The Efficacy of Approaching Homework as a Formative Self-Assessment in a High School Mathematics Classroom

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Abstract

The purpose of the study was to determine the effect of treating homework as a formative self-assessment, where participants graded and corrected their own assignments, had on a summative unit assessment. The researcher also wanted to determine the effect the treatment had on the participants' mathematics self-efficacy. Two research questions guided this study: Does the treatment of homework as a formative self-assessment have an effect on the participants' average scores on a summative unit assessment compared to those whose homework was graded and handed back by the teacher? And does grading treating homework as a formative self-assessment have an effect on participants' self-efficacy towards mathematics? It was hypothesized that by treating homework as a formative self-assessment, participants in the experimental group would have higher average scores on the summative assessment than the control group of participants. Also, it was hypothesized that the participants in the experimental group would have higher self-efficacies. Thirty-four ninth and tenth grade students from two of the researcher's Algebra I classes participated in the six-week study: one class was the experimental group and the other was the control group. The researcher used two different instruments on both groups: A summative unit assessment that was used to compare the two groups' average scores. And a five-point Likert-scale mathematics self-efficacy survey used to compare the two groups' average rating scores. The experimental group's average score was 7.20% higher than the control group on the unit assessment. Also, compared to the control group, the average rating score for the experimental group was 0.30 points higher on the self-efficacy survey.

Keywords: formative assessment, homework, self-efficacy

The Efficacy of Approaching Homework as a Formative Self-Assessment in a High School Mathematics Classroom

It is well known that homework is a critical component to any, especially secondary level, mathematics classroom. As educational researcher Harris Cooper stated, homework has a positive effect on assessments, improves grades and standardized test scores, and, compared to other interventions, has an above-average effect on achievement (as cited in Bembenutty, 2011). Though, assigning homework is a widely accepted practice in high school math classrooms as a means to raise student achievement, recent literature shows that teachers may not be using homework to its fullest potential (Snead & Burris, 2016). Furthermore, research has shown that both teachers and students view homework grades as rewards for working hard rather than as feedback about their learning (Vatterott, 2011). This shows a need for a shift in how homework is approached and used in a mathematics classroom.

At the same time, formative assessments, assessments that are used as a measurement for learning as opposed to of learning (known as summative assessments), have been shown to improve student achievement as well (Baleni, 2015; Schnepper & McCoy, 2017; Sumantri, 2016). Specifically, given the nature of mathematics building on itself, research has shown that the use of formative assessments when errors are identified and clarified will result in an adjustment in teaching and learning and, therefore, increase student achievement (Schnepper & McCoy, 2017). Going along with what was aforementioned about homework, recent research has shown that formative assessments should not necessarily be assigned a grade either because, as with homework, it devalues the process formative assessments have on the increasing of learning. Tying all of this together, while it is important for teachers to provide intrinsically rewarding and meaningful homework assignments, this researcher contends that it's as equally

important to analyze how the homework is addressed after students complete it (Snead & Burris, 2016). By blending the ideas of the importance of homework and formative assessments, the researcher found the need to examine the effectiveness of treating homework as a formative self-assessment.

The overall purpose of the study was to determine the effect of treating homework as a formative self-assessment, where participants graded and corrected their own assignments, had on a summative unit assessment. As a corollary to this overall purpose, a second purpose of this study was to determine the effect of treating homework as a formative self-assessment had on the participants' self-efficacy towards mathematics. For the purposes of this study, the approach of participants grading their own homework and making corrections was defined as a formative self-assessment whereas the approach of the teacher grading the homework and providing no feedback other than what was missed was defined as a summative assessment.

This study was guided by two research questions:

1. Does the treatment of homework as a formative self-assessment, where the participants grade their own homework and make corrections to their work and answers, have an effect on the participants' average scores on a summative unit assessment compared to those whose homework was graded and handed back by the teacher?
2. Does grading their own homework and correcting their mistakes have an effect on participants' self-efficacy towards mathematics compared to those whose homework is graded and handed back by the teacher?

The study hypothesized that by treating homework as a formative self-assessment where participants assess their own homework while also correcting their work and answers, the participants will take more ownership of their learning, causing the participants to have higher

average scores on a summative unit assessment than the control group of participants, whose homework assignments were graded by the teacher and handed back. The study also hypothesized that the participants who graded and corrected their own homework will have higher self-efficacies than those whose homework was graded and handed back by the teacher due to them taking more ownership of their learning.

In the following literature review, the researcher discussed the importance of formative assessments in a mathematics classroom. Also considered is the way formative assessments can be used in the classroom as well as reasons why teachers are not readily using them despite research showing how their use increases student achievement. The researcher also explained the importance of effective homework as well as teachers' perceptions of homework in a mathematics classroom. Finally, a review of research on the role homework and formative assessments have on students' self-efficacy was described.

The Importance of Formative Assessments in a Mathematics Classroom

Homework and assessments are at the core of secondary education, especially in mathematics. In particular, as mentioned previously, formative assessments used in mathematics classrooms have been shown to increase student achievement due to the nature of mathematical concepts building off of one another (Baleni, 2015; Schnepper & McCoy, 2017; Sumantri, 2016). Furthermore, due to the progressive nature of mathematics, insufficiencies of learning math are the result of students' "failure to understand the concepts of which form the basis for the procedures they are using" (Schnepper & McCoy, 2017, p. 2). Researchers have studied the effects of a teacher identifying and analyzing the errors made on short formative assessments after introducing a new concept in a high school math class. After the analysis, the teacher then clarified and re-taught the errors made the following day (Schnepper & McCoy, 2017).

Through analyzing the mistakes made, five error types were identified and characterized: incomplete answers, misused data, technical/computational errors, errors originating from misconceptions of previously learned material, and distorted/altered definitions for the context of the problem (Schnepper & McCoy, 2017). It was found that by the teacher making the error clear and re-teaching the concept that students increased in average scores on four of the five typical types of errors on the summative assessment. (Schnepper & McCoy, 2017). This is just the beginning of showing the power formative assessments have on raising student achievement and learning, especially when mistakes are identified and corrected, of which shows the need for further investigation as in this study.

Research has also shown that formative assessments can be done before, during, and after instruction in order to maximize its effect. In order for teachers to be "more productive and effective in monitoring and assessing student achievement", they need to be utilizing formative assessments all throughout their daily lessons (Riddell, 2016, p. 63). Although the number of formative assessments used has a direct correlation to raising student achievement, the feedback given to the students needs to be based on the quality of their work or their progress towards mastery of the concept (Riddell, 2016). As stated previously, it has been argued that formative assessments should not be assigned a grade because it devalues the process formative assessments have on the increasing of learning. Additionally, research has emphasized the point that teachers should be checking for understanding continuously throughout a lesson by using formative assessments: "Checking for understanding is an important aspect in understanding whether or not your students have actually internalized the concept or objective" (Riddell, 2016, p. 65). Again, teachers should be doing this before, during, and after instruction as shown in the following specific examples (Riddell, 2016).

For instance, before instruction, teachers can activate prior knowledge in order to form new knowledge by administering formative assessment activities like journaling or having a conversation with a partner about their understanding of the new topic (Riddell, 2016). During instruction, educators should use formative assessments in order to see where the students are at in their progress toward mastery by doing things such as clarifying a common misconception of the topic or by posing a question to the students and having them "think-pair-share" about the given topic (Riddell, 2016, p. 67). Finally, educators can check for understanding in their students learning processes by using formative assessments after instruction as well. It has been claimed that not only will checking for understanding at the end brings closure to the lessons or activities, it also informs the teacher of the effectiveness of their lessons and allows them to plan their next steps (Riddell, 2016). Like before, specific examples of formative assessments to use at the end of a lesson would be like using exit slips where students answer two to three questions about the topic(s) of the lesson and creating a graphic organizer to show the connections they made between the concepts covered in the lesson (Riddell, 2016).

Although the aforementioned research does not cite homework specifically as a type of formative assessment, as is being argued that there is a need for, the researcher does contend for the powerfulness formative assessments have on the learning process. While there is power behind students identifying their own mistakes and correcting them on their homework assignments, future research should combine that idea with the argument that the formative assessment process allows students to receive validation and affirmation on their learning process, while at the same time increasing their confidence and self-efficacy in performing mathematics concepts (Riddell, 2016).

