions 11 through 15 analyzed Attitude 3, "Use of Technology and Brightspace (Attitude 3)"; and questions 16 through 18 analyzed Attitude 4, "Use of Homework and learning with the assignment". On the post-survey, questions 19 and 20 were included in Attitude 4.

Quantitative data was collected from the Likert-scale questions on the pre-survey for students. The means for each question, on the pre-survey, were calculated for the treatment group and control groups and are presented in Table 6. Descriptive statistics were useful to determine students' attitudes at the beginning of the study. Additionally, the means informed the researcher about the differences and similarities of attitudes between each group.

An independent samples *t*-test was used to compare the means of the pre-survey scores in the treatment group and the means of the pre-survey scores in the control group. Results indicate that there was no significant difference between the pre-survey scores in the treatment and control group. An independent samples *t*-test was beneficial to compare students' attitudes in the treatment group to the students' attitudes in the control group, at the beginning of the study. The *t* value and 2-tailed significance is reported in Table 6.

Table 6

Descriptive Statistics and independent samples t-test comparing the pre-survey scores in the treatment group to the pre-survey scores in the control group (N = 75 in each group)

Attitude	Question	Treatment Group	Control Group	*t*	Sig. (2-tailed)
Attitude 1	1. I do not like school.	1.69	1.83	-.799	.426
	2. I like math.	2.79	2.84	-.350	.727
	3. I think mathematics is important in life.	3.09	3.23	-1.062	.290
	4. I learn more from talking with my friends than from listening to my teacher.	1.49	1.79	-1.597	.112
	5. I like hearing the thoughts and ideas of my peers in math class.	2.83	2.68	1.001	.318
Attitude 2	6. I like to go to the board or share my answers with peers in math class.	1.49	1.43	.317	.752
	7. I am not eager to participate in discussions that involve mathematics.	1.79	1.69	.595	.553
	8. I enjoy working in groups better than alone in math class.	2.87	2.76	.553	.581
	9. I prefer working alone rather than in groups when doing mathematics.	1.57	1.65	-.433	.666
	10. I learn more about mathematics working on my own.	1.76	1.65	.598	.551
Attitude 3	11. I enjoy using technology when learning mathematics.	2.67	2.84	-1.088	.278
	12. Technology can make	2.59	2.87	-1.698	.092

	mathematics easier to understand.				
	13. I have access to technology outside of school (computer, cell phone, chrome book, iPad, etc.).	3.80	3.75	.660	.510
	14. I have a good experience using Brightspace.	1.41	1.04	1.897	.060
	15. I have never had trouble accessing Brightspace inside or outside of school.	1.77	1.44	1.598	.112
Attitude 4	16. I feel that I have enough time to do homework inside or outside of school.	2.63	2.33	1.544	.125
	17. I feel that homework assignments help me to better understand the math lessons.	2.48	2.25	1.168	.245
	18. Reading, writing, discussing, and reflecting on math helps me to better understand math lessons.	2.84	2.63	1.266	.208

0 – strongly disagree, 1 – disagree, 2 – neutral/undecided, 3 – agree, 4 – strongly agree
* Indicates significance at $p < .05$

On the pre-survey, questions 1 through 5 analyzed Attitude 1 (M = 11.89, SD = 2.09) for the treatment group and M = 12.36, SD = 2.08 for the control control), "Deep affect: Positivity towards learning mathematics and school"; questions 6 through 10 analyzed Attitude 2 (M = 9.48, SD = 2.27 for the treatment group and M = 9.19, SD = 1.95 for the control control), "Working collaboratively and related effect and working privately"; questions 11 through 15 analyzed Attitude 3 (M = 12.24, SD = 2.79 for the treatment group and M = 11.93, SD = 2.85 for the control control), "Use of Technology and Brightspace (Attitude 3)"; and questions 16 through 18 analyzed Attitude 4 (M = 7.95, SD = 2.66 for the treatment group and M = 7.21, SD = 2.75 for the control control), "Use of Homework and learning with the assignment". The means are described in Table 7.

An independent samples *t*-test was used to compare the means of the four attitudes in the treatment group to the means of the four attitudes in the control group. Results indicate that there was no significant difference between the four attitudes in the treatment and control group. Though the results were not informative, an independent samples *t*-test was used to verify that there was no significant change in students' attitudes in the treatment group (at the beginning and end of the study) and in the control group (at the beginning and end of the study). The *t* value and 2-tailed significance is reported in Table 7.

Table 7

Descriptive Statistics and independent samples t-test comparing the four attitudes on the pre-survey scores in the treatment group to the four attitudes on pre-survey scores in the control group (N = 75 in each group)

Attitude	Treatment Group	Control Group	*t*	Sig. (2 – tailed)
1. Deep affect: Positivity towards learning mathematics and school	11.89	12.36	-1.370	.173
2. Working collaboratively and related effect and working privately	9.48	9.19	.848	.398
3. Use of Technology and Brightspace	12.24	11.93	.666	.507
4. Use of Homework and learning with the assignment	7.95	7.21	1.662	.099

* Indicates significance at $p < .05$

Quantitative data was collected from the Likert-scale questions on the post-survey for students. The means for each question, on the post-survey, were calculated for the treatment group and control groups and are presented in Table 8. An independent samples t-test was used to compare the means of the post-survey scores in the treatment group and the means of the post-survey scores in the control group. Results indicate that there was no significant difference between the post-survey scores in the treatment and control group for questions 1 through 16, 18, and 20. Results indicate that there was a statistically significant change in students' attitude (question 17) toward the statement, "I feel that the homework assignments helped me to better understand the math lessons" ($t(75) = 2.90$, $p < .05$). Results indicate that there was a statistically significant change in students' attitude (question 19) toward the statement, "Overall, the assignment helped me to have a better understanding of the unit" ($t(75) = 3.256$, $p < .05$). The *t* value and 2-tailed significance is reported in Table 8.

Table 8

Descriptive Statistics and independent samples t-test comparing the post-survey scores in the treatment group to the post-survey scores in the control group (N = 75 in each group)

Question	Treatment Group	Control Group	*t*	Sig. (2-tailed)
1. I do not like school.	1.63	1.83	-1.09	.277
2. I like math.	2.77	2.56	1.308	.193
3. I think mathematics is important in life.	3.03	2.97	.379	.705
4. I learn more from talking with my friends than from listening to my teacher.	1.80	1.85	-.284	.777
5. I like hearing the thoughts and ideas of my peers in math class.	2.67	2.69	-.162	.872
6. I like to go to the board or share my answers with peers in math class.	1.69	1.31	1.900	.059
7. I am not eager to participate in discussions that involve mathematics.	1.88	1.67	.242	.185
8. I enjoy working in groups better than alone in math class.	2.83	2.65	.052	.355
9. I prefer working alone rather than in groups when doing mathematics.	1.77	1.69	.422	.673
10. I learn more about mathematics working on my own.	1.91	1.79	.657	.512
11. I enjoy using technology when learning mathematics.	2.64	2.75	-.629	.530
12. Technology can make mathematics easier to understand.	2.60	2.79	-1.128	.265
13. I have access to technology outside of school (computer, cell	3.67	3.63	.378	.706

phone, chrome book, iPad, etc.).				
14. I have a good experience using Brightspace.	2.55	2.65	-.495	.621
15. I have never had trouble accessing Brightspace inside or outside of school.	2.48	2.53	-.254	.800
16. I feel that I had enough time to do homework inside or outside of school.	2.56	2.28	1.515	.132
17. I feel that the homework assignments helped me to better understand the math lessons.	2.83	2.32	2.903	.004*
18. Reading, writing, discussing, and reflecting on math helped me to better understand the math lessons.	2.67	2.41	1.507	.134
19. Overall, the assignment helped me to have a better understanding of the unit.	3.01	2.57	3.256	.001*
20. I would like to use this assignment again.	2.51	2.21	.009	.057

0 – strongly disagree, 1 – disagree, 2 – neutral/undecided, 3 – agree, 4 – strongly agree
* Indicates significance at $p < .05$

On the post-survey, questions 1 through 5 analyzed Attitude 1 (M = 11.89, SD = 2.75 for the treatment group and M = 11.91, SD = 1.95 for the control control), “Deep affect: Positivity towards learning mathematics and school”; questions 6 through 10 analyzed Attitude 2 (M = 10.08, SD = 2.22 for the treatment group and M = 9.11, SD = 2.10 for the control control), “Working collaboratively and related effect and working privately”; questions 11 through 15 analyzed Attitude 3 (M = 13.93, SD = 3.41 for the treatment group and M = 14.35, SD = 3.24 for the control control), “Use of Technology and Brightspace (Attitude 3)”; and questions 16 through 18 analyzed Attitude 4 (M = 13.57, SD = 3.74 for the treatment group and M = 11.80, SD = 3.43 for the control control), “Use of Homework and learning with the assignment”. The means are described in Table 9.

An independent samples *t*-test was used to compare the means of the four attitudes in the treatment group to the means of the four attitudes in the control group. Results indicate that there was no significant difference between the four attitudes in the treatment and control group for Attitude 1 and 3. Results indicate that there was a statistically significant change in Attitude 2: $t(75) = 2.759$, $p < .05$. Results indicate that there was a statistically significant change in Attitude 4: $t(75) = 3.024$, $p < .05$. The t value and 2-tailed significance is reported in Table 9.

Table 9

Descriptive Statistics and independent samples t-test comparing the four attitudes on the post-survey scores in the treatment group to the four attitudes on post-survey scores in the control group (N = 75 in each group)

Attitude	Treatment Group	Control Group	*t*	Sig. (2 – tailed)
1. Deep affect: Positivity towards learning mathematics and school	11.89	11.91	-.034	.973
2. Working collaboratively and related effect and working privately	10.08	9.11	2.759	.007*
3. Use of Technology and Brightspace	13.93	14.35	-.760	.448
4. Use of Homework and learning with the assignment	13.57	11.80	3.024	.003*

* Indicates significance at p < .05

A paired samples t-test was used to compare the means of the post-survey scores (Questions 1 through 19) to the means of the post-survey scores in the treatment group. Results indicate that there was a significant change in students' attitude on question 14 ("I have a good experience using Brightspace."): $t(75) = -5.094$, $p < .05$. Results indicate that there was a significant change in students' attitude on question 15 ("I have never had trouble accessing Brightspace inside or outside of school."): $t(75) = -4.764$, $p < .05$. The *t* value and 2-tailed significance was reported in Table 10.

Table 10

Paired samples t-test comparing the pre-survey scores to the post-survey scores in the Treatment Group

	t	Sig. (2-tailed)
1. I do not like school.	.336	.738
2. I like math.	.085	.933
3. I think mathematics is important in life.	.431	.668
4. I learn more from talking with my friends than from listening to my teacher.	-1.592	.116
5. I like hearing the thoughts and ideas of my peers in math class.	1.062	.292
6. I like to go to the board or share my answers with peers in math class.	-1.143	.257
7. I am not eager to participate in discussions that involve mathematics.	-.499	.619
8. I enjoy working in groups better than alone in math class.	.231	.818
9. I prefer working alone rather than in groups when doing mathematics.	-1.098	.276
10. I learn more about mathematics working on my own.	-.770	.444
11. I enjoy using technology when learning mathematics.	.157	.876
12. Technology can make mathematics easier to understand.	-.077	.939
13. I have access to technology outside of school (computer, cell phone, chrome book, iPad, etc.).	-1.521	.133
14. I have a good experience using Brightspace.	-5.094	.000*
15. I have never had trouble accessing Brightspace inside or outside of school.	-4.764	.000*
16. I feel that I have enough time to do homework inside or outside of school.	.330	.742
17. I feel that homework assignments help me to better understand the math lessons.	-1.987	.051
18. Reading, writing, discussing, and reflecting on math helps me to better understand math lessons.	-1.059	.293

* Indicates significance at $p < .05$

A paired samples *t*-test was used to compare the means of the pre-survey scores to the means of the post-survey scores in the control group. Results indicate that there was a significant change in students' attitude on question 2 ("I like math."): $t(75) = 2.546$, $p < .05$. Results indicate that there was a significant change in students' attitude on question 3 ("I think mathematics is important in life."): $t(75) = 2.393$, $p < .05$. Results indicate that there was a significant change in students' attitude on question 14 ("I have a good experience using Brightspace."): $t(75) = -8.964$, $p < .05$. Results indicate that there was a significant change in students' attitude on question 15 ("I have never had trouble accessing Brightspace inside or outside of school."): $t(75) = -4.845$, $p < .05$. The *t* value and 2-tailed significance was reported in Table 11.

Table 11

Paired samples t-test comparing the pre-survey scores to the post-survey scores in the Control Group

	t	Sig. (2-tailed)
1. I do not like school.	.000	1.000
2. I like math.	2.546	.013*
3. I think mathematics is important in life.	2.393	.019*
4. I learn more from talking with my friends than from listening to my teacher.	-.399	.691
5. I like hearing the thoughts and ideas of my peers in math class.	-.098	.922
6. I like to go to the board or share my answers with peers in math class.	.682	.497
7. I am not eager to participate in discussions that involve mathematics.	.203	.840
8. I enjoy working in groups better than alone in math class.	.642	.523
9. I prefer working alone rather than in groups when doing mathematics.	-.255	.800
10. I learn more about mathematics working on my own.	-.784	.436
11. I enjoy using technology when learning mathematics.	.600	.550
12. Technology can make mathematics easier to understand.	.512	.610
13. I have access to technology outside of school (computer, cell phone, chrome book, iPad, etc.).	-1.195	.236
14. I have a good experience using Brightspace.	-8.964	.000*
15. I have never had trouble accessing Brightspace inside or outside of school.	-4.845	.000*
16. I feel that I have enough time to do homework inside or outside of school.	.288	.774
17. I feel that homework assignments help me to better understand the math lessons.	-.416	.679
18. Reading, writing, discussing, and reflecting on math helps me to better understand math lessons.	-1.295	.199

* Indicates significance at $p < .05$

Qualitative Data

The open-ended questions, on the post-survey for students, were completed by 75 student participants. The comments left by students in the treatment group were coded to develop common themes. Student comments were recorded from the post-survey for students in the treatment group and the common themes were coded and discussed in Table 12.

Question 20 ("What suggestions can you make to improve learning with this assignment?") on the post-survey for students in the treatment group. Positive comments (12%) about the assignment were coded in the color purple, no suggestions (45.33%) for the assignment were coded in the color light green, suggestions for needing more time (4%) with the assignment were coded in the color blue, suggestions for incorporating more group work (6.67%) with the assignment were coded in the color yellow, suggestions for incorporating more "hands-on" activities (4%) with the assignment were coded in the color light blue, suggestions for incorporating more practice work (14.67%) with the assignment were coded in the color red, and frustrations with Brightspace (D2L) and/or the assignment (9.33%) were coded in the color dark green. Suggestions that were found with no common theme were not color coded (4%). Generally, there were no suggestions for improving learning with the assignment (45.33%).