Despite research supporting the use of formative assessments increasing student achievement, like mentioned above, many teachers are still not using it. Another researcher stressed that, since it has been found that the use of assessments account for almost a third of teachers' instructional time, all types of assessments must be used, especially formative assessments since they have been shown to enhance students' learning (Izci, 2016). Through research, it was discovered that despite current literature supporting the effectiveness of formative assessments increasing student achievement, teacher effectiveness, and overall school achievement, teachers are not readily adopting the use of formative assessments in their classrooms (Izci, 2016). Further, the next aim of the research was to uncover why teachers are reluctant to put formative assessments to work in their practice. The researcher found four factors that inhibited teachers from using formative assessments in their classrooms: personal, contextual, external, and resource-related (Izci, 2016).

Moving forward, it was found that the personal factors that hindered teachers from using formative assessments, as in such things like their beliefs, values, and attitudes towards them, played a huge role as well as their lack of knowledge about them (Izci, 2016). Another personal factor that weighed heavy against the use of formative assessments for teachers was their low self-efficacy and motivation towards them (Izci, 2016).

Furthermore, the researcher found that contextual factors such as there being nothing written about formative assessments in school policies, that then affects the amount of support from colleagues teachers get, prevent teachers from using them in their classrooms (Izci, 2016). Also, the researcher found that student and parent resistance to the use of formative assessments also contributes to the lack of teachers using them, since they prefer traditional paper and pencil

tests in which they will receive a grade for, while formative assessments don't necessarily have the students writing nor receiving a grade (Izci, 2016).

Likewise, the external factors the researcher found that contributed to the absence of formative assessment use in the classroom had to do with state educational policies and curriculum developers leaving them out (Izci, 2016). And finally, the researcher found that resource-related factors, like the lack of professional development and teacher preparation programs stressing the importance of using formative assessments, also contribute to teachers not using them (Izci, 2016). Since homework is such an intrinsic aspect of any secondary mathematics classroom, it is worth studying how shifting its focus to the students learning from their mistakes, and therefore, assessing their progress towards mastery of the concepts, like one does on formative assessments, to see how students' achievement is affected without any objections from teachers themselves or outside sources.

Further, while formative assessments improve overall student achievement, research has found that the type of formative assessment given, essay or multiple-choice, had a different impact on learners' success with high versus low self-directed learners (Sumantri, 2016). The researcher found that students who were given formative assessments in the form of essays outscored those students given them as multiple-choice questions (Sumantri, 2016). However, it is also notable that students with high self-direction had a higher average score when they were given the essay formative assessments, while low self-directed students had a high average score when given the formative assessments as multiple-choice questions (Sumantri, 2016). Therefore, it can be deduced that, since we have all types of self-directed learners, in our classrooms, there is a need to look for other avenues for formative assessments like changing our view of homework as in this study.

Additionally, it has been uncovered that the use of formative assessments may narrow the scope of the materials students study (Umer & Omer, 2015). This is because, driven by the need to merely get a good grade, the students feel that the content covered on the formative assessments must be what the instructor deems important and, therefore, will be what is assessed on the summative tests (Umer & Omer, 2015). Since homework in a mathematics classroom typically covers all essential learning standards, again, simply changing our perspective on how we view homework, that is, as a type of formative assessment, is an excellent approach to getting our students to make sure they are practicing and progressing towards all learning goals, not just the ones they think might be on the unit test.

Additionally, formative assessments should be an "interactive process between the teacher and the student to promote ongoing learning" (Ninomiya, 2016, p. 89). Correspondingly, formative assessments should not be as concerned with feedback from the teacher with aim at moving the student towards the educational target, but rather, should incorporate the students more into the "exploratory and dialogical process" (Ninomiya, 2016, p. 89). All ideas considered, this suggests that more research is needed to improve how formative assessments are used, especially based on the diverse types of learners in one's class, in order to increase student achievement.

The Importance of Effective Homework in a Mathematics Classroom

As previously indicated, the practice of assigning homework is deeply embedded into the secondary mathematics classroom. Again, though assigning homework is a widely accepted practice in high school math classrooms used to help raise student achievement, recent literature shows that teachers may not be using homework to its fullest potential. Though mathematics teachers perceive homework as important and a way to reaffirm learning through practice,

review, and reinforcement, as well as inform their instruction, they do not understand relevant issues associated with creating effective homework assignments that will raise student achievement (Snead & Burris, 2016).

Alarmingly, when researchers asked math teachers participating in their study why they assign homework, while 20 percent reported they use it for reinforcement and 19 percent reported they use it for practice, an astounding 27 percent could not or did not provide a reason for assigning homework (Snead & Burris, 2016). The teachers in the study were also asked how they assess the homework, to which a shocking 63 percent said that homework in their class is not graded, while only 10 percent responded that the students grade their own work (Snead & Burris, 2016). Further, the researchers found that teachers do not design homework assignments to differentiate for a range of students' needs, provide individual feedback, nor to be engaging. In fact, one teacher stated that they assign homework because "this is just what teachers are expected to do" (Snead & Burris, 2016, p. 74).

Further, researchers found a disconnect between how the participating math teachers perceive homework and their actual implementation of it in their classes: Though they believe homework is important and view it as a means of "influencing student learning by increasing their intellectual capacity", their responses to the researchers' questions suggest that homework is "an accepted practice that is generic, fairly routine, and non-reflective" (Snead & Burris, 2016, p. 72). Too add to that, it has also been found through research that assigning daily math homework assignments might imply that teachers are focusing too much on procedural, step-by-step algorithms without emphasizing conceptual understanding (Saam & Jeong, 2013). The researchers contend that a balance between procedural learning and conceptual understanding

should be sought in mathematics classrooms (Saam & Jeong, 2013). This evidence especially shows that a shift in how homework is used in our mathematics classrooms is needed.

Adding to the aforementioned research results, researchers observed that teachers seem to be confused about homework's role in the classroom and also how grades should represent it (Vatterott, 2011). Furthermore, it was discovered that both teachers and students view homework grades as rewards for working hard rather than as feedback about their learning: The argument is made that teachers have oversold grades to students as the indicator of a task's worth (Vatterott, 2011). The researcher states, "We expect students to take notes during lectures, do group work, and participate in discussions, yet we don't grade all these actions. They are expectations, just as, in many other countries, completing homework is an expectation" (Vatterott, 2011, p. 61). Teachers and students need to value homework for its learning not for its grade. In fact, Baker and LeTendre found a negative correlation between grading homework and student achievement (as cited in Vatterott, 2011). Yet, research found that there are three main reasons why teachers continue to grade homework.

First, they feel like if they don't grade it, the students won't do it (Vatterott, 2011). This goes along with the aforementioned statement of how educators have exaggerated grades to be the true gauge of a chore's worth. Secondly, going along with the first point, teachers feel like hard work should always be rewarded, and a way to do so is by assigning a grade to the assignment (Vatterott, 2011). And finally, teachers continue to assign grades to homework for the lack of not having a different alternative (Vatterott, 2011). While most, if not all, teachers would agree that homework is important, the researcher contends, "It's not about the student's responsibility for a task, but the student's responsibility for his or her learning" (Vatterott, 2011, p. 62).

Moreover, research discovered three homework practices teachers can employ in order to move toward focusing on learning in their classrooms. One suggested practice is tying homework to assessments by doing simple things like allowing students to use homework and/or notes on quizzes and tests (Vatterott, 2011). The other two practices suggested vastly lend themselves to the need for further research. First, each assignment should be evaluated to determine whether to grade it, which means to separate it into formative and summative assessments (Vatterott, 2011). Additionally, the researcher argues that such things like math and vocabulary practice as formative assessments should not be given a grade but things like research papers, portfolios, and other summative assessments should (Vatterott, 2011). Next, it is also suggested that teachers should focus on demonstration of learning on the homework assignments, not just on its completion (Vatterott, 2011). As stated previously, these two practices combined go along with the idea that homework in a math classroom should be viewed as a formative assessment in which students are to show their progress towards mastery of the concepts through not just completing the assignment but by identifying and fixing their mistakes.