Question 21 ("What are things that you would do differently, while learning with the assignment?") on the post-survey for students in the treatment group. Suggestions for things to do differently with the assignment were to study more (14.67%) and were coded in the color purple, to do nothing differently (61.33%) and were coded in the color light green, negative comments about not liking Brightspace (D2L) (8%) and were coded in the color blue, comments about students managing their time better (4%) and were coded in the color yellow, to include more group work (5.33%) and were coded in the color light blue, to ask more questions to deepen understanding (6.67%) and were coded in the color red, and suggestions that were found with no common theme were not color coded (0%). Overall, the students did not want to change anything with learning with the assignment (61.33%). Suggestions and improvements were coded, themed, and analyzed in Table 12.

Table 12

Treatment group-emerging themes

Students A – Question 20 What suggestions can you make to improve learning with this assignment?	**Students A – Question 21** What are things that you would do differently, while learning with the assignment?
Positive comments, students liked the assignment. – 9/12%	Study more – 11/14.67%
No suggestions – 34/45.33%	Nothing different – 46/61.33%
More time – 3/4%	Negative comments, students did not like aspects of D2L. – 6/8%
Group work – 5/6.67%	Students want to have more time management. – 3/4%
More "hands on" activities – 3/4%	Include more group work – 4/5.33%
Require more work – 11/14.67%	Ask more questions to deepen understanding – 5/6.67%
Frustrations specifically with D2L and/or homework assignments – 7/9.33%	Other – 0%
Other – 4%	

Post-survey for students in the control group. The open-ended questions, on the post-survey for students, were completed by 75 student participants. The comments left by students in the control group were coded to develop common themes. Student comments were recorded from the post-survey for students in the control group and the common themes were coded and discussed in Table 13.

Question 20 (“What suggestions can you make to improve learning with this assignment?”) on the post-survey for students in the control group. Positive comments (10.67%) about the assignment were coded in the color purple, no suggestions (29.33%) for the assignment were coded in the color light green, suggestions for needing more time (10.67%) with the assignment were coded in the color blue, suggestions for incorporating more group work (16%) with the assignment were coded in the color yellow, suggestions for incorporating more “hands-on” activities (4%) with the assignment were coded in the color light blue, suggestions for incorporating more practice work (8%) with the assignment were coded in the color red, and frustrations with Brightspace (D2L) and/or the assignment (12%) were coded in the color dark green. Suggestions that were found with no common theme were not color coded (9.33%). Overall, the emerging theme was that there were no suggestions for improving learning with the assignment (29.33%).

Question 21 (“What are things that you would do differently, while learning with the assignment?”) on the post-survey for students in the control group. Suggestions for things to do differently with the assignment were to study more (30.67%) and were coded in the color purple, to do nothing differently (32%) and were coded in the color light green, to include more group work (9.33%) and were coded in the color light blue, to ask more questions to deepen understanding (4%) and were coded in the color red, and suggestions that were found with no common theme were not color coded (13.44%). Overall, the students did not want to change anything with learning with the assignment (61.33%). There were two distinct and different themes that emerged from question 21 in the control group that did not appear in the treatment group. Two themes that appeared in the treatment group that did not appear in the control group were “negative comments about D2L" and "students needing more time management". However, two themes that appeared in the control and not treatment group were that students "would like to include more explanations, discussions, writing, and reflection" (5.33%) and were coded in the color blue and to include more "hands-on" activities and were coded in the color yellow. The overall emerging themes to improve learning with the assignment were that students suggested they need to study more (30.67%) and that they would not to anything different (32%). Suggestions and improvements were coded, themed, and analyzed in Table 13.

Table 13

Control group-emerging themes

Students B – Question 20 What suggestions can you make to improve learning with this assignment?	**Students B – Question 21** What are things that you would do differently, while learning with the assignment?
Positive comments, students liked the assignment. – 8/10.67%	Study more – 23/30.67%
No suggestions – 22/29.33%	Nothing different – 24/32%
More time – 8/10.67%	Would like to include more explanations, discussions, writing, reflection – 4/5.33%
Group work – 12/16%	More "hands on" – 4/5.33%
More "hands on" activities – 3/4%	Include more group work – 7/9.33%
Require more work – 6/8%	Ask more questions to deepen understanding – 3/4%
Would like to include more explanations, discussions, writing, reflection – 9/12%	Other – 13.34%
Other – 9.33%	

Research Question 3.

What are teachers' attitudes toward teaching with the assignment?

SPSS (IBM CORP., 2017) was not used due to the small number of teacher participants (N = 2). Descriptive statistics were analyzed for each question on the pre-survey and post-survey for teachers. Descriptive statistics were presented in Table 14.

Table 14

Descriptive Statistics for the means of the pre-surveys and post-surveys for Teachers (N = 2)

	Pre-survey	Post-survey
1. I enjoy using technology when teaching mathematics.	4	3.5
2. Technology can make mathematics easier for students to understand.	4	3.5
3. I have access to technology outside of school (computer, cell phone, chrome book, iPad, etc.).	4	4
4. I have a good experience using Brightspace.	2.5	4
5. I have never had trouble accessing Brightspace inside or outside of school.	3	4
6. I feel that my students had enough time to do homework inside or outside of school.	3.5	4
7. I feel that the homework assignments helped students to better understand the math lessons.	4	4
8. Reading, writing, discussing, and reflecting on mathematics helped students to better understand math lessons.	3.5	3.5
9. Overall, the assignments helped students to have a better understanding of the unit.		3.5
10. I would like to use this assignment again.		3.5

The open-ended questions, on the post-survey for teachers, were completed by two teacher participants. The comments, left by teachers, were coded, themed, and analyzed in Table 15.

Table 15

Comments left by teachers on the post-survey

	Teacher A	Teacher B
11. What suggestions can you make to improve teaching with this assignment?	I do not have any suggestions.	There is nothing that I would do differently.
12. What are things that you would do differently, while teaching with this assignment?	No suggestions. I thought it was great.	Nothing.

Teacher responses were recorded (Appendix M). The color light purple represented not having any suggestions for improving teaching with the assignment and the color light green represented not doing anything differently, while teaching with the assignment. Teachers did not have any suggestions to improve teaching with the assignment and would not do anything differently.

Phase III: Teacher Interviews (Qualitative)

Research Question 4.

What are their suggestions for improving the assignment?

The responses, on the teacher interviews, were coded, themed, and analyzed. The interview guide was utilized to guide the interview questions. The researcher recorded the teacher responses in a word document (Appendix N). At the end of the interviews, both teachers were allowed to read over the word document and make necessary revisions. The common themes were analyzed and discussed in Table 16.

Table 16

Comments left by teachers on the teacher interview guide

	Teacher A	Teacher B
1. Do you think that the assignment helped students to perform better on their unit-test?	Yes	Yes
2. Do you think there was enough time for you to implement the assignment in your classroom?	Yes	Yes
3. Do you think that students had enough time to complete the homework assignments?	Yes	Yes
4. Do you think that students had adequate technology to complete the homework assignments?	Yes	With time at school, yes
5. What suggestions can you make to improve teaching with this assignment?	I have no suggestions.	I like the length of them. I thought they were good.
6. What are things that you would do differently, while teaching with this assignment?	I would not do anything differently	Nothing

The color yellow represented that teachers believed that the assignment helped students to perform better on their unit-test, the color dark blue represented that teachers thought there was enough time to implement the assignment in their classroom, the color red represented that teachers thought students had enough time to complete the homework assignments, the color light blue represented that students had adequate technology to complete the homework assignments, the color light purple represented that teachers did not have any suggestions to improve teaching with the assignment, and the color light green represented that teachers would not do anything differently, while teaching with the assignment. The overall theme that emerged from the teacher interviews was that the teacher participants did not have any suggestions to improve teaching with the assignment. Both teachers thought that the assignment helped students to perform better on their unit-test, thought there was enough time for them to implement the assignment in their classroom, thought that students had enough time to complete the homework assignments, and thought that students had adequate technology to complete the homework assignments.

Summary

The purpose of this quasi-experimental design, with mixed-methods approach, was to address the effects of an assignment that incorporated reading and writing, discourse, and reflection for Honors Advanced Algebra students. Another goal of this study is to address students' and teachers' attitudes toward learning and teaching with the assignment and their suggestions for improving the assignment. The study aimed to determine if the assignment increases student achievement on the posttest (Phase I-quantitative). Students were surveyed at the beginning and end of the study to determine their attitudes of math, working collaboratively and privately, use of technology and Brightspace, use of homework and the assignment (Phase II-quantitative). Teachers were surveyed at the beginning and end of the study to determine their attitudes of technology and Brightspace and use of homework and the assignment (Phase II-quantitative). Teachers and students were allowed to make suggestions on how to improve the assignment (Phase II-qualitative). Teacher interviews were conducted at the end of the study (Phase III-qualitative). The surveys and interviews were coded and analyzed to develop common themes.

Analyses of quantitative data were used to determine if there was a significant difference between pre-test scores and post-test scores (Research Question 1) and change in attitudes on the pre-surveys and post-surveys for students (Research Questions 2 and 3). An analysis of qualitative data was used to determine common themes from the post-surveys for teachers and students (Research Questions 2 and 3). An analysis of the teacher interviews was used to determine common themes of suggestions to improve teaching with the assignment (Research Question 4).

An independent samples *t*-test was used to compare the means of the pre-test scores in the treatment group and the means of the pre-test scores in the control group and the results indicate that students in the control group had a significantly higher mean than the students in the treatment group: $t(75) = -3.17$, $p < .05$. However, an independent samples *t*-test was used to compare the means of the post-test scores in the treatment group and the means of the post-test scores in the control group and the results indicate that students in the treatment group had a significantly higher mean than the students in the control group: $t(75) = 4.60$, $p < .05$. These results signify a significant difference in achievement. A paired samples *t*-test was used to compare the means of the pre-test scores to the means of the post-test scores in the treatment group and results indicate that students, in the treatment group, had a significantly higher mean on the post-test than the pre-test: $t(75) = -73.865$, $p < .05$. A paired samples *t*-test was used to compare the means of the pre-test scores to the means of the post-test scores in the control group and results indicate that students, in the control group, had a significantly higher mean on the post-test than the pre-test: $t(75) = -29.677$, $p < .05$.

An independent samples *t*-test was used to compare the means of the post-survey scores in the treatment group and the means of the post-survey scores in the control group and results indicate that there was no significant difference between the post-survey scores in the treatment and control group for questions 1 through 16, 18, and 20. Yet, the results indicate that there was a statistically significant change in students' attitude (question 17) toward the statement, "I feel that the homework assignments helped me to better understand the math lessons": $t(75) = 2.90$, $p < .05$. Also, the results indicate that there was a statistically significant change in students' attitude (question 19) toward the statement, "Overall, the assignment helped me to have a better understanding of the unit": $t(75) = 3.256$, $p < .05$. An independent samples *t*-test was used to compare the means of the four attitudes in the treatment group to the means of the four attitudes in the control group and the results indicate that there was no significant difference between the four attitudes in the treatment and control group for Attitude 1 and 3. On the contrary, results indicate that there was a statistically significant change in Attitude 2: $t(75) = 2.759$, $p < .05$ and a statistically significant change in Attitude 4: $t(75) = 3.024$, $p < .05$.

A paired samples *t*-test was used to compare the means of the pre-survey scores to the means of the post-survey scores in the treatment group and results indicate that there was a significant change in students' attitude on question 14 ("I have a good experience using Brightspace."): $t(75) = -5.094$, $p < .05$ and a significant change in students' attitude on question 15 ("I have never had trouble accessing Brightspace inside or outside of school."): $t(75) = -4.764$, $p < .05$. A paired samples *t*-test was used to compare the means of the pre-survey scores to the means of the post-survey scores in the control group and results indicate that there was a significant change in students' attitude on question 2 ("I like math."): $t(75) = 2.546$, $p < .05$, results indicate that there was a significant change in students' attitude on question 3 ("I think mathematics is important in life."): $t(75) = 2.393$, $p < .05$, results indicate that there was a significant change in students' attitude on question 14 ("I have a good experience using Brightspace."): $t(75) = -8.964$, $p < .05$, and results indicate that there was a significant change in students' attitude on question 15 ("I have never had trouble accessing Brightspace inside or outside of school."): $t(75) = -4.845$, $p < .05$.

On the post-survey for students in the treatment group, there were no suggestions for improving learning with the assignment (45.33%) and students did not want to change anything with learning with the assignment (61.33%). On the post-surveys for students in the control group, there were no suggestions for improving learning with the assignment (29.33%) and the students did not want to change anything with learning with the assignment (61.33%). There were two diverse themes that developed from question 21 in the control group that did not appear in the treatment group. Two themes that appeared in the treatment group that did not appear in the control group were "negative comments about D2L" and "students needing more time management". Conversely, two themes that appeared in the control and not treatment group were that students "would like to include more explanations, discussions, writing, and reflection" (5.33%) and were coded in the color blue and to include more "hands-on" activities and were coded in the color yellow. The general evolving themes to improve learning with the assignment were that students suggested they need to study more (30.67%) and that they would not to anything different (32%). Teachers did not have any suggestions to improve teaching with the assignment and would not do anything differently. Chapter five provides a discussion of the findings and recommendations of the study.

Chapter V

DISCUSSION

This chapter contains an overview of the study, discussion of the findings, and includes and introduction, a review of the study's purpose, a synopsis of the related literature, and an overview of the study's research design, limitations, and data analysis. Discussion of the findings includes conclusions drawn from the research, recommendations for action with regards to the assignment for Honors Advanced Algebra students, and recommendations for future study. The findings in the study were based upon the pre-test and posttest scores, students' and teachers' attitudes toward learning and teaching with the assignment their suggestions for improving the assignment.

Purpose of the Study

In order to address the effects of an assignment that incorporates reading, writing, discourse, and reflection in their learning, student achievement from using this assignment, and students' and teachers' attitudes toward learning and teaching with the assignment and their suggestions for improving the assignment must be measured and analyzed. There were two purposes of this study. The first purpose was to determine the effects of an assignment that incorporates reading, writing, discourse, and reflection for Honors Advanced Algebra students and the second purpose was to determine students' and teachers' attitudes toward learning and teaching with the assignment and their suggestions for improving the assignment must be measured and analyzed. This study was guided by four research questions:

Research Question 1. What are the effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students?

Research Question 2. What are students' attitudes toward learning with the assignment?

Research Question 3. What are teachers' attitudes toward teaching with the assignment?

Research Question 4. What are their suggestions for improving the assignment?

Related Literature

Critical thinking in mathematics was discussed through the use of mathematical communities, constructivism, and persuasive pedagogy. When students write about math, they are constructing new knowledge by applying previous knowledge (Mueller & Maher, 2009). Mathematical communities should provide students with opportunities to make their ideas public, use peers as resources, explore critical thinking through the use writing, have frequent interactions, and share similar goals (Fennema et al.,1999); Lambert et al., 2002). Cooper (2012) suggested that teachers should continuously provide students with new forms of communication where students can express their knowledge. Mueller et al. (2014) described mathematical communities as a place that encourages reasoning and justification. Teachers should create a classroom environment that is welcoming, safe, and requires students to use critical thinking to create new knowledge (Jia, 2010).

Dewey (1933), Piaget (1959), and Vygotsky (1978) were primary contributors to the constructivist theory. Hennessey et al. (2012) described how the NCTM supports the use of constructivism in mathematics. Teachers should not tell information to students and expect them to comprehend concepts (Dewey, 1987; Joldersma, 2011). Jia (2010) and Mueller and Maher (2009) described that constructivism relies on the practice of students using their previous knowledge to construct new knowledge. Learning relies on students being active in their learning experiences (Confrey, 2006; Oguntoyinbo, 2012). Learning does not occur from remote procedures and skills (Barret & Long, 2012; Keiser, 2012; Hintz, 2014). In fact, if students learn an incorrect formula to use for several problems, then they are going to continue learning with misconceptions (Thompson et al., 2008; Burns, 2012).

Persuasive pedagogy is an option to replace constructivist teaching and helps teachers to address students' misconceptions (Hennessey et al., 2012). To facilitate learning experiences, persuasive pedagogy promotes problem solving, reasoning and proof, communication, and using previous knowledge to construct new meaning.

Mathematical communication was described through the use of reading and writing, discourse, and reflection. Writing about mathematics helps students to make sense of what they are learning and promotes mathematical thinking (Singer, 2007; Schwartz & Kenney, 2012). Math teachers should require students to use forms of writing as a way to develop students' critical thinking (Vu & Hall, 2012). Teachers can improve their instructional practices and promote critical thinking when students provide written justification for their answers (Paul, 2004). Staats and Bateen (2009) advocated for the use of writing in mathematics and suggested that students should be provided with a rubric for writing assignments. Stahl et al. (2010) reviewed an online forum for students to record their writing and found that the forum was useful for students to take ownership in their learning by making their ideas public, allow students to interact, and allows students to reflect on their ideas and correct any misunderstandings. Burns (2012) discussed how writing requires students to think critically because they are solving problems by making sense of the mathematics and allows students to exchange their ideas. Writing in mathematics was not used in traditional mathematics instruction but technology has allowed students a place to record their writing (Cooper, 2012). Students should be provided with recurrent opportunities to write and view writing ask a process for thinking about problems and making their ideas public (Lardner, 2008). Peterson (2007) and Mwei (2017) believed writing helps students gain a deeper understanding of mathematics and will help students to apply their knowledge to new situations.

Discussions are important to help students to make sense of their mathematical experiences, build critical thinking skills, and increase their mathematical knowledge (Pytash & Morgan, 2013; Bruner, 1966; Buter et al., 2014). Goldsmith (2013) discussed how teachers should not do most of the taking in the classroom, as done in traditional math classrooms, and students should be engaged in discourse. Goldsmith insists that teachers should help students engage in meaningful discourse and practice communicating in all content areas. Classrooms should emphasize student discourse and allow students time to share their ideas, representations, and correct misconceptions (Mueller & Maher, 2009). Hansen-Thomas (2009) shared two linguistic practices where teachers modeled practice in discourse and acknowledged students' correct use of language. Stahl (2006) first developed VMT, an online forum for students to write about their reasoning and justification for solving problems in math and interact with other students. Stahl et al. (2010) discussed how VMT allowed students to work collaboratively to solve problems. Singer (2007) shared that teachers should serve more as the coach and students should be the workers. Teachers should promote discourse among the students so that they can work together to solve problems. Herbel-Eisenmann and Wagner (2010) found that mathematical discourse allows for critical reflection.

Cooper (2012) suggested that writing allows students to reflect and clarify their ideas. Reflection requires students to communicate mathematically, think critically, and be able to justify their solutions (Hennessey et al., 2012; Roake & Varlas, 2013). Students become critical thinkers when they understand their strategies that they choose to solve problems (Checkley, 2006; Hintz, 2014). Bloom (1956) shared that students synthesize their thinking when they justify their answers to mathematical problems. Students improve their mathematical thinking skills when they revise their thoughts (Schwartz & Kenney, 2012). Kuane et al., (2011) believed that students have a deeper understanding of mathematics when they reflect on their ideas, misconceptions, and discourse they used in the classroom. Soares et al., (2012) examined a teaching process that promoted student reflection. The study indicated that students have difficulty providing explanations to solving problems but those students who were able to provide reasoning and justifications were able to correctly solve problems.

Implications for mathematics instruction addressed the GSE, traditional mathematics instruction, and improving mathematics instruction. The GSE (2015) addressed the required processes used in mathematics pedagogy and the standards for Honors Advanced Algebra. Students should be able to justify their solutions to problems, communicate their reasoning to others, respond to the arguments of others, and use previous knowledge to construct new knowledge. Traditional mathematics classrooms focused on teachers lecturing students doing the work for students and students learning math by memorizing routine procedures and skills (Barret & Long, 2012; Jia, 2010; Allen, 2011; Sriraman & English, 2010). Marshall (2006) and Keiser (2012) emphasized learning does not occur when teachers assign traditional worksheets that include numerous problems that repeat the same skill.

Mathematical literacy emphasized that students should communicate their ideas in order to think critically and deepen their mathematical understanding (Barlow & Drake, 2008). Teachers should view students as learners who actively construct their own meaning through written format and discourse (Ahn et al., 2013; Dewey, 1987). Teachers should promote mathematical reasoning through providing mathematical tasks that require students' justifications to solving problems and create a classroom environment that encourages students to make their ideas public (Mueller et al., 2014; Sammons, 2011; Sores et al., 2012). Students create a deeper understanding of mathematics when they create their own learning and understanding (Thompson et al., 2008; Rothman, 2012; Steffe, 2010). Burns (2012) and Dickey (2013) discussed the Common Core Standards and how that initiative suggested that teachers should move away from rote learning and should create a classroom that fosters critical thinking. Teachers should pose open-ended tasks that require written communication, encourage students to take ownership in their learning, evaluate other student's work by listening to their ideas, and receive quality professional development (Mueller et al., 2014; Kinzer et al., 2011). Classrooms should require students to use communication and reflection

(Allen, 2011; Phillips & Wong, 2012; Soares et al., 2012). Teachers should receive professional development that focuses on utilizing reflective practices (Ghaye, 2011; Zwozdiak – Myers, 2012; Marzano, 2012; Doerr & Lesh, 2003; Faulkner 2013).

Methods

This quasi-experimental study, with mixed-methods approach, examined the effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students, determined students' and teachers' attitudes toward learning and teaching with the assignment and their suggestions for improving the assignment. Longitudinal data was collected to determine if student and teacher attitudes of the assignment changed over a short period of time. Three phases were used to collect quantitative and qualitative data. The first phase yielded quantitative data from the pre-test and post-test scores. Students took one pre-test and one posttest. The pre-tests and post-tests measured student achievement on the Unit 1 Test. SPSS (IBM CORP., 2017) was used to calculate an independent and a paired samples t-test.

The second phase yielded quantitative and qualitative data. The Likert-scale questions from the student and teacher surveys yielded quantitative data. The Likert-scale categories were: "Strongly Disagree (0)", "Disagree (1)", "Neutral/Undecided (2)", "Agree (3)", and "Strongly Agree (4)". The open-ended questions on the student and teacher surveys yielded qualitative data. Student and teacher surveys (pre and post) were collected. The teacher survey was different from the student survey. Once the surveys were completed, the third-party individual placed the pre-identified code on the surveys and gave them to the researcher. Surveys were given to the student and teacher participants at the beginning and end of the study. The Likert-scale questions on the student surveys measured their attitudes of math, working collaboratively and privately, use of technology and Brightspace, use of homework and learning with the assignment. The Likert-scale questions on the teacher surveys measured their attitudes of technology and Brightspace and use of homework and teaching with the assignment. The Likert-scale questions from the surveys (pre and post), for teachers and students, were analyzed by calculating an independent and paired samples t-test in SPSS (IBM CORP., 2017). The open-ended question on the post surveys for students and teachers allowed the participants to make suggestions for improving the assignment. The open-ended questions on the post surveys, for teachers and students, were coded, themed and analyzed to determine common themes.

The third phase yielded qualitative data. Teacher interviews were used to analyze teachers' suggestions for improving the assignment. The interviews allowed teachers to make suggestions for improving the assignment. The comments made by teachers were coded, themed and analyzed to determine common themes.

Instrumentation. Creswell (2009) defined mixed methods research as by "an approach to inquiry that combines or associates both qualitative and quantitative forms" (p. 4). In this study, the timing for data collection consisted of quantitative data being collected first, followed by qualitative data. Both quantitative and qualitative data were equally weighted. Creswell (2009) referred to the mixing of data as a connected approach where the analysis of the data from one form is linked to the data collection of another form. The scores of students on the pretest and posttest were used as quantitative data. SPSS (IBM CORP., 2017) was used to analyze the statistical differences between the means of the two groups (Kent State University Libraries, 2018).

Longitudinal analysis was used in quasi-experimental studies. Longitudinal data was collected from the surveys (pre and post) for students and teachers, which measured students' and teachers' attitudes toward learning and teaching with the assignment. Berbaum (2018) defined longitudinal analysis at the study of short serious of observation obtained from many respondents over a period of time. According to Creswell (2009), theorizing in mixed method studies can be done either explicitly or implicitly. Creswell described explicit theorizing as stating the theory on which the study is based and implicit theorizing as not stating the theory on which the study is based. Implicit theorizing was used in this study. According to Fraenkel and Wallen (2009), the ability to study a topic more deeply is an advantage in mixed methods studies.

Procedures and Data Analysis. Quantitative and qualitative data were collected during this quasi-experimental, with mixed-methods approach, study to answer the four research questions. Both data analysis methods were employed to evaluate, analyze, and interpret the findings and draw conclusions. Prior to soliciting participation in the study, the necessary paperwork for the Institutional Review Board (IRB) to review the study was issued in a letter of approval in August 2018. The study was deemed expedited from IRB oversight by the Review Board. Once IRB approval was granted, phase I (quantitative) of the study began with an informed consent for teacher participants, a parental consent and an informed consent for student participants. The evidence for Phase I was addressed by calculating an independent samples *t*-test, using SPSS (IBM CORP., 2017), to compare means of the pre-test and post-test for the control and treatment groups. A paired samples *t*-test was used to determine statistical significance between the pre-test and post-test in the treatment and control group. The quantitative evidence from Phase I helped answer the first research question. Descriptive statistics (the mean and differences) were found for the pre-test and post-test. The quantitative evidence for Phase II was addressed by calculating an independent samples *t*-test, using SPSS (IBM CORP., 2017), to compare means of the surveys (pre and post) for the control and treatment group. A paired samples *t*-test was used to determine a statistical significance between the pre-survey scores and post-survey scores in the treatment and control group. An independent samples *t*-test was used to determine a statistical significance in the change in the four attitudes between the pre-surveys and post-surveys in the control and treatment group. Descriptive statistics (mean) were found for the surveys for students and teachers and for the four attitudes. The evidence from Phase II helped answer the second research question. The qualitative data from Phase II was analyzed from the open-ended questions from the post surveys for teachers and students. The open-ended questions were coded, themed, and analyzed to answer the third research question.

The qualitative evidence for Phase III was addressed by analyzing the comments, left by the teacher participants, on the interviews. The evidence in Phase III was used to answer the fourth research question. In this sequential mixed-methods study, the qualitative phase (open-ended questions from the post surveys for teachers and students) was informed by the results of the quantitative analysis (pre-test and post-test scores and Likert-scale questions from the surveys), with an expectation that the findings and themes of this phase would provide further explanation and interpretation of the quantitative findings.

Limitations

A significant limitation of this study is the inability to generalize, due to a small sample size of students (N = 150), teachers (N = 2), and geographic location. The sample in this study was representative of students in an Honors Advanced Algebra class and teachers of Honors Advanced Algebra students. Therefore, the results are limited to students and teachers at this level of mathematics. Though the assignment could be modified to any subject, teachers may be hesitant because the assignment was specific to an Honors Advanced Algebra class. This study was limited to one school, focused on eleventh (and some tenth) grade Honors Advanced Algebra students, and Honors Advanced Algebra teachers, at a rural Title 1 high school, located in southwest Georgia. The participating mathematics teachers may not accurately represent other level mathematics teachers or other content teachers. Therefore, caution should be used when generalizing findings beyond the research site. Ensuring student participation is a frequent issue in classrooms. Teacher participants had to consistently remind students to turn in completed consent forms, complete the pre/posttest, complete the surveys, and complete the homework assignments, in a timely manner.

Quasi-experimental designs can be accomplished without extensive pre-screening and randomization (Explorable, 2018). This process decreases the amount of time and resources needed for experimentation. However, a disadvantage of quasi-experimental designs is that the results may not be able to be generalized to larger populations because pre-existing factors are not considered. Nonetheless, if these flaws are recognized in the study, a quasi-experimental design can guarantee valid results.

An assumption for this study was that students do not obtain high achievement on math assessments that incorporate open-ended and extended response questions because students do not practice answering these types of questions during classroom instruction. Another assumption is that students and teachers have a negative attitude about incorporating an assignment that requires students to read, write, and use discourse and reflection in daily classroom practice.

Summary of the Findings

The research questions were employed in this quasi-experimental study, with a mixed-methods approach. Quantitative data was collected and analyzed, from the participants in the treatment and control groups, to determine statistically significant results between the pre-test and post-test scores and surveys (pre and post) for teachers and students. SPSS (IBM CORP., 2017) was deemed an appropriate tool to analyze the quantitative data. Qualitative data was collected, coded, themed, and analyzed from the open-ended questions on the surveys for teachers and students. Qualitative data was collected from the teacher interviews, at the end of the study. Creswell (2009) defined mixed methods research as by "an approach to inquiry that combines or associates both qualitative and quantitative forms" (p. 4). In this study, the timing for data collection consisted of quantitative data being collected first, followed by qualitative data. Both quantitative and qualitative data were equally weighted. Creswell referred to the mixing of data as a connected approach where the analysis of the data from one form is linked to the data collection of another form. The scores of students from the pre-test and post-test and the Likert-scale questions on the surveys (pre and post) for students and teachers. All scores were used as quantitative data. SPSS (IBM CORP., 2017) was used to analyze the statistical differences between the means of the two groups (Kent State University Libraries, 2018).

Longitudinal analysis was used in quasi-experimental studies. Longitudinal data was collected from the surveys (pre and post) for students and teachers, which measured students' and teachers' attitudes toward learning and teaching with the assignment. Berbaum (2018) defined longitudinal analysis at the study of short serious of observation obtained from many respondents over a period of time. According to Creswell (2009), theorizing in mixed method studies can be done either explicitly or implicitly. Creswell described explicit theorizing as stating the theory on which the study is based and implicit theorizing as not stating the theory on which the study is based. Implicit theorizing was used in this study. According to Fraenkel and Wallen (2009), the ability to study a topic more deeply is an advantage in mixed methods studies.