The Role Homework and Formative Assessments have on Self-Efficacy

Homework has a positive relationship with self-efficacy, responsibility for learning, and the delay of gratification with things like social media and television in students through identifying maladaptive homework behaviors (Bembenutty, 2011). Research has shown that students tend to do such things like self-handicap by engaging in activities that can detract from accomplishing their academic goals (Bembenutty, 2011). It has been shown that students also procrastinate, set unrealistically low expectations for themselves, allow technology like instant messaging and social media to distract them, and/or allow their parents to become too deeply involved in their homework tasks (Bembenutty, 2011). Though this list of maladaptive

homework practices may seem daunting for educators to overcome, research has uncovered many solutions to combat their behaviors. Some strategies educators can employ are teaching students how to goal set, how to use weekly planners and homework logs, promoting optimistic beliefs that will enhance self-efficacy beliefs, and instilling the value of homework and the importance of delayed gratification of the ever-present distractors like cellphones and television (Bembenutty, 2011).

At the same time, research has found that some programs are inadequately aligned to the self-regulatory needs of students that affect their learning (Bembenutty, 2011). It is suggested that students engage in these maladaptive behaviors in order to cope with the high demands of homework, which calls for more self-regulatory training, not just for the students but also for their parents (Bembenutty, 2011). Coupled with that, research findings "put homework at the center of the educational self-regulatory process based on high self-efficacy beliefs, appropriate teacher training, and parental assistance" (Bembenutty, 2011, p. 470). According to research, the maladaptive behaviors that exist in some learners in their approach of homework assignments begs for the examination of educators' homework practices and policies to better serve the students' needs in order to become more self-efficacious, as is deemed to need to be further assessed.

In summation, looking past some people's notion that giving students a second attempt on homework and/or assessments is compromising the reliability of students' achievement, letting students have a chance to learn from their mistakes is aligned with the fundamentals of the educational system (Baleni, 2015). If we truly want our students to learn, "assessment, and not the curriculum, defines how and what students learn" (Baleni, 2015, p. 228). Additionally, according to research on the role formative assessments played on the participating students,

while they helped all students achieve at a higher level, it largely impacted low achievers by focusing specifically on their misconceptions that were uncovered from their teacher's feedback by providing them with a clear picture of the mistake and how to fix it (Baleni, 2015).

Teachers must also work to make their classrooms a safe and supportive environment so that students feel comfortable to comment on their own and each other's work, while also receiving feedback from their teacher (Saradareh, 2016). Furthermore, it has been found that feedback is more effective when the students reflect on the task, reason together, and become more central participants, just as is being suggested in the current study (Saradareh, 2016). The benefits of formative assessments and the need to refine how they are used in the classroom, combined with the positive aspects of homework and the need to address current homework practices and policies in our educational system, brings us to the need of this study.

Methods

The research conducted used a quantitative study approach that utilized an experimental design. The researcher collected data for a total of six weeks from ninth and tenth grade participants in the researcher's classroom during the spring semester of 2019. The study consisted of two groups of participants: the control group and the experimental group. Participants in the control group had their daily homework graded and handed back by the teacher. Participants in the experimental group graded their own homework, identified and corrected their mistakes, and asked the teacher to clarify anything they didn't understand. The following information details the participants, setting, data source and research materials, and data collection procedures.

Participants and Setting

Participants in this study were a random sampling from two of the researcher's Algebra I classes. Specifically, the participants were randomly assigned to classes using a scheduling computer system within the school's counseling department. The control group was one class and the experimental group was another class. The sample included male and female with ages ranging from 14 to 16 years and grades 9 and 10. All participants were Caucasian. There were 35 participants: 18 in the experimental group and 17 in the control group. All participants who receive math instruction in the general education classroom participated in the study.

One student in the control group was extremely sick and was absent during the first three weeks of the study. Returning to school during week four, the participant turned in one homework assignment before a family emergency caused him to miss the rest of week four and all of week five. During week six, the participant and his family made the decision to pull him from his classes and home-school him. Therefore, that participant has no final scores to report and is excluded from the data, leaving the control group with 16 participants.

The location of this study was in Algebra I classes in a high school in a rural, farming community in northwestern Illinois of approximately 1,500 residents. In 2017, according to the information on the school's most recent Illinois report card, with 191 students attending the school, 93.7% were white students, 1% were black students, 2.6% were Hispanic students, 1% were Asian students, and 1.6% were multiracial students (Illinois State Board of Education, 2017). According to the report, 33% of students were low-income with a 4% mobility rate and 9% of students had an Individualized Education Plans (Illinois State Board of Education, 2017).

Data Source and Research Materials

The researcher used two different instruments on both groups of participants to conduct this study. The instruments are as follow:

1. A summative unit assessment on systems of equations and inequalities that was created by the teacher researcher and her colleagues (see Appendix A). The contents of the assessment measured the participants' understanding of solving systems of equations and inequalities using a variety of methods. Additionally, the summative unit assessment assessed the participants' comprehension of systems with no solution and infinitely many solutions and applying their understanding of systems of equations to a real-life situation. This instrument was used to compare the average scores between the two groups of participants in order to answer the first research question.

2. A mathematics self-efficacy Likert-scale survey that was created by the teacher researcher (see Appendix B). The contents of the survey assessed how the two approaches to homework grading affected the participants' self-efficacy towards mathematics. This instrument was used to compare the average rating scores between the two groups of participants in order to answer the second research question.

Procedures of Data Collection

The six-week study occurred while Algebra I participants studied a unit on systems of equations. The classes were assigned approximately one to two identical homework assignments per week that were either graded by the participants or by the teacher-researcher, depending on which group they were in, the following class period.

This first week was spent introducing the concept of systems of equations, how to graph them to find their solutions, and ended with an introduction to the substitution method of

solving the systems. Students had two homework assignments during week one over the graphing and substitutions methods.

The second week focused on the continuation of practicing the substitution method as well as the introduction and practicing of the elimination method of solving very basic systems of equations. Students had just one assignment that week that covered both aforementioned methods of solving.

The third week focused on solving more complex systems of equations still using the elimination method and the students had just one homework assignment where they strictly just practiced the elimination method with a range in the complexity of several systems of equations.

The fourth week was spent practicing all three methods of solving (graphing, substitution, and elimination) as well as using the methods to solve real-life application problems. During this week, students had two assignments: the first was a review over all three methods and the other assignment was all real-life application problems.

The fifth week was devoted to solving systems of inequalities and the students had just one culminating assignment towards the end of the week where they practiced solving the systems of inequalities.

The final week consisted of reviewing and preparing for the summative unit test. The students had one homework assignment that was a review of the entire unit.

At the end of the study, the two groups were administered the identical summative unit test on systems of equations and inequalities. Additionally, the students were also given the identical Likert-scale survey. As an added note, the summative unit tests were graded by a fellow teacher to avoid biases.

Data Analysis and Results

Data was analyzed quantitatively using descriptive analysis. Participants for this study were chosen based on a random sampling from two of the researcher's Algebra I classes and were assigned to experimental and control groups. The researcher collected homework scores of the 34 participants for six weeks: 18 students in the experimental group and 16 students in the control group. For both groups, the first five weeks of homework were the result of content delivery over the unit on systems of equations and inequalities. Again, for both of the experimental and control groups, the last week of data was the result of reviewing for the summative unit assessment as well as administering the summative unit assessment and mathematics self-efficacy Likert-scale survey.

Data Analysis

Each week the researcher collected data from homework scores that was analyzed quantitatively from both the experimental and control groups. All of the data collected from all of the homework assignments was organized and reported as percentages on two different bar graphs using Microsoft Excel. The first bar graph shows each experimental group participant's homework scores for all six weeks of the study. The second bar graph shows each control group participant's homework scores for all six weeks of the study.

Participants in the experimental group treated homework as a formative self-assessment as they graded their own homework while also correcting their work and answers. Conversely, participants in the control group had their homework assignments graded by the teacher and then handed back. Given the treatment, it was hypothesized that the participants in the experimental group will take more ownership of their learning, causing them to have higher average scores on the summative unit assessment and high self-efficacies towards mathematics compared to the

control group. With the focus being on the treatment of how the homework assignments are assessed, a table was created to compare the mean scores of the experimental group and the control group for each of the eight homework assignments. Additionally, due to the aforementioned hypotheses, two bar graphs were created using Microsoft Excel to display each participant's score on the summative unit assessment: one graph for the experimental group, the other for the control group. Next, two tables were created to display the results of the mathematics self-efficacy Likert-scale survey: one table for the experimental group, the other for the control group. Finally, also aligned with the hypotheses, a third table was created to compare the results of the experimental and control group on the mathematics self-efficacy Likert-survey. Following is a discussion of the results of the study based on the research questions.

Results

Overall results from the summative unit assessment showed that participants in the control group had a slightly higher average percentage score compared to that of the experimental group. The average control group score was 81.13% while the average experimental group score was 79.56% by the end of the six-week study, as seen later in Table 1. However, participants in the experimental group reported a higher self-efficacy towards mathematics than participants in the control group with an overall difference of 0.24 points on the five-point scale, as seen later in Table 5.

Research Question One: Does the treatment of homework as a formative self-assessment where the participants grade their own homework and make corrections to their work and answers have an effect on the participants' average scores on a summative unit assessment compared to those whose homework was graded and handed back by the teacher?

Experimental group's results. First, Figure 1 below shows the percentage scores collected on all eight homework assignments for the participants in the experimental group. The highest score was 100%. All participants scored 100% at least once out of all eight homework assignments. The lowest score was 0%. Participants 2, 8, 9, 12, 13, and 16 all scored 0% at least once out of all eight homework assignments due to either getting all of the problems wrong on an assignment or not doing the assignment at all.

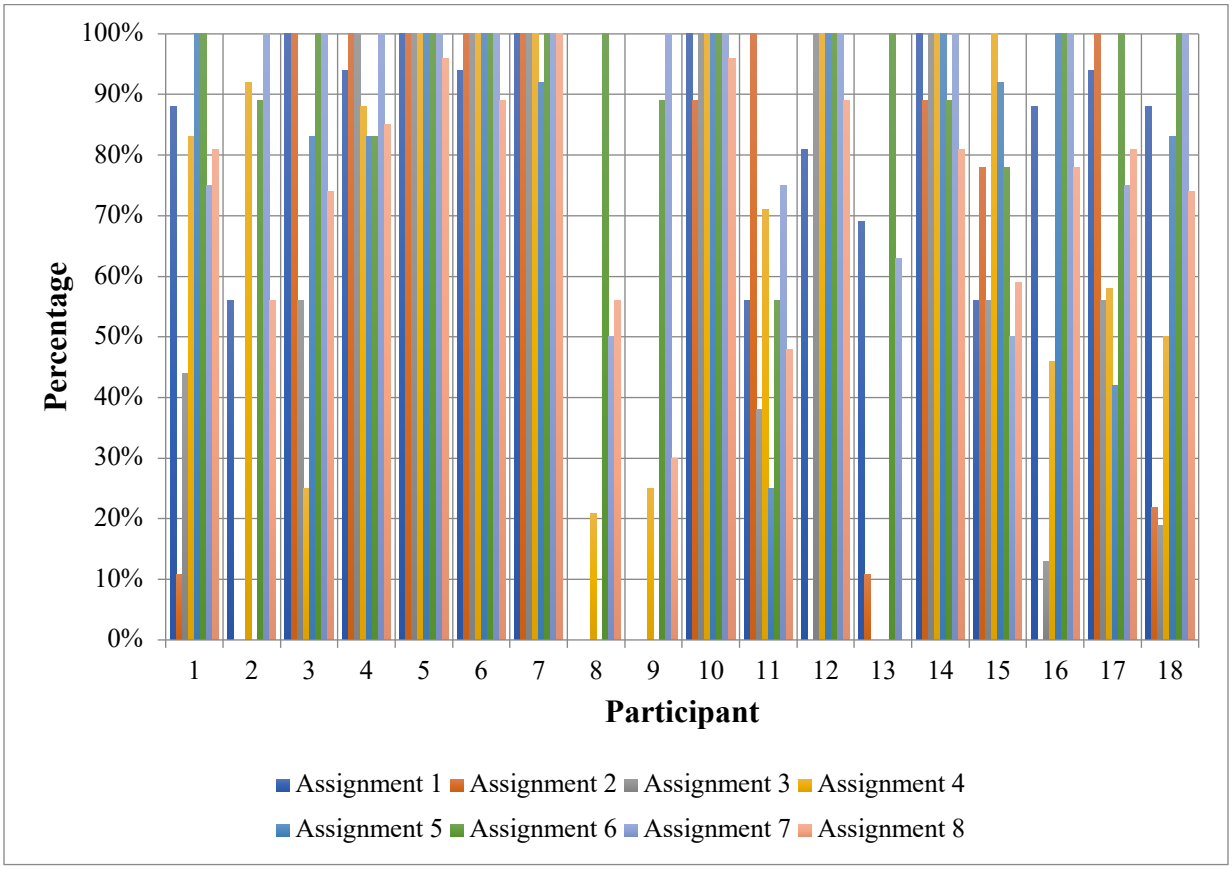

Figure 1. Experimental Group Participants' Homework Percentage Scores for the Six-Week Study

Next, Figure 2 below show the percentage scores of the experimental group participants' summative unit assessment scores. Participant 6 scored the highest score with 100%. Participant 9 scored the lowest score with 31%.

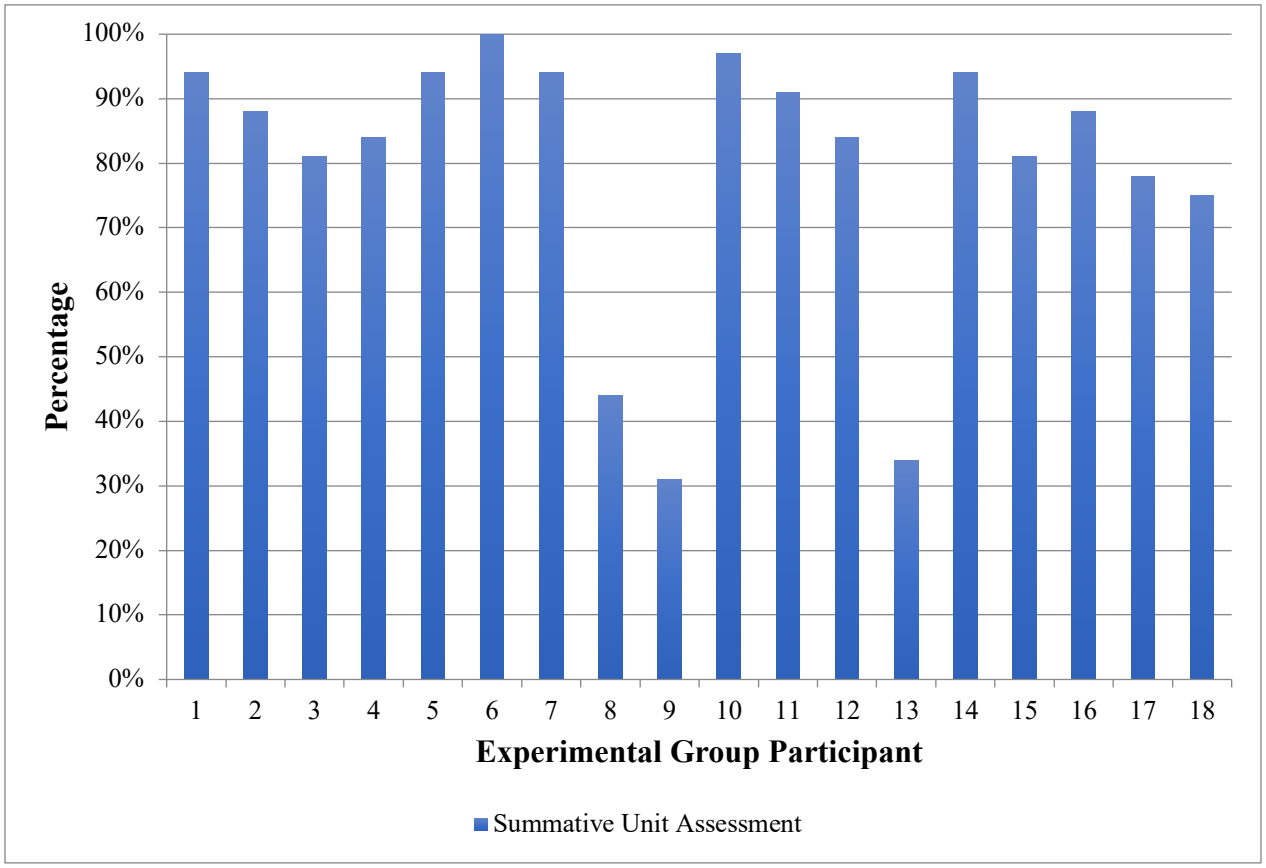

Figure 2. Percentage of the Participants Score of Summative Unit Assessment for Experimental Group

Control group's results. First, Figure 3 below shows the percentage scores collected on all eight homework assignments for the participants in the control group. The highest score was 100%. Participants 19, 20, 22, 23, 25, 26, 28, 29, 30, 31, 32, and 33 all scored 100% at least once out of all eight homework assignments. The lowest score was 0%. Participants 22, 24, 25, 26, 28, and 32 all scored 0% at least once out of all eight homework assignments due to either getting all of the problems wrong on an assignment or not doing the assignment at all.