Research Question 1

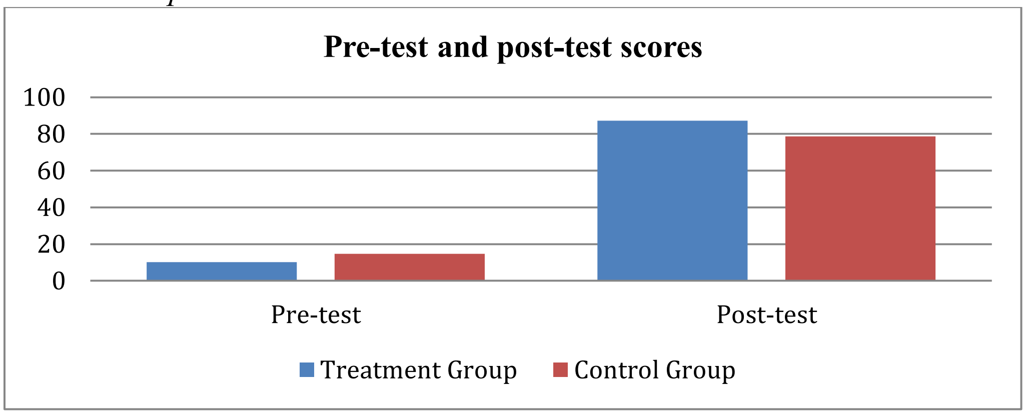
Research Question 1 sought to determine the effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students. SPSS (IBM CORP., 2017) was used to analyze the scores on the pre-test and post-test in the treatment and control group. The means were calculated for the pre-test and post-test scores in both groups. An interesting find was that students in the control group had a higher mean on the pre-test but then the students in the treatment group scored higher on the post-test. An explanation for this difference could be that the students in the control group had a higher mathematical knowledge, in the beginning. In turn, this difference in scores could have more substantial significance because it displays greater growth. The difference between the post-test and pre-test scores in the treatment group is 77.14 points and the difference between the post-test and pre-test scores in the control group is 64.05 points. The percent change in pre-test scores to post-test scores in the treatment group is 763.01%. The percent change in pre-test scores to post-test scores in the control group is 437.8%.

An independent samples *t*-test was used to compare the means of the pre-test scores in the treatment group and the means of the pre-test scores in the control group. Results indicate that students in the control group had a significantly higher mean, on the pre-test, than the students in the treatment group, $t(75) = -3.17$, $p < .05$. An independent samples *t*-test was used to compare the means of the post-test scores in the treatment group and the means of the post-test scores in the control group. Results indicate that students in the treatment group had a significantly higher mean than the students in the control group, $t(75) = 4.60$, $p < .05$. The researcher expected to find that the homework assignments, in the treatment group, would increase student achievement. As a result, these findings may indicate that students in the control group had more prior knowledge of the material in the unit. However, after the homework assignments, it appears that students in the treatment group gained a deeper understanding of the material in the unit.

A paired samples *t*-test was used to compare the means of the pre-test scores to the means of the post-test scores in the treatment group. Results indicate that students, in the treatment group, had a significantly higher mean on the post-test than the pre-test, $t(75) = -73.865$, $p < .05$. A paired samples *t*-test was used to compare the means of the pre-test scores to the means of the post-test scores in the control group. Results indicate that students, in the control group, had a significantly higher mean on the post-test than the pre-test, $t(75) = -29.677$, $p < .05$. The scores of the pre-test and post-test are presented in Figure 1.

Figure 1

Pre-test and post-test scores



Research Question 2

Research Question 2 intended to determine students' attitudes toward learning with the assignment. Quantitative data was collected from the Likert-scale questions on the student surveys. On the pre-survey, students in the treatment and control group strongly agreed (M = 3.80, SD = .47 and M = 3.75, SD = .52) with question 13 ("I have access to technology outside of school (computer, cell phone, chrome book, iPad, etc.) but disagreed (M = 1.41, SD = 1.35 and M = 1.04, SD = 1.05) with question 14 ("I have a good experience using Brightspace"). On the post-survey, students in both groups still strongly agreed with question 13 (M = 3.67, SD = .60 and M = 3.63, SD = .69) but had a change in attitude to agree with question 14 (M = 2.55, SD = 1.43 and M = 2.65, SD = 1.20).

A paired samples *t*-test was used to compare the means of the post-survey scores (Questions 1 through 19) to the means of the post-survey scores in the treatment group. Results indicate that there was a significant change in students' attitude on question 14

("I have a good experience using Brightspace."), $t(75) = -5.094$, $p < .05$. Results indicate that there was a significant change in students' attitude on question 15 ("I have never had trouble accessing Brightspace inside or outside of school."), $t(75) = -4.764$, $p < .05$.

A paired samples *t*-test was used to compare the means of the pre-survey scores to the means of the post-survey scores in the control group. Results indicate that there was a significant change in students' attitude on question 2 ("I like math."), $t(75) = 2.546$, $p < .05$. Results indicate that there was a significant change in students' attitude on question 3 ("I think mathematics is important in life."), $t(75) = 2.393$, $p < .05$. Results indicate that there was a significant change in students' attitude on question 14 ("I have a good experience using Brightspace."), $t(75) = -8.964$, $p < .05$. Results indicate that there was a significant change in students' attitude on question 15 ("I have never had trouble accessing Brightspace inside or outside of school."), $t(75) = -4.845$, $p < .05$.

An interesting find from the results of the post survey was that students in the treatment group had a higher mean on questions 2 (treatment group: M = 2.77, SD = 1.03 and control group: M = 2.56, SD = .96) and 3 (treatment group: M = 3.03, SD = .97 and control group: M = 2.97, SD = .74) but the control group had a higher mean on questions 14 (treatment group: M = 2.55, SD = 1.43 and control group: M = 2.65, SD = 1.20) and 15 (treatment group: M = 2.48, SD = 1.36 and control group: M = 2.53, SD = 1.21). Results could indicate that students in the control group had an easier time posting homework examples in Brightspace because they were only required to post the algebraic solutions. Yet, after the homework assignment, students in the treatment group liked math more and found mathematics to be more important in life when compared to students in the control group.

Descriptive statistics and independent samples *t*-test was used to compare the four attitudes on the post-survey scores in the treatment group to the four attitudes on the post-survey scores in the control group. There was a statistically significant difference in attitudes 2, $t(150) = 2.76$, $p < .05$, and 4, $t(150) = 3.02$, $p < .05$. Students in the treatment group had a higher mean than the group for attitude 2 ("Working collaboratively and related effect and working privately") and attitude 4 ("Use of Homework and learning with the assignment"). Figure 2 and Figure 3 display the mean of scores on the pre-survey and post-survey.

Figure 2

Pre-surveys for students

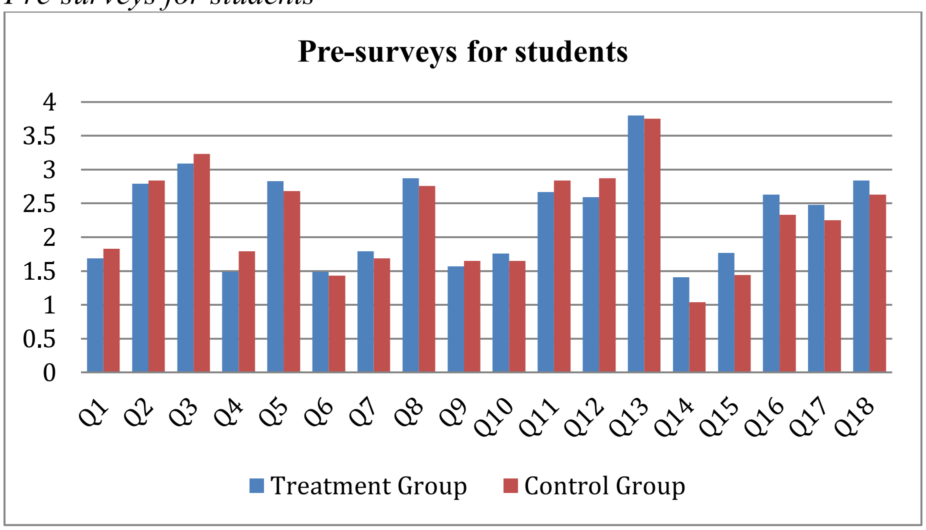
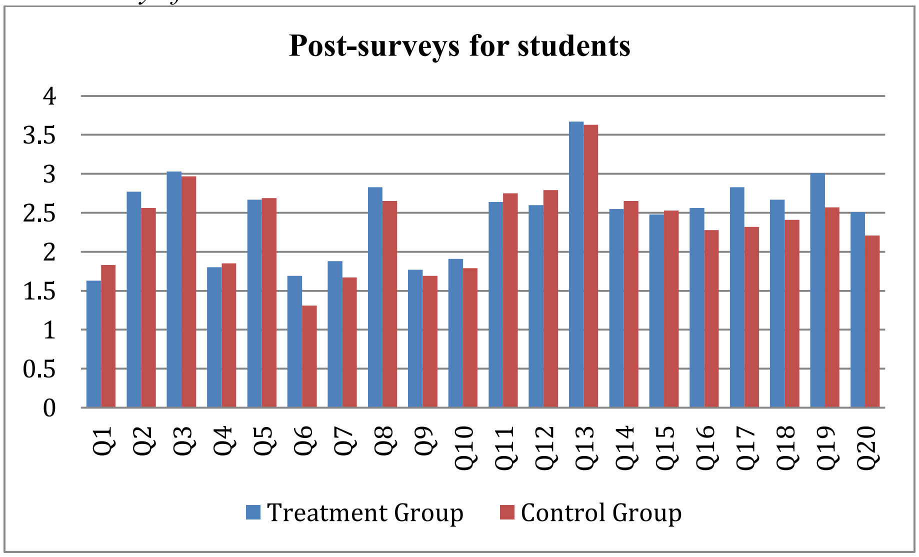


Figure 3

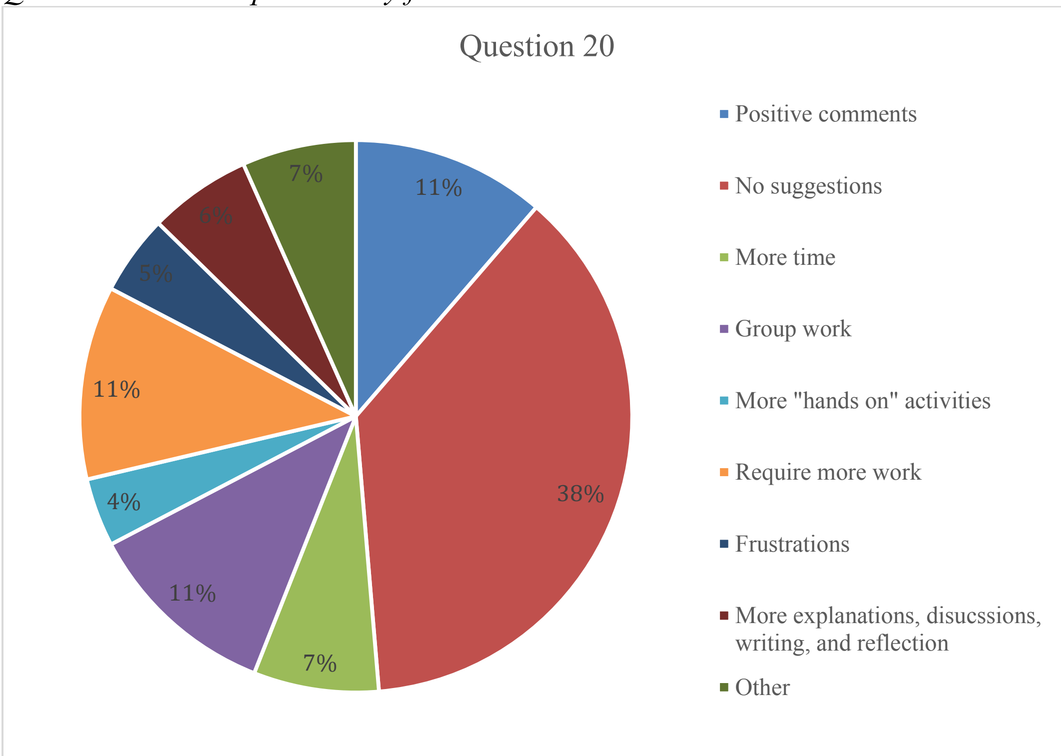
Post-surveys for students



Qualitative data was collected from the open-ended questions on the post-surveys for students. Overall, 38% of students (N = 150), in the treatment and control group, did not have any suggestions for improving learning with the assignment. An interesting theme that emerged was that students in the control group wanted to incorporate more explanations, discussions, writing, and reflection. Figure 4 displays the percentages for each common theme that was found, when analyzing question 20.

Figure 4

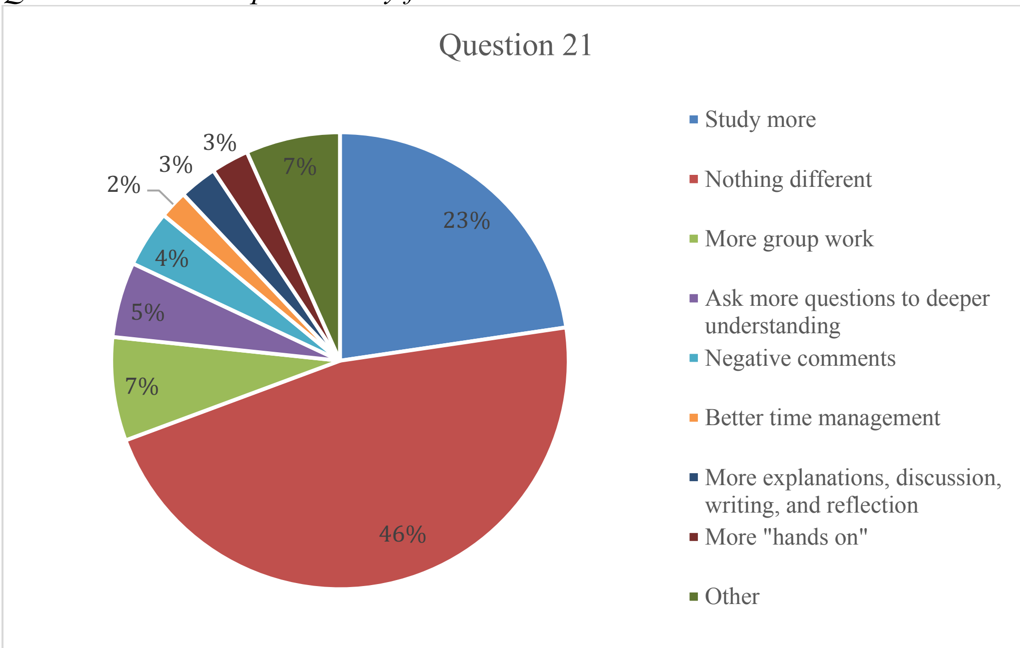
Question 20 on the post-survey for students



Overall, 46% of students (N = 150), in the treatment and control group, did not want to do anything differently on the assignment. Students in the control group suggested that they would include more explanations, discussions, writing, and reflection. Figure 5 displays the percentages for each common theme that was found, when analyzing question 21.