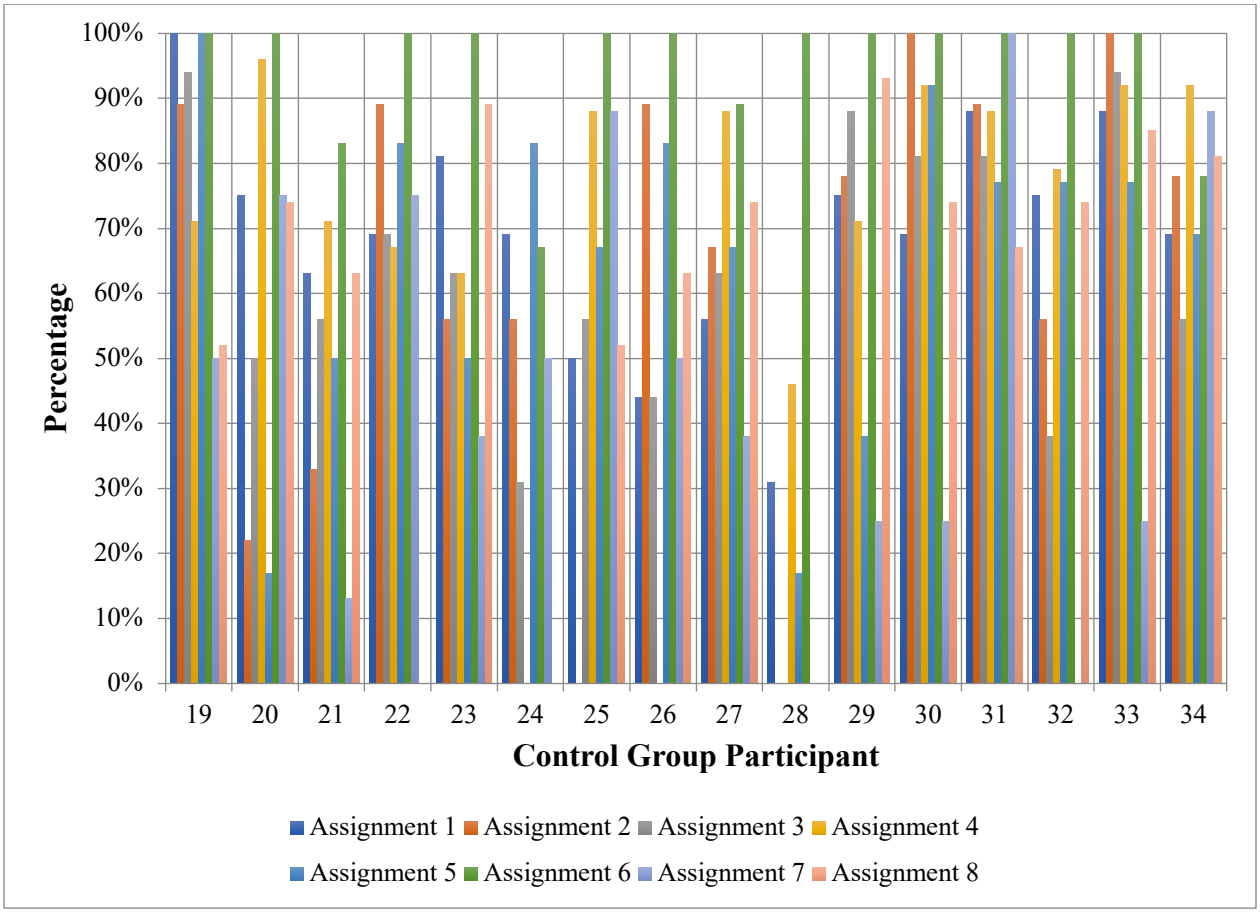

Figure 3. Control Group Participants' Homework Percentage Scores for the Six-Week Study

Next, Figure 4 below shows the percentage scores of the control group participants' summative unit assessment scores. Participant 34 scored the highest score with 100%. Participant 25 scored the lowest score with 50%.

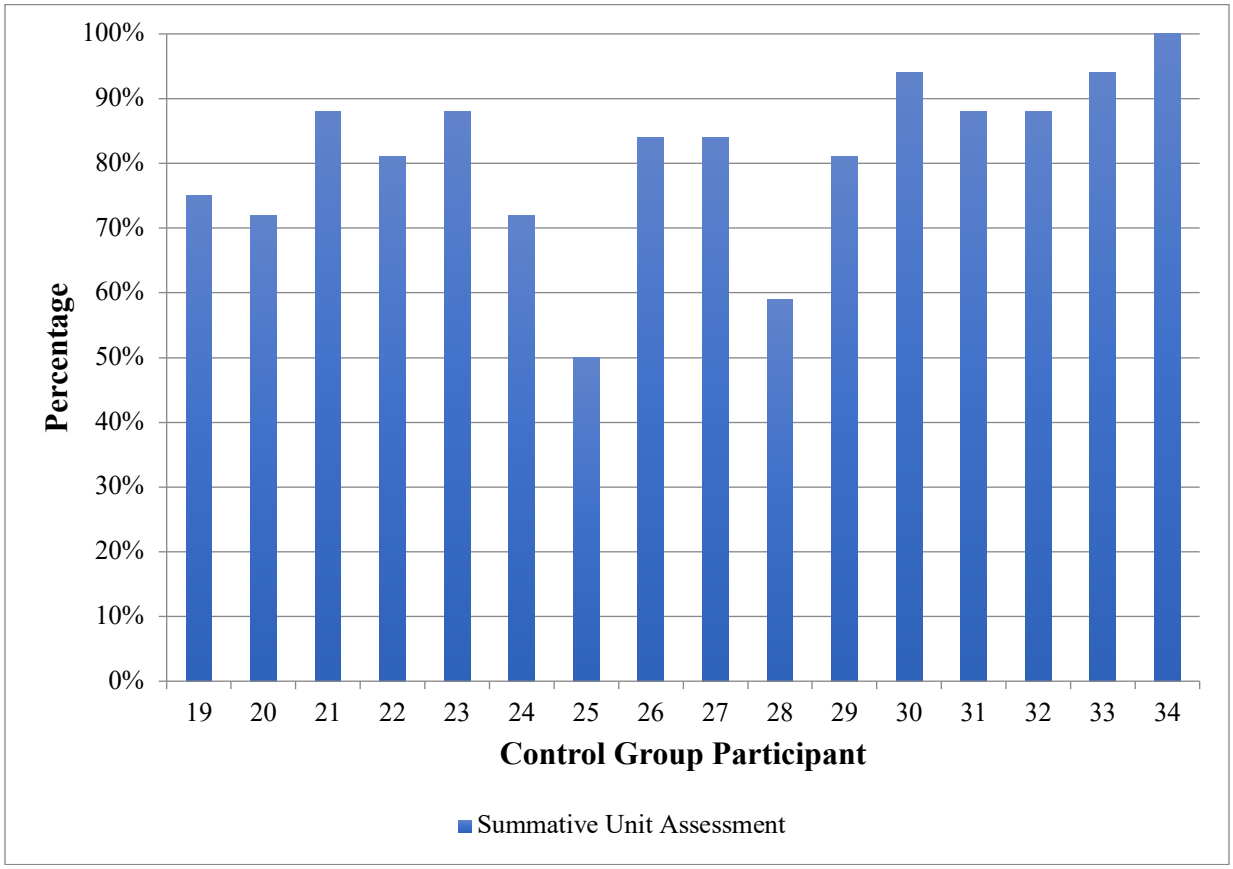

Figure 4. Percentage of the Participants Score of Summative Unit Assessment for Control Group

Comparison of Experimental and Control Groups' Results. Table 1 below shows the comparison of the average scores of each group on each of the eight homework assignments. Assignment 6 resulted in the highest scores for both the experimental group and control group, with averages of 93.56% and 94.47%, respectively. Assignment 2 resulted in the lowest scores for both groups, with the experimental groups' average being 62.50% and the control groups' average being 62.63%. The average experimental group score was highest for Assignment 6 at 93.56% and lowest for Assignment 3 at 61.75%. The average score group score was highest for Assignment 6 at 94.47% and lowest for Assignment 7 at 46.25%. As seen from the table, after finding the overall average score for the eight assignments for each of the groups, the

experimental group scored 8.96% higher overall compared to the control group on the homework assignments.

Table 1

Average Percentage of Scores from Each of the Eight Assignments for Experimental and Control Groups

Assignment	Experimental Group	Control Group	Difference
1	85.00	68.88	16.12
2	62.50	62.63	-0.13
3	61.75	64.27	-2.52
4	71.33	78.86	-7.53
5	75.50	65.44	10.06
6	93.56	94.47	-0.91
7	88.22	46.25	41.97
8	73.39	58.81	14.58
Mean	76.41	67.45	8.96

Table 2 shows the comparison of the two groups' mean scores on the summative unit assessment. To answer the first research question, the control group scored slightly higher than the experimental group by a difference of 1.57%.

Table 2

Mean Score of Summative Unit Assessment for Experimental and Control Groups

Group	Mean
Experimental	79.56
Control	81.13
Overall Difference	-1.57

Research Question Two: Does grading their own homework and correcting their mistakes have an effect on participants' self-efficacy towards mathematics compared to those whose homework is graded and handed back by the teacher?

Experimental group's results. Table 3 displays the ratings each participant in the experimental group reported on each of the six items as well as each of their mean scores on the mathematics self-efficacy Likert-scale survey. Participant 3 had the highest overall reported self-efficacy score with a mean of 5.00 on a 5-point scale. Participant 13 had the lowest overall self-efficacy score with a mean of 3.00 on a 5-point scale. Item 2 on the Likert-scale survey resulted in the highest mean of 4.33. Item 5 on the Likert-scale survey resulted in the lowest mean of 4.00.

Table 3

Experimental Group Scores for Each Item on the Mathematics Self-Efficacy Likert-scale Survey

Participant/Item	1	2	3	4	5	6	Individual Mean
1	4	4	4	3	3	3	3.50
2	4	4	4	5	5	5	4.50
3	5	5	5	5	5	5	5.00
4	4	4	4	4	4	4	4.00
5	5	5	5	4	5	5	4.83
6	5	5	5	5	4	4	4.67
7	4	4	4	4	4	4	4.00
8	3	4	3	4	4	4	3.67
9	4	5	4	4	5	5	4.50
10	5	5	4	5	4	4	4.50
11	4	3	3	4	3	3	3.33
12	4	5	5	4	5	5	4.67
13	4	3	3	3	2	3	3.00
14	5	5	5	5	5	4	4.83
15	5	5	3	5	2	3	3.83
16	5	5	4	4	4	4	4.33
17	4	4	5	4	4	4	4.17
18	3	3	4	4	4	4	3.67
Group Mean	4.28	4.33	4.11	4.22	4.00	4.06	4.20

Note: Items on the survey were rated using a five-point scale.

Control group's results. Table 4 displays the ratings each participant in the control group reported on each of the six items as well as each of their mean scores on the mathematics self-efficacy Likert-scale survey. Participant 30 had the highest overall reported self-efficacy score with a mean of 4.83 on a five-point scale. Participant 26 had the lowest overall self-efficacy score with a mean of 3.00 on a five-point scale. Item 4 on the mathematics self-efficacy Likert-scale survey resulted in the highest mean of 4.25 on a five-point scale. Item 6 on the mathematics self-efficacy Likert-scale survey resulted in the lowest mean of 3.25 on a five-point scale.

Table 4

Control Group Scores for Each Item on the Mathematics Self-Efficacy Likert-scale Survey

Participant/Item	1	2	3	4	5	6	Individual Mean
19	4	3	4	4	4	4	3.83
20	4	4	4	4	4	3	3.83
21	5	5	4	5	5	4	4.67
22	4	4	4	4	4	4	4.00
23	4	4	4	5	5	2	4.00
24	4	3	4	4	4	3	3.67
25	5	4	5	4	5	5	4.67
26	3	3	3	3	3	3	3.00
27	3	3	3	4	3	3	3.17
28	4	4	3	4	3	4	3.67
29	5	4	2	3	3	2	3.17
30	5	5	5	5	5	4	4.83
31	4	4	3	5	5	4	4.17
32	4	4	4	5	5	4	4.33
33	5	4	5	5	5	4	4.67
34	4	4	3	4	4	3	3.67
Group Mean	4.19	3.88	3.44	4.25	4.19	3.25	3.96

Note: Items on the survey were rated using a five-point scale.

Comparison of Experimental and Control Groups' Results. Table 5 shows the comparison of mean scores on each item as well as the overall difference in mean scores of the

experimental group and the control group on the mathematics self-efficacy Likert-scale survey. The experimental group reported the highest mean score for Item 2 at 4.33 and the lowest mean score for Item 5 at 4.00 on a five-point scale on the mathematics self-efficacy Likert-scale survey. The control group reported the highest mean score for Item 4 at 4.25 and the lowest mean score for Item 6 at 3.25 on a five-point scale on the mathematics self-efficacy Likert-scale survey. As seen in the table, to answer the second research question, participants in the experimental group reported an overall higher self-efficacy towards mathematics compared to those in the control group by a difference of .24 points on a five-point scale.

Table 5

Experimental Group and Control Group Mean Scores for Each Item on the Mathematics Self-Efficacy Likert-Survey

Item on Survey	Experimental Group	Control Group	Difference
1	4.28	4.19	0.09
2	4.33	3.88	0.45
3	4.11	3.44	0.67
4	4.22	4.25	-0.03
5	4.00	4.19	-0.19
6	4.06	3.25	0.81
Mean	4.20	3.96	0.24

Note: Items on the survey were rated using a five-point scale.

Further Analysis. The research questions that drove this study were focused on the effect of how homework was graded, either by the students or by the teachers, had on the participants' scores on the summative unit assessments and on their feelings of self-efficacy towards mathematics. Therefore, it is important that we take a closer look at the homework data

specific to these two groups of participants. Precisely, participants 8, 9, and 13 in experimental group attempted only half of the required eight homework assignments throughout the study. In turn, participants 8, 9, and 13 scored very low on the summative unit assessment with scores of 44%, 31%, and 34%, respectively, as seen in Figure 2. Therefore, having not even attempted the homework for 50% of the data, final data from the summative unit assessment and the mathematics self-efficacy Likert-survey from participants 8, 9, and 13 was removed by the researcher under the assumption that they did not complete enough of the homework assignments in order for their results to be valid for the treatment. It should also be noted that only three participants in the control group did not turn in one assignment each: notably, participants 24, 26, and 28. Consequently, their final data was not removed from the control group's mean scores on the summative unit assessment nor on the mathematics self-efficacy Likert-scale survey.

Therefore, Table 6 below shows the adjusted comparison of the two groups' mean scores on the summative unit assessment after removing the scores from participants 8, 9, and 13 in the experimental group's final data. Now, to answer first research question again, the experimental group scored higher than the control group by a difference of 7.20%.

Table 6

Adjusted Mean Score of Summative Unit Assessment for Experimental and Control Groups

Group	Mean
Experimental	88.33
Control	81.13
Overall Difference	7.20

Table 7 shows the adjusted comparison of mean scores on each item as well as the overall difference in mean scores of the experimental group and the control group on the mathematics self-efficacy Likert-scale survey after removing data from participants 8, 9, and 13. Now, the experimental group reported the highest mean score for Items 1 and 2 both at 4.40 and the lowest mean score for Item 5 at 4.07 on a five-point scale on the mathematics self-efficacy Likert-scale survey. The control groups' overall results did not change because no participants were removed from the data. To reiterate, the control group reported the highest mean score for Item 4 at 4.25 and the lowest mean score for Item 6 at 3.25 on a five-point scale on the mathematics self-efficacy Likert-scale survey. Now, to answer the second research question again, participants in the experimental group reported an overall higher self-efficacy towards mathematics compared to those in the control group by a difference of 0.30 points on a five-point scale.