Figure 5

Question 21 on the post-survey for students

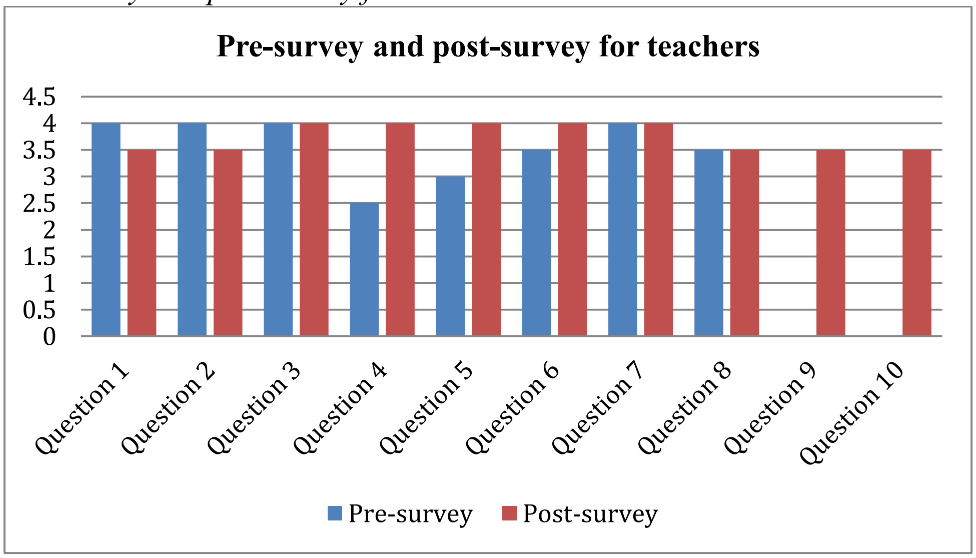


Research Question 3

Research Question 3 expected to determine teachers' attitudes toward teaching with the assignment. On the pre-survey, both teachers strongly agreed with most statements on the survey but agreed with questions 4 ("I have a good experience using Brightspace", M = 2.5) and 5 ("I have never had trouble accessing Brightspace inside or outside of school", M = 3). On the post-survey, both teachers strongly agreed with all statements. Figure 6 displays the means of the pre-survey and post-surveys scores for teachers.

Figure 6

Pre-survey and post-survey for teachers



Research Question 4

Research Question 4 intended to determine teachers' suggestions for improving the assignment. Teachers did not have any suggestions to improve teaching with the assignment and would not do anything differently.

Discussion

The design of this study was created based upon This research provided convincing evidence that reading, writing, discourse, and reflection had a positive effect on student achievement. The results of the post-test scores compared to the pre-test scores are not surprising. The homework assignments in the treatment group incorporated reading, writing, discourse, and reflection. As a result, the findings were clear that students in the treatment group performed higher than students in the control group. Math assignments should incorporate the strategies of reading, writing, discourse, and reflection. The literature supports this finding that reading, writing, and using discourse and reflection help create a classroom environment that is conducive for students to obtain a deeper understanding of mathematics (Cooper, 2012; Lardner, 2008; Peterson, 2007; Stahl et al., 2010; Hansen-Thomas, 2009; Hennessey et al., 2012; Kaune et al., 2011).

Based on the literature and the researcher's teaching experience, the study was designed to find an effective strategy that can be used in daily instruction. Teachers understand that if a person truly understands how to solve problems then they will be able to explain their process and this can be accomplished through writing, discourse, and reflection. Through writing, students can describe their thinking process for solving problems. Teachers should encourage discourse in the classroom. In order to incorporate discourse in the classroom, the teacher must create a safe environment for the students to feel comfortable to use discourse with one another. The first step in creating an environment that is conducive to these conditions, student relationships must be created and ensured by teachers. When students feel safe to engage in these type of learning experiences, they will feel comfortable to become active learners. The researcher wanted to determine a formal way of documenting student's discourse. When students reflect on their thinking process, they are allowed to address any misconceptions that may be occurring in their learning. The design of the study was created to determine an effective strategy that incorporated the use of reading and writing, discourse, and reflection. The results of the study indicate that the homework assignments are an effective, easy to use, classroom strategy that improves student learning.

The research suggests that the majority of students did not have any suggestions for improving the assignment and would not do anything differently with the assignment. Likewise, teachers did not want to alter the assignment. The results indicate that there is enough evidence that reading, writing, discourse, and reflection should be incorporated in math assignments (Thompson et al., 2008; Rothman, 2012; Steffe, 2010; Burns, 2012; Dickey, 2013; Mueller et al., 2014). The results indicate that there was a statistically significant change in students' attitude (question 17) toward the statements, "I feel that the homework assignments helped me to better understand the math lessons.", "Overall, the assignment helped me to have a better understanding of the unit.", "I have a good experience using Brightspace.", "I have never had trouble accessing Brightspace inside or outside of school.", "I like math.", "I think mathematics is important in life.", "I have a good experience using Brightspace.", and "I have never had trouble accessing Brightspace inside or outside of school.".

Teachers should receive high-quality professional development so that they can better understand how to create such assignments (Kinzer et al., 2011; Soares et al., 2012; Burns, 2012; Hintz, 2014). Classroom environments should promote mathematical communication reflective practice (Allen, 2011; Phillips & Wong, 2012; Barrett and Long, 2012; Soares et al., 2012; Ghaye, 2011; Zwozdiak-Myers, 2012; Danielson, 2009; Marzano, 2012; Doerr & Lesh, 2003; Faulkner, 2013). Administration should create and administer guidelines that teachers should utilize in their classroom (Marshall; 2006; Hintz, 2014; Larson et al., 2012).

Implications of the Results

The findings of this study should serve as a call to action for mathematics teachers and school leaders at both the K-12 level and at the post-secondary level. The need for incorporating effective mathematical practices that emphasize reading, writing, discourse, and reflection has been well-established. Therefore, it is critical that educators provide this type of strategy in mathematics. While there is a push to incorporate reading, writing, discourse, and reflection in mathematics classrooms, there is lack of research discussing practical applications (Goldsmith, 2013; Singer, 2007; GSE, 2015; Staats and Bateen, 2009; Mwei, 2017; Stahl et al., 2010). The primary concern for this study was the lack of evidence supporting effective assignments that incorporate reading, writing, discourse, and reflection in math. Honors Advanced Algebra students and teachers of those students, located at a rural high school in southwestern Georgia, were the targets of the study. Teachers have expressed a need for incorporating effective strategies that require students to practice justifying their solutions to problems. Teachers have not been provided with adequate resources, training, or support for incorporating assignments that allow students to use critical thinking and mathematical communication while solving problems. This study addressed the effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students. In addition, this study addressed students' and teachers' attitudes toward learning and teaching with the assignment and their suggestions for improving the assignment. This study could provide attainable and practical assignments for teachers to use in their daily or weekly lessons.

The results of this study provide evidence that an assignment that incorporated reading, writing, discourse, and reflection increased student achievement. Results of the test scores (pre and post) indicated that there was a statistically significant difference between the treatment and control group, where the treatment group solved the examples in the homework assignment by using reading, writing, discourse, and reflection. The implication of this finding is that educators should strive to incorporate reading, writing, discourse, and reflection in mathematical assignments. Singer (2007), Schwartz & Kenney (2012), Vu & Hall (2012), Paul (2004), and Staats and Bateen (2009) suggest that reading, writing, discourse, and reflection are classroom practices that support student success and are vital elements of learning. This finding could lead to improved practical strategies in mathematics' classrooms and could also appeal to other subjects because reading, writing, discourse, and reflection are practices that can be implemented in any subject.

Students and teachers, alike, had a positive attitude towards learning and teaching with the assignment. Results indicate that there was a significant change in students' attitudes towards good experiences using Brightspace and being able to access Brightspace inside or outside of school, as evidenced by scores from the Likert-scale questions on the surveys. Students in the treatment group posted their homework assignments in Brightspace, which is an online forum where students can post their written explanations to their homework, communicate with other students in their class, and reflect on their learning. Brightspace is similar to the forum used in the study by Stahl et al. (2010). It was found that students and teachers did not have any suggestions for improving the assignment nor changing anything with the assignment, as evidenced by the open-ended questions on the surveys and teacher interviews. Students believed that the homework assignments helped them to better understand the math lessons in the unit. Online forums are a way for students to take ownership in their learning (Burns, 2012; Cooper, 2012). Students in the treatment group reflected on their learning by viewing the comments left by other students in the class. An implication of this finding is that online forums could be a useful and applicable tool for students to communicate their thinking processes and use writing and reflection on math assignments.

Recommendations for Future Research

The analyses of this study found that implementing an assignment that incorporated reading, writing, discourse, and reflection in Honors Advanced Algebra had positive effects on student achievement. Educators should receive training on how to create assignments that incorporate reading, writing, discourse, and reflection. Currently, a gap in the literature exists related to information on implementing effective classroom practices. The findings from this study are significant because there has been little research related to assignments where students are required to read, write, and use discourse and reflection to solve mathematical problems. Suggested recommendations for future research based upon the findings from this study include:

1. Conduct a state-wide and district-wide studies on how to create effective assignments that incorporate reading, writing, discourse, and reflection. The sample size (N = 150) was very low. Room exists for future studies in various mathematical courses.
2. Conduct a state-wide and district-wide studies on how to create effective assignments that incorporate reading, writing, discourse, and reflection in various subjects. Room exists for future studies in various subject areas.
3. Conduct a state-wide and district-wide studies on how to create effective assignments that incorporate reading, writing, discourse, and reflection in diverse locations, in addition to rural areas. Room exists for future studies in other locations.

4. Coordinate a state-wide and district wide studies on student and teacher attitudes toward learning and teaching with this type of assignment. The results can be used to target specific attitudes about the assignment, based upon the needs of implementing a practical assignment that both students and teachers deem beneficial.
5. Coordinate a state-wide and district wide studies on other possible forums for students communicate their thinking processes. Brightspace, along with many other online forums, are an effective tool for posting online. The results can be used to determine other online forums.
6. Provide formal training on creating classroom practices that integrate reading, writing, discourse, and reflection.
7. Conduct research on various assignments that include reading, writing, discourse, and reflection to solve mathematical problems. It would be sensible for the state of Georgia and for individual school districts to train on best practices in using these strategies.
8. The state of Georgia and school districts should pilot more experimental studies, with a treatment group and control group, with schools of similar demographics to determine significant results.

Summary

There is a demand to integrate practices that include reading, writing, discourse, and reflection to solve mathematical problems. A quasi-experimental design, with mixed methods approach, using both quantitative and qualitative techniques, was used to answer the research questions. The purpose of the quantitative part of the design was to determine if there was a significant difference on an Honors Advanced Algebra posttest after the implementation of an assignment that requires students to use reading, writing, discourse and reflection while solving mathematical problems and algebraically solving mathematical problems on homework assignments in Brightspace. It was determined that the assignment increased student achievement on the posttest. Additional quantitative elements of this study were measured by two student surveys and two teacher surveys, given at the beginning and end of the study. The purpose of this quantitative part of the design was to determine students' and teachers' attitudes toward learning and teaching with the assignment. There were statistically significant changes in student attitudes. Specifically, students feel that the assignment helped them to better understand the lessons in the unit. Qualitative elements of this study were measured by open-ended questions on the surveys (pre and post) for students and teachers and teacher interviews. The qualitative elements determined student and teacher suggestions for improving learning and teaching with the assignment. Overall, students and teachers did not have any suggestions for improving the assignment.

Creating new instructional practices without proper discussion, training, and offering attainable resources will result in educators not consistently implementing the necessary strategies in their classroom. There is a call to conduct more research on creating effective classroom practices that integrate reading, writing, discourse, and reflection. In order to generalize findings, further research should be conducted in various mathematical courses, other subject areas, and in more geographical locations. The sample size was small (N = 150) and was conducted at one school in a small, rural school district. Extensive literature addresses how reading, writing, using discourse and reflection help students to better understand mathematics. Currently, there is a gap in the literature on specific classroom assignments that include reading, writing, discourse, and reflection on solving mathematical problems (Cooper, 2012; Lardner, 2008; Peterson, 2007; Stahl et al., 2010; Hansen-Thomas, 2009; Hennessey et al., 2012; Kaune et al., 2011). The conclusions of this study contribute to an increasing body of research on how to implement reading, writing, discourse, and reflection in mathematical assignments. In order to provide educators with additional resources, future studies should continue to investigate instructional practices that incorporate reading, writing, discourse, and reflection.

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APPENDIX A:

Treatment Group/Brightspace Homework Assignments

Honors Advanced Algebra_GROUP 1
Brightspace Lessons 1 and 2 HW

(Reading and Writing) In complete sentences, provide justification for solving each problem (1-3).
(Discourse) Next, respond to one person's solution to a problem (state whether you agree or disagree with their solution in complete sentences).
(Reflection) After a person has responded to your problem, reflect on their response and your solution and reply to their comment in complete sentences.

1. $4(2x - 5) = -24$ 2. $\frac{2}{3}x + 7 = -9$ 3. $16x - 3(4x + 7) = 6x - (2x + 21)$

(Reading and Writing) In complete sentences, provide justification for solving each problem (4-6).
(Discourse) Next, respond to one person's solution to a problem (state whether you agree or disagree with their solution in complete sentences).
(Reflection) After a person has responded to your problem, reflect on their response and your solution and reply to their comment in complete sentences.

4. $2x + 4 < -6$ 5. $-4(x + 6) \geq 12$ 6. $-6 < 2x - 3 \leq 7$

Honors Advanced Algebra_GROUP 1
Brightspace Lessons 3 and 4 HW

(Reading and Writing) In complete sentences, explain how you would graph each problem (1-4).
(Discourse) Next, respond to one person's solution to a problem (state whether you agree or disagree with their solution in complete sentences).
(Reflection) After a person has responded to your problem, reflect on their response and your solution and reply to their comment in complete sentences.

1. $y = \frac{2}{3}x - 4$ 2. $2x - 3y = -12$ 3. $y \leq \frac{2}{3}x - 4$ 4. $y > -4x + 1$

Honors Advanced Algebra_GROUP 1
Brightspace Lesson 5 HW

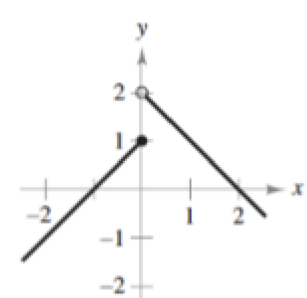
(Reading and Writing) In complete sentences, explain how you would evaluate the piecewise function (1-8).

$$f(x) = \begin{cases} 2x + 1 & if\ x < 1 \\ -2x + 3 & if\ x \geq 1 \end{cases}$$

1. $f(-2) =$ 2. $f(6) =$ 3. $f(1) =$ 4. $f(0) =$

Using the graph, explain how you would evaluate each piecewise function:

5. $g(0) =$ 6. $g(1) =$



7. $g(-2) =$ 8. $g(2) =$

(Discourse) Next, respond to one person's solution to a problem (state whether you agree or disagree with their solution in complete sentences).
(Reflection) After a person has responded to your problem, reflect on their response and your solution and reply to their comment in complete sentences.

Honors Advanced Algebra_GROUP 1
Brightspace Lessons 6 and 7 HW

(Reading and Writing) In complete sentences, state the transformations and vertex. Explain how you know what each number tells you about the functions. Explain how you graph each function. Then, explain how to solve both equations, algebraically.

1. $f(x) = -|x - 1| + 4$ 2. $f(x) = 2|x - 5| - 4$

(Discourse) Next, respond to one person's solution to a problem (state whether you agree or disagree with their solution in complete sentences).
(Reflection) After a person has responded to your problem, reflect on their response and your solution and reply to their comment in complete sentences.

APPENDIX B:

Control Group/Brightspace Homework Assignments

Honors Advanced Algebra_GROUP 2
Brightspace Lessons 1 and 2 HW

Solve the following equations (1-3).

1. $4(2x - 5) = -24$

2. $\frac{2}{3}x + 7 = -9$

3. $16x - 3(4x + 7) = 6x - (2x + 21)$

Solve the following inequalities (4-6).

4. $2x + 4 < -6$

5. $-4(x + 6) \geq 12$

6. $-6 < 2x - 3 \leq 7$

Honors Advanced Algebra_GROUP 2
Brightspace Lessons 3 and 4 HW

Graph the following equations and inequalities (1-4). You must upload a picture of each graph.

1. $y = \frac{2}{3}x - 4$

2. $2x - 3y = -12$

3. $y \leq \frac{2}{3}x - 4$

4. $y > -4x + 1$

Honors Advanced Algebra_GROUP 2
Brightspace Lesson 5 HW

Evaluate problems 1-4, using the following piecewise function:

$$f(x) = \begin{cases} 2x + 1 & if\ x < 1 \\ -2x + 3 & if\ x \geq 1 \end{cases}$$

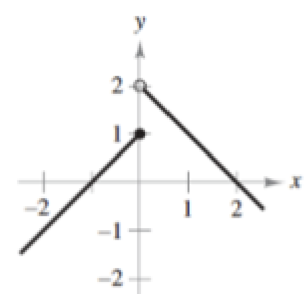
1. $f(-2) =$

2. $f(6) =$

3. $f(1) =$

4. $f(0) =$

Evaluate problems 5-8, using the following graph:



5. $g(0) =$

6. $g(1) =$

7. $g(-2) =$

8. $g(2) =$

Honors Advanced Algebra_GROUP 2
Brightspace Lessons 6 and 7 HW

Graph the following function. You must upload a picture of the graph. State the transformations and the vertex.

1. $f(x) = -|x - 1| + 4$

Solve the following equation:

2. $2|x - 5| - 4 = 0$

APPENDIX C:

Honors Advanced Algebra

Unit 1 Test (PRE/POSTTEST)

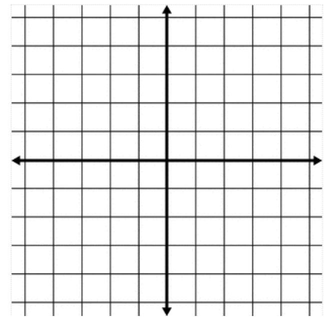
Honors Advanced Algebra ID: ________________________

Unit 1 Test (PRE/POSTTEST)

10 points (2 for each transformation, 1 for the vertex, and 1 for the graph)

1. State the transformations and the vertex, then graph.

$g(x) = -\frac{1}{2}|x+3| + 1$



10 points (5 points for a and 5 points for b)

2. Solve each equation for x. Show your work. Then, in complete sentences, explain your process for solving the equation.

a. $7(2x+5) = 91$

b. $\frac{1}{3}x - 4 = \frac{1}{5}x + \frac{1}{3}$

10 points (2 points for each letter)

3. Evaluate each of the following, given the piecewise function. Show your work. In complete sentences, explain how you knew which equation to use to evaluate the problem.

$$f(x) = \begin{cases} -4, & x < -3 \\ -2x - 2, & -3 \le x < 0 \\ \frac{1}{3}x + 1, & 0 \le x \le 3 \end{cases}$$

a. $f(-2)$

b. $f(0)$

c. $f(-5)$

d. $f(4)$

e. $f(-3)$

10 points (5 points for a and 5 points for b)

4. Solve the compound inequality, graph the solution, and state the interval notation. In complete sentences, explain your process for solving each inequality.

a. $x + 5 < 3$ *or* $x - 5 \ge -3$

b. $-6 < 4x + 3 \le 5$

10 points (2 for writing "f(x) = " or "y = " , 4 for placing the correct horizontal;/vertical shifts, 2 for placing the vertical stretch, and 2 for the absolute value bars)

5. Create the equation of an absolute value function described below.

Domain is all real numbers, range is $[1, \infty)$ *, vertex is* $(-2, 1)$ *, has vertical stretch by a factor of 3*

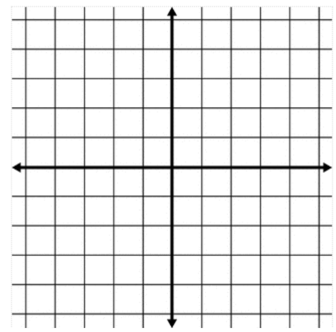
10 points (5 for solving correctly and 5 for the explanation)

6. Solve the following equation. In complete sentences, explain your process for solving the equation.
$5|2x - 1| + 4 = 9$

10 points (5 for solving correctly, 5 for graphing correctly)

7. Sketch the graph for the following equation.

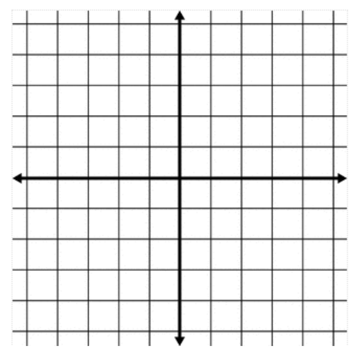
$2x + y = -4$



10 points (5 for solving correctly, 3 for graphing correctly, and 2 for shading correctly)

8. Sketch the graph of the inequality.

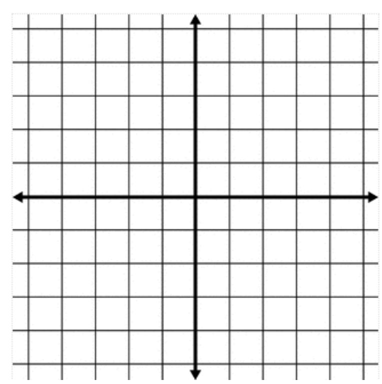
$y > \frac{1}{3}x + 2$



10 points (3 for graphing each piece correctly, 2 for using the correct open/closed circle, and 2 for placing arrows in the correct direction)

9. Graph the piecewise function

$$f(x) = \begin{cases} \frac{1}{2}x - 4, & x < 2 \\ 3 - 2x, & x \geq 2 \end{cases}$$



10 points (5 for solving correctly and 5 for explaining the correct process)

10. Read the following equation: $5(x + 1) - 2(x + 3) = 8$
Write about the process for solving the equation, in complete sentences.

APPENDIX D:

Attitudes of Students (Pre) Survey

Attitudes of Students (Pre) Survey

School:______________________________
ID: _______________

The questionnaire is designed to measure your attitudes of math, working collaboratively and privately, use of technology and Brightspace, use of homework and learning with the assignment. It should take about 10 minutes of your time. It is usually best to respond with your first impression, without giving a question much thought. Your answers will remain confidential.

Circle the appropriate responses based on the key below:

0 Strongly Disagree	1 Disagree	2 Neutral/Undecided	3 Agree	4 Strongly Agree

Deep affect: Positivity towards learning mathematics and school (Attitude 1)

1. I do not like school.	0	1	2	3	4
2. I like math.	0	1	2	3	4
3. I think mathematics is important in life.	0	1	2	3	4
4. I learn more from talking with my friends than from listening to my teacher.	0	1	2	3	4
5. I like hearing the thoughts and ideas of my peers in math class.	0	1	2	3	4

Working collaboratively and related effect and working privately (Attitude 2)

6. I like to go to the board or share my answers with peers in math class.	0	1	2	3	4
7. I am not eager to participate in discussions that involve mathematics.	0	1	2	3	4
8. I enjoy working in groups better than alone in math class.	0	1	2	3	4
9. I prefer working alone rather than in groups when doing mathematics.	0	1	2	3	4
10. I learn more about mathematics working on my own.	0	1	2	3	4

Use of Technology and Brightspace (Attitude 3)

11. I enjoy using technology when learning mathematics.	0	1	2	3	4
12. Technology can make mathematics easier to understand.	0	1	2	3	4
13. I have access to technology outside of school (computer, cell phone, chrome book, iPad, etc.).	0	1	2	3	4
14. I have a good experience using Brightspace.	0	1	2	3	4
15. I have never had trouble accessing Brightspace inside or outside of school.	0	1	2	3	4

Use of Homework and learning with the assignment (Attitude 4)

16. I feel that I have enough time to do homework inside or outside of school.	0	1	2	3	4
17. I feel that homework assignments help me to better understand the math lessons.	0	1	2	3	4
18. Reading, writing, discussing, and reflecting on math helps me to better understand math lessons.	0	1	2	3	4

APPENDIX E:

Attitudes of Students (Post) Survey

Attitudes of Students (Post) Survey

School:______________________________
ID: ________________

The questionnaire is designed to measure your attitudes of math, Brightspace, homework, the assignment, knowledge of the lessons in Unit 1, and suggestions for improving the assignment. It should take about 20 minutes of your time. It is usually best to respond with your first impression, without giving a question much thought. Your answers will remain confidential.

Circle the appropriate responses based on the key below:

0	1	2	3	4
Strongly Disagree	Disagree	Neutral/Undecided	Agree	Strongly Agree

Deep affect: Positivity towards learning mathematics and school (Attitude 1)

1. I do not like school.	0	1	2	3	4
2. I like math.	0	1	2	3	4
3. I think mathematics is important in life.	0	1	2	3	4
4. I learn more from talking with my friends than from listening to my teacher.	0	1	2	3	4
5. I like hearing the thoughts and ideas of my peers in math class.	0	1	2	3	4

Working collaboratively and related effect and working privately (Attitude 2)

6. I like to go to the board or share my answers with peers in math class.	0	1	2	3	4
7. I am not eager to participate in discussions that involve mathematics.	0	1	2	3	4
8. I enjoy working in groups better than alone in math class.	0	1	2	3	4
9. I prefer working alone rather than in groups when doing mathematics.	0	1	2	3	4
10. I learn more about mathematics working on my own.	0	1	2	3	4

Use of Technology and Brightspace (Attitude 3)

11. I enjoy using technology when learning mathematics.	0	1	2	3	4
12. Technology can make mathematics easier to understand.	0	1	2	3	4
13. I have access to technology outside of school (computer, cell phone, chrome book, iPad, etc.).	0	1	2	3	4
14. I have a good experience using Brightspace.	0	1	2	3	4
15. I have never had trouble accessing Brightspace inside or outside of school.	0	1	2	3	4

Use of Homework and learning with the assignment (Attitude 4)

16. I feel that I had enough time to do homework inside or outside of school.	0	1	2	3	4
17. I feel that the homework assignments helped me to better understand the math lessons.	0	1	2	3	4
18. Reading, writing, discussing, and reflecting on math helped me to better understand the math lessons.	0	1	2	3	4
19. Overall, the assignment helped me to have a better understanding of the unit.	0	1	2	3	4
20. I would like to use this assignment again.	0	1	2	3	4

Instructions (21-22): Please answer the questions in two or more sentences.

21. What suggestions can you make to improve learning with this assignment?

22. What are things that you would do differently, while learning with the assignment?

APPENDIX F:

Attitudes of Teachers (Pre) Survey

Attitudes of Teachers (Pre) Survey

School:________________________
ID: _______________

The questionnaire is designed to measure your attitudes of technology, Brightspace, homework, and teaching with the assignment. It should take about 5 minutes of your time. It is usually best to respond with your first impression, without giving a question much thought. Your answers will remain confidential.

Circle the appropriate responses based on the key below:

0 Strongly Disagree	1 Disagree	2 Neutral/Undecided	3 Agree	4 Strongly Agree

Use of Technology and Brightspace (Attitude 1)

1. I enjoy using technology when teaching mathematics.	0	1	2	3	4
2. Technology can make mathematics easier for students to understand.	0	1	2	3	4
3. I have access to technology outside of school (computer, cell phone, chrome book, iPad, etc.).	0	1	2	3	4
4. I have a good experience using Brightspace.	0	1	2	3	4
5. I have never had trouble accessing Brightspace inside or outside of school.	0	1	2	3	4

Use of Homework and teaching with the assignment (Attitude 2)

6. I feel that my students have enough time to do homework inside or outside of school.	0	1	2	3	4
7. I feel that homework assignments help students to better understand the math lessons.	0	1	2	3	4
8. Reading, writing, discussing, and reflecting on math helps students to better understand math lessons.	0	1	2	3	4

APPENDIX G:

Attitudes of Teachers (Post) Survey

Attitudes of Teachers (Post) Survey

School:_________________________
ID: ________________

The questionnaire is designed to measure your attitudes of technology, Brightspace, homework, the assignment, and suggestions for improving the assignment. It should take about 10 minutes of your time. It is usually best to respond with your first impression, without giving a question much thought. Your answers will remain confidential.

Circle the appropriate responses based on the key below:

0 Strongly Disagree	1 Disagree	2 Neutral/Undecided	3 Agree	4 Strongly Agree

Use of Technology and Brightspace (Attitude 1)

1. I enjoy using technology when teaching mathematics.	0	1	2	3	4
2. Technology can make mathematics easier for students to understand.	0	1	2	3	4
3. I have access to technology outside of school (computer, cell phone, chrome book, iPad, etc.).	0	1	2	3	4
4. I have a good experience using Brightspace.	0	1	2	3	4
5. I have never had trouble accessing Brightspace inside or outside of school.	0	1	2	3	4

Use of Homework and teaching with the assignment (Attitude 2)

6. I feel that my students had enough time to do homework inside or outside of school.	0	1	2	3	4
7. I feel that the homework assignments helped students to better understand the math lessons.	0	1	2	3	4
8. Reading, writing, discussing, and reflecting on math helped students to better understand math lessons.	0	1	2	3	4
9. Overall, the assignment helped students to have a better understanding of the unit.	0	1	2	3	4
10. I would like to use this assignment again.	0	1	2	3	4

Instructions (11-12): Please answer the questions in two or more sentences.