Table 7

Adjusted Experimental Group and Control Group Mean Scores for Each Item on the Mathematics Self-Efficacy Likert-Survey

Item on Survey	Experimental Group	Control Group	Difference
1	4.40	4.19	0.21
2	4.40	3.88	0.52
3	4.27	3.44	0.83
4	4.33	4.25	0.08
5	4.07	4.19	-0.12
6	4.13	3.25	0.88
Mean	4.26	3.96	0.30

Note: Items on the survey were rated using a five-point scale

In total, participants in the experimental group that treated homework as a formative self-assessment, where they graded their own homework and made corrections to their work and answers, scored higher on the summative unit assessment compared to participants in the control group whose homework was graded and handed back by the teacher. Additionally, in sum, participants in the experimental group who graded their own homework and corrected their mistakes reported higher self-efficacy towards mathematics compared to those in the control group whose homework was grade and handed back by the teacher. The overall results show that the mean score for the experimental group participants was 7.20% higher than the mean score of the control group participants and the mean score for the experimental group participants was 0.30 points higher on the five-point Likert-scale survey compared to those in the control group.

Findings, Implications, Limitations

Findings

After adjusting the data for the participants that took advantage of the treatment in the experimental group, positive effects were seen as a result of the study. Based on the data collected during the study, treating homework as a formative self-assessment, where participants graded and corrected their own assignments, had a positive effect on the experimental group's average score on the summative unit assessment compared to the control group's average score. Additionally, the treatment of homework as a formative self-assessment also had a positive effect on the experimental group participants' self-efficacy towards mathematics, again, compared to the participants in the control group.

The first purpose of the study was to determine the effect of treating homework as a formative self-assessment, where participants graded and corrected their own assignments, had

on a summative unit assessment. The research question that drove this purpose focused on the treatment of homework as a formative self-assessment and what effect it had on the participants' average scores on a summative unit assessment compared to those whose homework was graded and handed back by the teacher. The study hypothesized that by treating homework as a formative self-assessment, the participants will take more ownership of their learning which would cause them to have higher average scores on a summative unit assessment than the control group of participants, whose homework assignments were graded by the teacher and handed back. The study concluded, after removing the data of the students that did not do 50% of the homework assignments, the treatment of homework as a formative self-assessment caused the participants in the experimental group to have a higher average score on the summative unit assessment compared to the participants in the control group by 7.20%.

Additionally, the second purpose of the study was to determine the effect of treating homework as a formative self-assessment had on the participants' self-efficacy towards mathematics. The research question that drove this purpose focused on whether participants grading their own homework and correcting their mistakes would have an effect on their self-efficacy towards mathematics compared to those whose homework was graded and handed back by the teacher. The study hypothesized that the participants who graded and corrected their own homework would have higher self-efficacies than those whose homework was graded and handed back by the teacher due to them taking more ownership of their learning. The study concluded, again, after removing the data of the students that did not do 50% of the homework assignments, the treatment of homework as a formative self-assessment caused the participants in the experimental group to report a higher overall average score for their self-efficacy towards

mathematics compared to participants in the control group by 0.30 points on the five-point Likert-scale survey.

Implications

Teachers are always striving to find ways to have their students take more ownership of their learning. At the same time, specifically for any mathematics classroom, homework is a staple due to its positive effect on achievement. On top of that, formative assessments have been shown to improve student achievement as well. Therefore, to make best use of their limited time with their students, teachers can blend the idea of homework and formative assessments together in order for the students to take more control of their learning.

The results of this study showed that for participants in the Algebra I classrooms used in the study, treating homework as a formative self-assessment where participants graded and corrected their homework caused them perform better on the summative unit assessment compared to the participants whose homework was graded and handed back by the teacher. Speculatively, this implies that the students who graded their own homework took more ownership of their learning. This was due to them identifying what problems they missed, figuring out what thought processes resulted in the wrong solution or explanation, and then correcting not only their solution but also their initial incorrect thought process.

To further support the idea that the students who graded and corrected their own homework took more ownership of their learning, the results of this study indicate that those participants felt more confident in their abilities to perform well and more prepared for the summative unit test. In fact, of the six items on the mathematics self-efficacy Likert-survey, the mean scores of the participants in the experimental group were higher than those of the participants in the control group for five of the items. The only mean score that was higher for

the control group was for the item on the survey that asked how participants felt about how the difficulty of the homework prepared them for the difficulty of the test. This could be due to participants in the experimental group feeling like the homework assignments weren't as difficult because they were able to identify their misconceptions on their homework assignments on their own and correct their thinking, work, and answers. Again, if that is indeed the case, this shows that participants in the experimental group took more ownership of their learning. Just by simply shifting how homework is viewed and used in a mathematics classroom, teachers can make an already common practice in the mathematics classroom even more effective.

Limitations

One limitation of the study was that the sample of participants was rather small with only 16 students in the control group and 18 students in the experimental group. Also, another limitation is that the study took place in only one classroom with one teacher. Perhaps a larger sample of students with multiple educators would produce more reliable results. On top of that, a last limitation of the study is that it was conducted with only ninth and tenth graders enrolled in an Algebra I course and covered just one unit of the curriculum. Possibly conducting the study in multiple grade levels such as the middle level grades and other courses such as Geometry and Algebra II would result in a more accurate account of effectiveness as well. Another option to produce more reliable results would be to stay in an Algebra I classroom but extend the time period of the study to a semester or full school year to see what effect of treating homework as a formative self-assessment has on students' success and mathematics self-efficacy.

Reflection and Action Plan

Reflection

Treating homework as a formative self-assessment where participants graded and corrected their homework proved to be an effective strategy to raise student success on a summative unit assessment. Furthermore, the treatment also proved to increase the participants' mathematics self-efficacy. This confirmed what the researcher hypothesized. When conducting the study, the researcher observed that a few of the participants in the experimental group, when presented with the answers to the homework assignments, would often just write down the right answers and not figure out where they went wrong if the problem was more complex. On the other hand, other participants asked many questions and worked with each other to figure out their mistakes and correct them. For participants in the control group, the researcher observed that only highly-motivated students would come into the classroom during their studyhall period or before school to ask for help on the homework and no participants would ask clarifying questions when graded homework assignments were handed back in class.

Despite the differences in student behavior towards grading their own homework in the experimental group, those participants still outscored the participants in the control group on average on the summative unit assessment and reported higher levels of self-efficacy towards mathematics. Therefore, the researcher reflects that perhaps that even if a student just wrote down the right answer instead of figuring out why they got it wrong, just being present in the classroom when other students asked questions still benefited them. Therefore, though more research is needed, the researcher feels comfortable continuing this homework treatment in the future.

Action Plan

As stated previously, the researcher plans to continue to treat homework as a formative self-assessment in her Algebra I course in order to see if similar results of this study will follow. The researcher also plans to present this study at a future mathematics department meeting to share the findings of the study with mathematics colleagues and enlist them to employ the treatment of homework as a formative self-assessment to see if they get similar results to this study as well. The data and findings of the study will be presented to an action research committee at Eastern Illinois University using Power Point slides and a professional poster.

The researcher suggests that more research be done on the treatment of homework as a formative self-assessment. Larger participant samples, multiple grade levels, multiple courses, and a longer study would be beneficial in collecting more reliable data. In the meantime, the researcher will use the knowledge gained from this study to better serve students in the classroom when it comes to more efficient and effective ways to approach homework in her mathematics classroom.

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Appendix A

Name:_____

Algebra I – **Chapter 6 Test**

<u>Solve Systems of Equations Algebraically</u>:

Solve by either SUBSTITUTION or ELIMINATION:

1. $\begin{aligned} 4x + 3y &= 16 \\ 2x - 3y &= 8 \end{aligned}$

2. $\begin{aligned} x + y &= 4 \\ y &= x + 2 \end{aligned}$

1. _____

2. _____

3. $\begin{aligned} 2x + 3y &= 1 \\ 3x - 5y &= -8 \end{aligned}$

4. $\begin{aligned} -x + y &= 5 \\ x + 8 &= y \end{aligned}$

3. _____

4. _____

5. $\begin{aligned} x + 2y &= 1 \\ 5x + 3y &= -23 \end{aligned}$

5. _____

<u>Short Answer</u> Write your answers in complete sentences.

6. After solving problems 1 through 5, first pick a problem and then explain what method you used and why you chose that method.

a) Circle what problem you will refer to: 1 2 3 4 5

b) What method did you use? _____

c) Why did you chose that method?

7. What is the difference between the solution of a system of linear inequalities and the solution of a system of linear equations?