11. What suggestions can you make to improve teaching with this assignment?

12. What are things that you would do differently, while teaching with this assignment?

APPENDIX H:

Teacher Interview Guide

Teacher Interview Guide

Date:

Time:

Location:

Interviewer:

Interviewee: Mrs. _____

Opening Comments by Interviewer

A welcome statement will be given and I will thank the interviewee for her participation: Good Morning Ms. _____! Thank you for taking the time to complete this interview in the research process. Your participation on this assignment in Honors Advanced Algebra will help improve students' ability to use reading writing, discourse, and reflection in mathematics. This study will help determine an effective strategy to use in daily instruction. Ultimately, the goal is to help increase student learning and achievement in mathematics. I will remind the interviewee that I will record their answers to the questions by writing their response on this guide. The interviewee will receive an emailed copy of the transcripts and can look over the transcripts for accuracy to ensure that I have captured what the interviewee intended say. The interviewee will have the right to make any corrections or additions. I will take notes during the interview. To ensure confidentiality, I will explain to the interviewee that his/her name will not be used in the transcripts. I will explain to the interviewee that no one at the school will see or have access to the notes and transcripts of the interview.

As you know we set aside 15 minutes for the interview, is that still okay with you? We will not go past 15 minutes, unless you would like to do so. I will take notes during the interview, is that still okay with you? Do you have any questions before we start the interview?

Research Question Four: What are teacher suggestions for improving teaching with the assignment?

Interview Questions:

1. Do you think that the assignment helped students to perform better on their unit-test?
2. Do you think there was enough time for you to implement the assignment in your classroom?
3. Do you think that students had enough time to complete the homework assignments?
4. Do you think that students had adequate technology to complete the homework assignments?
5. What suggestions can you make to improve teaching with this assignment?
6. What are things that you would do differently, while teaching with this assignment?

APPENDIX I:

IRB Consent to Participate Approval

VALDOSTA STATE UNIVERSITY

Consent to Participate in Research

You are being asked to participate in a research project entitled "The effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students: A quasi-experimental study". This research project is being conducted by Anna Cutts, a doctoral student in Curriculum and Instruction at Valdosta State University. The researcher has explained to you in detail the purpose of the project, the procedures to be used, and the potential benefits and possible risks of participation. You may ask the researcher any questions you have to help you understand this project and your possible participation in it. A basic explanation of the research is given below. Please read this carefully and discuss with the researcher any questions you may have. The University asks that you give your signed agreement if you wish to participate in this research project.

Purpose of the Research: This study involves research. The purpose of the study is to address the effects of an assignment that incorporates reading and writing, discourse, and reflection for Honors Advanced Algebra students. Another purpose of the study is to address students' and teachers' attitudes toward learning and teaching with the assignment and their suggestions for improving the assignment.

Procedures: The study will last approximately 3 weeks. During that time, the students will be given a pre-test (Unit 1 Test) at the beginning of the study and a posttest (Unit 1 Test) at the end of the study; the students will be given a survey (at the beginning and end of the study) to measure their attitudes of math, working collaboratively and privately, use of technology and Brightspace, use of homework and learning with the assignment; and the students will complete 4 weekly homework assignments in Brightspace (D2L). The post survey will also allow students to make suggestions improving the assignment. Teachers will be given a survey (at the beginning and end of the study) to measure attitudes about the use of technology and Brightspace, use of homework and teaching with the assignment. The post survey will allow teachers to make suggestions for improving the assignment. Teacher interviews will be conducted at the end of the survey to measure teachers' suggestions for teaching with the assignment.

The homework assignments are problems from original weekly homework sheets, given in Honors Advanced Algebra. The weekly homework problems consist of problems that students are required to solve in the lessons for Unit 1 (7 lessons). The homework assignments will be assigned weekly in Brightspace and the students will be notified of due dates. Parents may request their child's login to see all homework assignments and due dates. Due dates for the weekly homework assignments and Unit Test will be located on the colander on the first page of the student's Unit 1 booklet. Solving the homework problems algebraically in Brightspace and the posttest are required for course completion and academic credit. The activities that are part of the research project and therefore voluntary include the surveys and solving the homework problems by using reading, writing, discourse, and reflection. The surveys and weekly homework assignments in Teacher A's classes are the procedures that are experimental. An alternative procedure for Teacher A's homework assignments is to solve the homework problems algebraically. If a student chooses not to use reading, writing, discourse, and reflection to solve the homework problems in Brightspace, then their average in the course will not be altered. If a student chooses not to participate in the surveys, then their average in the course will not be altered.

There will be two groups in this study (control/treatment) and two Honors Advanced Algebra teachers (Teacher A/Teacher B). If a student is in Teacher A's class, they will be in the treatment group. If a student is in Teacher A's group, they will be required to solve the weekly homework problems in Brightspace by reading the problems, writing about how to solve the problems, use discourse by responding to another student's problem, view the comment left by another student and reflect on their solution to ensure that their problem is accurate. If a student is in is in Teacher B's class, they will be in the control group. The weekly homework problems in Brightspace will only require students to solve the problems algebraically.

Possible Risks or Discomfort: Although there are no known risks to the students or teachers associated with these research procedures, it is not always possible to identify all potential risks of participating in a research study. However, the University has taken reasonable safeguards to minimize potential but unknown risks. By agreeing to participate in this research project, you are not waiving any rights that you may have against Valdosta State University for injury resulting from negligence of the University or its researchers.

Potential Benefits: Although you may not benefit directly from this research, your participation will help the researcher gain additional understanding of the effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students. Knowledge gained may contribute to addressing a strategy that will increase student achievement.

Costs and Compensation: There are no costs to you and there is no compensation (no money, gifts, or services) for your participation in this research project.

Assurance of Confidentiality: Valdosta State University and the researcher will keep your information confidential to the extent allowed by law. Members of the Institutional Review Board (IRB), a university committee charged with reviewing research to ensure the rights and welfare of research participants, may be given access to your confidential information. Students' and teachers' information, for research purposes, will be identified only by a pre-assigned identification number placed on the surveys, pre/posttests, and interviews. The researcher will compile the instruments, removing all student and teacher identity, so that the researcher has no knowledge of the identity of the participants. You will not be identified; therefore, the study should not place you at risk for privacy or confidentiality risks. The researcher will administer the pretests/posttests and conduct teacher interviews. Teacher responses from the interviews will be typed in a word document to determine their suggestions for improving the homework assignments. Teacher participants will be able to read their typed responses and make any revisions. A third-party individual will administer the surveys. Only the researcher will have access to the compiled data. No actual names will be used. All paper documents containing student and teacher responses will be kept in a locked filing cabinet in the researcher's office for 3 years. Only the researcher will have access to the compiled data. All data collected will be destroyed at the appropriate time using a paper shredding machine by the researcher. No other persons will be a part of the analyzing of data. The signed parental consent forms will be placed in a sealed envelope that the researcher will provide. A label on the envelope with instructions will be provided by the researcher. The researcher will place signed parental consent forms in a large envelope. The researcher will collect the sealed parental consent forms. Participants will return the sealed parental consent forms into Anna Cutts, located in room 206 at Colquitt County High School. The completed instruments will be stored in a locked cabinet and will only be shared with members of the dissertation committee. Once the code has been assigned, the code will be used in place of the students' names. Your rights will be protected by removing all names from materials used as part of the study. All data collected will be destroyed at the appropriate time using a paper shredding machine by the researcher. No other persons will be a part of the analyzing of data. The data from the study will be reported in combination with information from other participants, not associated with participants by name, and not individually identifiable.

Voluntary Participation: Your decision to participate in this research project is entirely voluntary. If you agree now to participate and change your mind later, you are free to leave the study. Your decision not to participate at all or to stop participating at any time in the future will not have any effect on any rights you have or any services you are otherwise entitled to from Valdosta State University. You may skip any questions on the surveys or interview that you do not want to answer.

Information Contacts: Questions regarding the purpose or procedures of the research should be directed to Anna Cutts at 229-891-6948 or aedenson@valdosta.edu. This study has been approved by the Valdosta State University Institutional Review Board (IRB) for the Protection of Human Research Participants. The IRB, a university committee established by Federal law, is responsible for protecting the rights and welfare of research participants. If you have concerns or questions about your rights as a research participant, you may contact the IRB Administrator at 229-333-7837 or irb@valdosta.edu.

Agreement to Participate: The research project and my role in it have been explained to me, and my questions have been answered to my satisfaction. I agree to participate in this study. By signing this form, I am indicating that I am 18 years of age or older. I have received a copy of this consent form.

I would like to receive a copy of the results of this study: _____ *Yes* _____ *No*

Mailing Address: ______________________________

e-mail Address: ______________________________

____
Printed Name of Participant

____
Signature of Participant Date

____
Signature of Person Obtaining Consent Date

This research project has been approved by the Valdosta State University Institutional Review Board for the Protection of Human Research Participants through the date noted below:

VALDOSTA STATE UNIVERSITY INSTITUTIONAL REVIEW BOARD
APPROVAL DATE
08.06.2018
IRB #
03656-2018
EXPIRATION DATE
05.05.2019

APPENDIX J:

IRB Parent Consent Approval

VALDOSTA STATE UNIVERSITY

Parent/Guardian Permission for Child's/Ward's Participation in Research

You are being asked to allow your child (or ward) to participate in a research project entitled "The effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students: A quasi-experimental study". This research project is being conducted by Anna Cutts, a doctoral student in Curriculum and Instruction at Valdosta State University. The researcher has explained to you in detail the purpose of the project, the procedures to be used, and the potential benefits and possible risks to your child (or ward). You may ask the researcher any questions you have to help you understand this study and your child's (or ward's) possible participation in it. A basic explanation of the research is given below. From this point on in this form, the term "child" is used for either a child or a ward. Please read the remainder of this form carefully and ask the researcher any questions you may have. The University asks that you give your signed permission if you will allow your child to participate in this research project.

Purpose of the Research: This study involves research. The purpose of the study is to address the effects of an assignment that incorporates reading and writing, discourse, and reflection for Honors Advanced Algebra students. Another purpose of the study is to address students' and teachers' attitudes toward learning and teaching with the assignment and their suggestions for improving the assignment.

Procedures: Your child will not be required to stay afterschool hours. All lessons, class assignments, homework, and post-test will be conducted as usual. The lessons, class assignments, and homework are all required elements of the course. The study will last approximately 3 weeks. During that time, your child will be given a pre-test (Unit 1 Test) at the beginning of the study and a posttest (Unit 1 Test) at the end of the study; your child will be given a survey (at the beginning and end of the study) to measure their attitudes of math, working collaboratively and privately, use of technology and Brightspace, use of homework and learning with the assignment; and your child will complete 4 weekly homework assignments in Brightspace (D2L). The post survey will allow students to make suggestions for improving learning with the assignment. The homework assignments are problems from original weekly homework sheets, given in Honors Advanced Algebra. The weekly homework problems consist of problems that students are required to solve in the lessons for Unit 1 (7 lessons). The homework assignments will be assigned weekly in Brightspace and your child will be notified of due dates. You may request your child's login to see all homework assignments and due dates. Due dates for the weekly homework assignments and Unit Test will be located on the calendar on the first page of the student's Unit 1 booklet. Solving the homework problems algebraically in Brightspace and the posttest are required for course completion and academic credit. The activities that are part of the research project and therefore voluntary include the surveys and solving the homework problems by using reading, writing, discourse, and reflection. The surveys and weekly homework assignments in Teacher A's classes are the procedures that are experimental. An alternative procedure for Teacher A's homework assignments is to solve the homework problems algebraically. If your child chooses not to use reading, writing, discourse, and reflection to solve the homework problems in Brightspace, your child's average in the course will not be altered. If your child chooses not to participate in the surveys, your child's average in the course will not be altered.

There will be two groups in this study (control/treatment) and two Honors Advanced Algebra teachers (Teacher A/Teacher B). If your child is in Teacher A's class, they will be in the treatment group. If your child is in Teacher A's group, they will be required to solve the weekly homework problems in Brightspace by reading the problems, writing about how to solve the problems, use discourse by responding to another student's problem, view the comment left by another student and reflect on their solution to ensure that their problem is accurate. If your child is in Teacher B's class, they will be in the control group. The weekly homework problems in Brightspace will only require students to solve the problems algebraically.

__Possible Risks or Discomfort__: Although there are no known risks to your child associated with these research procedures, it is not always possible to identify all potential risks of participating in a research study. However, the University has taken reasonable safeguards to minimize potential but unknown risks. By granting permission for your child to participate in this research project, you are not waiving any rights that you or your child may have against Valdosta State University for injury resulting from negligence of the University or its researchers.

__Potential Benefits__: Although your child may not benefit directly from this research, his/her participation will help the researcher gain additional understanding of the effects of an assignment that incorporated reading, writing, discourse, and reflection for Honors Advanced Algebra students. Knowledge gained may contribute to addressing a strategy that will increase student achievement.

__Costs and Compensation__: There are no costs to you or your child and there is no compensation (no money, gifts, or services) for your child's participation in this research project.

__Assurance of Confidentiality__: Valdosta State University and the researcher will keep your child's information confidential to the extent allowed by law. Members of the Institutional Review Board (IRB), a university committee charged with reviewing research to ensure the rights and welfare of research participants, may be given access to your child's confidential information. Your child's information, for research purposes, will be identified only by a pre-assigned identification number placed on the surveys and pre/posttests by the researcher, removing all student identity so that the researcher has no knowledge of the identity of the participants. Your child in the study will not be identified; therefore, the study should not place them at risk for privacy or confidentiality risks. The researcher will administer the pretests/posttests. A third-party individual will administer the surveys. Only the researcher will have access to the compiled data. No actual names will be used. To protect the integrity of the data, all student responses from the surveys, that is to be collected solely for research purposes (not grades), will be placed in an envelope, and sealed for collection. All paper documents containing student and teacher responses will be kept in a locked filing cabinet in the researcher's office for 3 years. Only the researcher will have access to the compiled data. All data collected will be destroyed at the appropriate time using a paper shredding machine by the researcher. No other persons will be a part of the analyzing of data. The signed consent forms will be placed in a sealed envelope that the researcher will provide. A label on the envelope with instructions will be provided by the researcher. The researcher will place signed parental consent forms in a large envelope. The researcher will collect all signed parental consent forms. It is asked that your child return the parental consent form to the researcher, **Anna Cutts, located in room 206 at Colquitt County High School**. The completed documents will be stored in a locked cabinet and will only be shared with members of the dissertation committee. Once the code has been assigned, the code will be used in place of the students' names. Your child's rights will be protected by removing all names from materials used as part of the study. No other persons will be a part of the analyzing of data. The data from the study will be reported in combination with information from other participants, not associated with participants by name, and not individually identifiable.