Real-World Application

8. Two hamburgers and three milkshakes cost $12. Four hamburgers and two milkshakes cost $16.

a. Circle the system of equations that correctly represents the situation. Let *h* represent the price of a hamburger and let *m* represent the price of a milkshake.

A. $\begin{aligned} 2h+3m&=16 \\ 4h+2m&=12 \end{aligned}$ **B.** $\begin{aligned} 3h+2m&=16 \\ 2h+4m&=12 \end{aligned}$ **C.** $\begin{aligned} 3h+2m&=11 \\ 2h+4m&=16 \end{aligned}$ **D.** $\begin{aligned} 2h+3m&=12 \\ 4h+2m&=16 \end{aligned}$

b. Solve the chosen system of equations to find the price of one hamburger and the price of one milkshake.

Price of a Hamburger (*h*):_____

Price of a Milkshake (*m*):_____

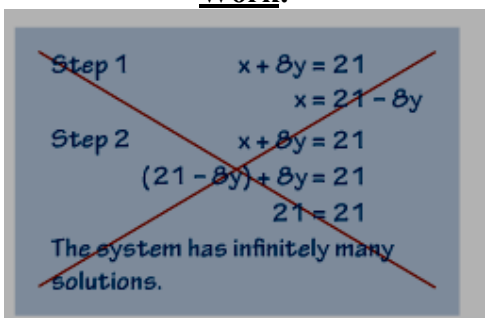
Error Analysis

9. Given the following system of equations, evaluate the work in solving the system by substitution. Circle the mistake and explain your reasoning.

System of Equations:

$$\begin{aligned} 7x+5y&=14 \\ x+8y&=21 \end{aligned}$$

Work:



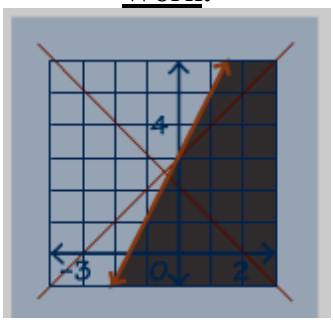
Explanation:

10. Given the following linear inequality, evaluate the work in graphing the inequality. Circle the mistake and explain your reasoning.

System of Equations:

$y \geq 2x + 3$

Work:



Explanation:

Short Answer Write your answers in complete sentences.

11. Explain why the answer to the following system of equations is (0, 2) WITHOUT substituting in the point.

$y = 5x + 2$

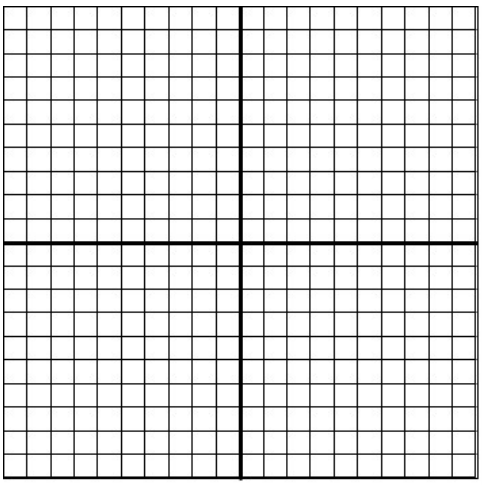
$y = -\frac{1}{2}x + 2$

Graph Systems of Inequalities

Graph:

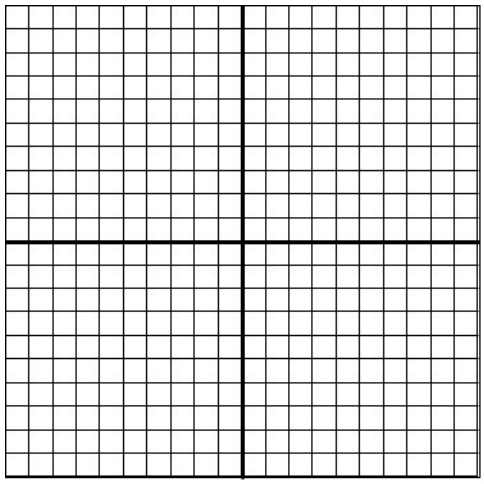
12. $y < 4x + 2$

$y \geq -\frac{1}{3}x + 1$



13. $2x + y > 3$

$y \geq \frac{1}{2}x - 1$



Appendix B

Mathematics Self-Efficacy Survey

Name:_____

Thinking back to today's unit test, please respond to the following:

Question:	**Strongly Disagree**	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**
1. I felt confident in my ability to do well on the test.	1	2	3	4	5
2. I felt prepared for today's unit test.	1	2	3	4	5
3. I was able to recognize and fix my own mistakes as I completed the test.	1	2	3	4	5
4. I felt like the homework prepared me for the test.	1	2	3	4	5
5. I felt like the difficulty of the homework prepared me for the difficulty of the test.	1	2	3	4	5
6. I felt like how homework was graded helped prepare me for the test.	1	2	3	4	5

Appendix C

Erie Community High School
Erie Unit District No. 1
435 Sixth Avenue
Erie, IL 61250

January 10, 2019

To whom it may concern:

I am writing this letter in regards to Haley Hawkins' research project she has proposed. She has my permission to implement the project in her classroom using The Efficacy of Approaching Homework as a Formative Assessment in a High School Mathematics Classroom compared to the method described by the school district's curriculum. I feel that this is an exciting project that is grade level appropriate and will provide good data for the school.

After discussing the project with Haley, I am confident she can complete it in the six week timeline that she presented. Haley will also gain written permission from the legal guardian of each student in her class before starting the project.

If you have any questions for me, please feel free to e-mail me at tmcconnell@ecusd.info or call at 309-659-2239.

Sincerely,

Tim McConnell, Principal
Erie High School

Phone: 309-659-2239 www.ecusd.info Fax: 309-659-2032

Appendix D

January 2019

Dear Parent/Guardian,

I will be conducting an action research project in the classroom this semester as a requirement for my master's degree course at Eastern Illinois University. Students assigned to my classroom will be the participants of the research project. The title of the project is The Efficacy of Approaching Homework as a Formative Assessment in a High School Mathematics Classroom.

During approximately a six week unit, I will be teaching Algebra I in the same manner that I have been all year, however, the approach to homework grading will be slightly altered. In one class, I will collect homework, grade it for accuracy, and hand it back to the students for them to see what they missed. In another class, given the answers to the homework, students will grade their own work and identify their mistakes. At the end of the unit, identical summative tests will be given in order to compare average scores of the two classes to see what kind of effect, if any, the approaches to homework grading had on their mastery of the content. Additionally, the students will be surveyed to see how the approach to homework grading affected their feelings towards math.

The results gathered for the study will be used exclusively for the purpose of this project. All collected data will be confidential and the outcomes presented will not contain any specific identifying information. I have been granted permission from the school administration at Erie High School to conduct this action research project in my classroom this semester. As a parent/guardian of a student in my classroom, it is your right to exclude your child from the study. If this is your wish, please contact me via email or phone using the contact information below.

Please let me know if you have any questions or concerns about the project or your child's participation.

Sincerely,

Haley Hawkins

Haley Hawkins
hhawkins@ecusd.info
309-659-2239

Appendix E

January 29, 2019

Haley Hawkins
Teaching Learning and Foundations

Thank you for submitting the action research protocol titled, "The Efficacy of Approaching Homework as a Formative Assessment in a High School Mathematics Classroom" for review by the Eastern Illinois University Institutional Review Board (IRB). The protocol was reviewed on 1/29/2019 and has been certified that it meets the federal regulations exemption criteria for human subjects research. The protocol has been given the IRB number 19-005. You are approved to proceed with your project.

The classification of this protocol as exempt is valid only for the research activities and subjects described in the above named protocol. IRB policy requires that any proposed changes to this protocol must be reported to, and approved by, the IRB before being implemented. You are also required to inform the IRB immediately of any problems encountered that could adversely affect the health or welfare of the subjects in this study. Please contact me in the event of an emergency. All correspondence should be sent to:

Institutional Review Board
c/o Office of Research and Sponsored Programs
Telephone: 217-581-8576
Fax: 217-581-7181
Email: eiuirb@www.eiu.edu

Thank you for your cooperation, and the best of success with your research.

Holly Pondenis, Compliance Coordinator
Office of Research and Sponsored Programs
Telephone: 581-8576
Email: hcpondenis@eiu.edu