__Voluntary Participation__: Your decision to allow your child to participate in this research project is entirely voluntary. If you agree now to allow your child to participate and you change your mind later, you are free to withdraw your child from the study at that time. Even if you give your permission and want your child to be part of the study, your child may decide not to participate at all, or he/she may leave the study at any time. By not allowing your child to participate in this study or by withdrawing him/her from the study before the research is complete, you are not giving up any rights that you or your child have or any services to which you or your child are otherwise entitled to from Valdosta State University. Likewise, if your child decides on his/her own not to participate or to drop out of the study later on, he/she is not giving up any rights, including rights to services from Valdosta State University to which he/she is otherwise entitled. If your child chooses not to participate at any time, it will not affect their grades. Your child may skip any questions on the surveys that he/she does not want to answer.

<u>**Information Contacts**</u>:
Questions regarding the purpose or procedures of the research should be directed to Anna Cutts at 229-891-6948 or aedenson@valdosta.edu. This study has been approved by the Valdosta State University Institutional Review Board (IRB) for the Protection of Human Research Participants. The IRB, a university committee established by Federal law, is responsible for protecting the rights and welfare of research participants. If you have concerns or questions about your child's rights as a research participant, you may contact the IRB Administrator at 229-333-7837 or irb@valdosta.edu.

<u>Agreement to Participate</u>: The research project and my child's (or ward's) role in it have been explained to me, and my questions have been answered to my satisfaction. I grant permission for my child to participate in this study. By signing this form, I am indicating that I am either the custodial parent or legal guardian of the child. I have received a copy of this permission form.

I would like to receive a copy of the results of this study: ____ *Yes* ____ *No*

Mailing Address: ______________________________

e-mail Address: ______________________

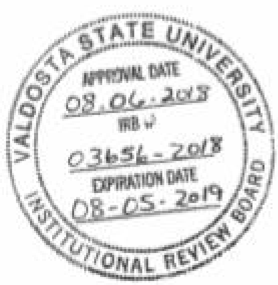
____
Printed Name of Child/Ward

____
Printed Name of Parent/Guardian

____
Signature of Parent/Guardian Date

____
Signature of Person Obtaining Consent Date

This research project has been approved by the Valdosta State University Institutional Review Board for the Protection of Human Research Participants through the date noted below:



APPENDIX K:

Treatment group – comments left by students on the post-survey

Treatment group – comments left by students on the post-survey

Student	**Question 20** What suggestions can you make to improve learning with this assignment?	**Question 21** What are things that you would do differently, while learning with the assignment?
Student A – 1	Do more work with technology	Study more, do more homework
Student A – 2	Nothing, this learning system is very good.	I would give more things to practice with.
Student A – 3	I think we do well as is	Study more
Student A – 4	None	Focus more and write down more notes
Student A – 5	NA	NA
Student A – 6	NA	NA
Student A – 7	Extra practice problems if needed	Not post homework on d2l
Student A – 8	I think everything was great	I wouldn't do anything differently.
Student A – 9	Group work/group activities	I'm not sure
Student A – 10	NA	NA
Student A – 11	Study on a focus on your work	Review and go over it more
Student A – 12	NA	NA
Student A – 13	I'm not sure. You're a great teacher	Take the same problems and redo them if I need the practice
Student A – 14	More group work	Nothing really
Student A – 15	I would like more time. I think D2L should be better with math based assignments.	Maybe I'd review my answers before turning them in. I wouldn't put off my assignment until it was almost due.
Student A – 16	None	I learned everything very well just the way you taught it
Student A – 17	I would suggest that we have other activities that are more collaborative and hands on. This would make the assignment less boring.	I believe that I should learn to manage my time better. This way, things are not done last minute.
Student A – 18	NA	NA
Student A – 19	I don't think there is anything I would change	I don't think I would do anything differently
Student A – 20	Review everything a little more (I struggle with abs. value)	More grading homework.
Student A – 21	NA	NA
Student A – 22	More example problems	No D2L
Student A – 23	Doing pop quizzes that might not count in grade	I would not do anything different. I like the

	book as a checkpoint to see how we are doing.	way you teach. ☺ You are a really cool teacher, and you make math more fun in a way. ☺
Student A – 24	Nothing just do you	Nothing different, I like the way I do my assignment
Student A – 25	Doing more Brightspace related discussions, I enjoyed those.	Do group work or more assignments to better understand the lesson.
Student A – 26	Larger amounts of time	Nothing
Student A – 27	Require less writing	Nothing
Student A – 28	I believe the homework helped me understand the unit better. But, over explaining made me second guess myself.	I would write the explanations as I worked through the problems.
Student A – 29	None	None
Student A – 30	NA	NA
Student A – 31	NA	NA
Student A – 32	NA	Ask more questions
Student A – 33	None	I would work more efficiently
Student A – 34	I feel as if the way we did this assignment was quite simple. The online homework was a bit annoying though.	The assignment was fine the way it was administered. I wouldn't change anything.
Student A – 35	NA	Ask more questions
Student A – 36	Give slightly harder practice problems in class.	I would not do anything different.
Student A – 37	Be a little more hands on	Nothing really, try to explain things more
Student A – 38	Nothing it has been great! ☺	Nothing it has been great! ☺
Student A – 39	NA	NA
Student A – 40	Nothing, I can think of.	Think I'm fine.
Student A – 41	NA	NA
Student A – 42	I think doing more group work or activities would help.	Have students come to the board to share their answers more often.
Student A – 43	I don't think there are any suggestions to improve learning with this assignment. Everything was good.	Nothing. I wouldn't do anything differently.
Student A – 44	Maybe do more activities to get me engaged.	Get things more clearly.
Student A – 45	More work on formulas and application to specific types of problems.	More notes on how and why we do those problems, not in the "why we do this" but

		more of why we need the answers for, more of what when I think about it.
Student A – 46	Nothing	Nothing
Student A – 47	NA	NA
Student A – 48	NA	NA
Student A – 49	More discussions as a class and more “this is why do this”	More review
Student A – 50	Nothing	Nothing
Student A – 51	Maybe teach some key words to help explain the problems. (like greater/less/absolute…)	I don’t know
Student A – 52	I don’t have any	Also none
Student A – 53	None	None
Student A – 54	Hands on visual learning instead of paper work	NA
Student A – 55	Nothing. I like it now.	Nothing
Student A – 56	It is not very easy to speak with people on discussions, for the notifications do not work very well. Also, it was not very easy to find where the assignments were in the start.	There is not much more to do, for it was quite simplistic. The assignments themselves were easy to understand and did not take much time. The worst part was having to elaborate on the works of others.
Student A – 57	Everything was ok, a lot of material was in this unit	I like the way we did this unit
Student A – 58	Nothing really, I understood everything easily.	I would study a little more. I would take my time to fully absorb it.
Student A – 59	NA	NA
Student A – 60	NA	NA
Student A – 61	More practice in unit.	Color more on practice
Student A – 62	Less D2L please. It’s very confusing I’d much rather just do it on paper and turn in that paper.	NA
Student A – 63	Not having the assignments so frequently.	Not as much explaining should be required with the assignment.
Student A – 64	NA	NA
Student A – 65	NA	NA
Student A – 66	Do regular homework instead of D2L	Instead of too much independent work, do more problems as a class to get a more thorough explanation of the current work being done

Student A – 67	None	Respond to more than 1 person
Student A – 68	Nothing	Nothing
Student A – 69	I would like to do small projects that will help me improve with math.	I would try to take notes and listen carefully to understand the assignment.
Student A – 70	I have no suggestions.	Nothing
Student A – 71	Give a little extra time.	I don't know what I would do differently.
Student A – 72	NA	NA
Student A – 73	Make sure what you use works more consistently and if not offer an alternative	The only thing that bothered me was d2l didn't always work, I wouldn't know how to fix it, though.
Student A – 74	I don't have any suggestions. Keep the assignment the same.	I would look at feedback and reply to others.
Student A – 75	Learning in groups to work on assignments. Practice examples on the board in class.	Nothing much, because I feel like I did well in this unit. I studied, did homework, and practiced in class as well.

APPENDIX L:

Control group – comments left by students on the post-survey

Control group – comments left by students on the post-survey

Student	**Question 20** What suggestions can you make to improve learning with this assignment?	**Question 21** What are things that you would do differently, while learning with the assignment?
Student B – 1	To talk things out. Explain the work.	NA
Student B – 2	More class work	IDK
Student B – 3	To know what's on it to study the right thing 2 or 3 days before it	NA
Student B – 4	It was fine the way it was.	Assign less HW.
Student B – 5	Go over the assignments in class longer. We do not spend enough time on units.	Spend more preparation time learning the assignment before making us do it ourselves. Doing that would help with our understanding.
Student B – 6	Work in groups more	I would try harder
Student B – 7	NA	NA
Student B – 8	No change, it was fine how it was	Nothing
Student B – 9	Pay attention to learn everything.	Listen and learn everything.
Student B – 10	None	Nothing really
Student B – 11	I don't know	I don't know
Student B – 12	NA	NA
Student B – 13	Make flashcards and foldables	Put quizzes up on quizlet to help me study
Student B – 14	Homework is an unnecessary part of school life. It reinforces ideas and concepts that are don't in the classroom, but it is often that only the ones who do not need it complete it on their own while the ones that do need it do not care and either copy another's work or forgot the homework entirely.	I would have to spend extra time verbalizing my methods, thoughts, and ideas, which I feel impedes the thought process for questions as a whole.
Student B – 15	NA	Explain more
Student B – 16	I don't really have any suggestions. My way of learning best was the way we learned it. It's explained and then we do some on our own.	I liked the way we were taught. For me, I wouldn't want it to be taught differently.
Student B – 17	None	I wouldn't do anything differently.
Student B – 18	Come talk to my teacher about something I don't understand during hawg time or after school.	Don't freak out if I don't understand at first, but if I don't understand later on I can call my teacher over and ask for a more simple explanation.
Student B – 19	In my opinion, they were perfectly fine and I learned what I needed to learn from it.	I would spend more time doing practices.
Student B – 20	Putting videos	Nothing else

Student B – 21	More practice would benefit	I would have taken more time outside of school to watch videos to help me understand the content better
Student B – 22	More practice work?	I don't think I would do anything differently
Student B – 23	NA	NA
Student B – 24	To go over questions more than one time.	Do more of the practice questions.
Student B – 25	Go over assignments long in class. This is my second sentence.	Probably pay closer attention. That was a big problem.
Student B – 26	I don't have any suggestions. I'm fine the way things are.	I wouldn't really do anything different. I'm fine learning it the way I did.
Student B – 27	NA	NA
Student B – 28	I would not make any suggestions.	Nothing
Student B – 29	I suggest that students pay attention. Students need to follow directions.	I would always ask questions if I need to. I will also try to learn to the best of my ability.
Student B – 30	NA	Turning in things in brightspace
Student B – 31	Have more classroom activities to make it fun to learn so that we enjoy it.	Have group activities encourage us to want to learn and want to participate.
Student B – 32	More explaining	Practice more
Student B – 33	NA	NA
Student B – 34	Nothing	Nothing
Student B – 35	I can't really make any the assignment was great a little challenge but do able. But maybe give more time for it.	Pay attention more and stay focused and have more time while doing it.
Student B – 36	IDK	IDK
Student B – 37	I would suggest spending a little more time on absolute value. Giving a little more review time for that would help enough.	Doing more of my homework would improve it. The other problem was trying the questions we haven't learned yet (questions I had no idea how to do).
Student B – 38	NA	I would go over homework and quizzes as a class.
Student B – 39	I personally like the way class is currently being ran.	Practice more
Student B – 40	More groups/hand on	Less just listening
Student B – 41	I would like to see you slow down sometimes. And take the time to come over and help.	I would pay attention if it was a little slower and I would be more confident.
Student B – 42	NA	NA

Student B – 43	More practice	Work w/ others
Student B – 44	Less worksheets, more hands on activity	NA
Student B – 45	That we talk more and work in groups and go over it slower	Work in groups and go over it slower
Student B – 46	Give more time for questions	Explain all the steps and write them out
Student B – 47	NA	NA
Student B – 48	Working with peers	Take my time
Student B – 49	Review the assignment	Pay more attention to the questions
Student B – 50	Group work	More hands on
Student B – 51	Nothing	I don't know
Student B – 52	Nothing	Nothing
Student B – 53	Partner work	Partner work
Student B – 54	Nothing	Practice more
Student B – 55	Well the assignments were good if you actually did them. To learn better we could practice more at home.	Ask questions either in class or on remind. Perhaps find more practice to further understanding.
Student B – 56	Paying attention in class	Study in class
Student B – 57	Talk more about the activity. Step by step how to figure it out	More group/partner work. More technology involvement
Student B – 58	None really	None really
Student B – 59	By understanding more and explaining a little bit more so I could understand better.	Just pay attention and ask for help when I need it.
Student B – 60	More daily grades. A chance to get our grades up if we don't do well on quizzes and stuff.	Review my work more, to avoid making careless mistakes.
Student B – 61	To improve learning with this assignment I think we should get more time working together. Other students can help me understand the lessons better.	I would study more throughout the unit rather than only studying a lot for the test.
Student B – 62	None	None
Student B – 63	Better wifi	Work in groups
Student B – 64	Give more time working on our own with assignments in class. It gives us a chance to try it independently but ask questions when needed.	I would not make any major changes when learning. I got the concept well when it was being taught.
Student B – 65	More group activities	Study more

Student B – 66	Group/partner work	Practice problems and work with others
Student B – 67	None	Nothing, practice more
Student B – 68	NA	NA
Student B – 69	Working with groups helps improve my learning. Other people help me when working problems.	To do better on my assignment I would study more. I usually only study 10 minutes.
Student B – 70	None needed	Study more outside of class
Student B – 71	More group work	Practice more
Student B – 72	The lesson was fine I just wish it went a little faster.	I would check over my work so I wouldn't make careless mistakes.
Student B – 73	More practice	Hands on activity
Student B – 74	Writing every step	More practice in class
Student B – 75	I suggest that we do more group based assignments and let discussion happen more often	Study more with it. Practice problems more outside of school.

APPENDIX M:

Comments left by teachers on the post-survey

Comments left by teachers on the post-survey

	Teacher A	Teacher B
11. What suggestions can you make to improve teaching with this assignment?	I do not have any suggestions.	There is nothing that I would do differently.
12. What are things that you would do differently, while teaching with this assignment?	No suggestions. I thought it was great.	Nothing.

APPENDIX N:

Comments left by teachers on the teacher interview guide

Comments left by teachers on the teacher interview guide

	Teacher A	Teacher B
1. Do you think that the assignment helped students to perform better on their unit-test?	Yes	Yes
2. Do you think there was enough time for you to implement the assignment in your classroom?	Yes	Yes
3. Do you think that students had enough time to complete the homework assignments?	Yes	Yes
4. Do you think that students had adequate technology to complete the homework assignments?	Yes	With time at school, yes
5. What suggestions can you make to improve teaching with this assignment?	I have no suggestions.	I like the length of them. I thought they were good.
6. What are things that you would do differently, while teaching with this assignment?	I would not do anything differently	Nothing