

The Effect Reflective Writing has on Math Comprehension
in Pre-Algebra with Middle School Males

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Abstract

The purpose of this action research study was to determine the effects of reflective writing in a seventh grade Pre-Algebra math class of ten males. The study took place in an Independent School in Baltimore County. Ten males in seventh grade used reflective writing assignments as a learning tool in Pre-Algebra class in the spring of 2019 during a Ratio and Proportion unit. Reflective writing was used twice a week for four weeks with feedback given once a week on the students' writing. A pre-and post-test and a pre-and post-survey quasi-experimental design is used in the study. Results showed the impact of the use of reflective writing to deepen math comprehension.

CHAPTER I

INTRODUCTION

Overview

Seventh grade math prepares students with fundamental concepts for future courses in Pre-Algebra and Algebra. Students expand and deepen their knowledge of rational numbers. Skills of computation, evaluation, estimation, proportions, geometry, statistics, probability, and patterns and functions are explored. This year strongly emphasizes strategies to prove the effects math operations have in order to simplify numbers resulting in the balance of expressions and equations. As educators, our job is to develop thinking and problem solving skills. So many kids shut down if they can't immediately answer a problem or write a single number answer with a single step. A lack of focus leads to little productivity. The practice of linear thinking and organization of thoughts in order solve problems and communication is lost. Students believe they know it all. However, when asked to write down a strategy, or the cause and effect of a math operation, they often respond with 'I know it, but I don't know how to explain it.' Students greatly struggle when math assignments incorporate writing with detail.

Statement of Problem

What are the effects of reflective writing in Pre-Algebra with middle school males?

Hypothesis

The null hypothesis shows there will be no significant difference between math comprehension scores of seventh grade males after they complete consecutive reflective writing assignments on a unit focusing on ratios.

Operational Definitions

Throughout the ratio unit reflective writing will be a tool the students use two days a week. Prior to this writing tool being used in math class, a survey and a pretest will be given to the students. A post unit test will be given and the students will take the same survey at the end of the unit.

Reflective writing in mathematics combines arithmetic and detailed justifications focusing on what numbers represent. To help students frame their thinking, an anchor chart including verbs such as describe, tell, explain, aid students with thought organization. Focused sentence prompts such as, describe a new strategy you learned, tell a math word and explain what it means, describe a mistake you made and what you learned from it, explain how you challenged yourself today, and tell about something you observed today and how it helped you solve a math problem, aid students along a growth mindset path. Providing students with opportunities to self-reflect and transfer their thoughts onto paper is a powerful way to help them understand that their effort must be focused and organized. Once feedback is given, it gives students specific areas they can work on to improve and deepen their knowledge of math relationships and connections.

These writing pieces can be assessed with a rubric that scores four categories with points ranging from 0-3. The categories are as follows:

- 1.) What (Stating the problem)
- 2.) So What (What do you already know that will be important information to use)
- 3.) Now What/Why (What have you been learning in class that you can apply and explain why)
- 4.) Legible handwriting

Twelve points can be earned as classwork/homework points and feedback will be given. The feedback will clear up misunderstanding about a topic or specific skill and create a fluid dialog between teacher – student. These reflective pieces are used a tool to enhance the students learning of a concept because his actions are active and engaging. Instead of absorbing material and working a set of problems, students will be conveying knowledge and discovering connections of the math material. Lastly, with math writing the teacher is able to get an idea of a student's thought process as well as address concerns or deeper frustrations their students may demonstrate.

CHAPTER II

REVIEW OF THE LITERATURE

Overview

Mathematics allows us the ability to logically learn, critically think, and reflectively explore. Learning at a deeper level can be more important than knowledge since knowledge is at ones fingertips, available on the Internet. Making mathematical connections is a continuous journey. Students find these connections a challenge when interpreting math problems. They struggle with the ‘what’, ‘so what’, and ‘now what’ of the problem. They struggle with making sense of the question and the strategies they need to unveil in order to find an answer.

From an Etymology angle, the word mathematics means ‘learning’ in Greek and ‘thinking’ in Hebrew. This angle is quite intriguing. A vehicle to accomplish a deeper understanding of mathematics comprehension is reflective writing (Lew & Schmidt, 2011).

Does reflective writing play a part in mathematical success? Thinking, followed by writing down ideas, is the journey to learning. Writing ideas and math processes down, combines writing and numeracy. The links created when crossing content allow learners to stay focused on the subject they are studying but enables them to practice the skills taught by English and Math teachers (Fuentes, 1998).

Blending writing and math show that students are able to think independently and don’t have to be robotic learners. It also allows teachers to see how supporting reading, writing, communication and math throughout middle school years will lead to examination success but also to success beyond the exam as they are able to see the relevance of aligning multiple content areas and becoming multifaceted thinkers and learners.

In an effort to inform my understanding of how students can deepen their math comprehension, this researcher explored peer reviewed journal articles from experts. This review of the literature presents research focused on areas of math comprehension, forms of reflective writing, and the impact reflective writing has on math comprehension.

Math Comprehension

Placing meaning behind a concept demands a higher level of thinking than executing a procedure. Math comprehension is extremely important. It is pivotal between the difference of a student shutting down and responding ‘I don’t know’, as opposed to ‘What do I know in order to solve this problem.’ Without the ability to identify and analyze, math becomes a hated subject. Alibali, Stephens, Brown, Kao, and Nathan (2014) stated “When a students’ conceptual understanding is lacking, they sometimes misapply procedures learned by rote or generate symbolic expressions that are syntactically incorrect or do not appropriately capture the mathematical relations they wish to express” (p.238). Understanding mathematics is vital to mathematical growth and independent thinking and learning. “Here’s how you can solve the problem” is quite different from “this is what I thought about as I solved the problem”. A final answer does not showcase the body of evidence and strategies that are showcased during problem solving. Exploring the depths of math comprehension through writing creates a powerful path of learning in order to understand and making meaning as opposed to memorize and forget (Yang, 2005).

Reflective Writing

Reflective writing provides a safe way to understand what students feel and learn in math class. Teachers are able to observe the depth of students’ ideas. Communication through writing displays strengths and areas of improvement of student’s knowledge of a math skill (Martin,

2015). Writing provides evidence as well as a portfolio for feedback. Reflective writing is one part of a continuous learning process a student embarks on. Feedback can be given, more practice and additional skills can be applied, and reflective writing is a tool used again and again.

Writing can be a useful catalyst. Writing supplies students with an opportunity to describe their feelings, thinking, and ideas clearly, and also serves as a means of communicating with other people. Writing “about mathematics, such as describing how a problem was solved, also helps students clarify their thinking and develop deeper understanding” (National Council of Teachers of Mathematics, 2000 p. 26).

Mathematical reflective writing is a different way to represent thinking. It is useful because it allows a student time to think and not feel uncomfortable having to participate in oral discussion. Understanding can be expressed on paper with less fear of whether or not an answer shared is correct or not. The body of evidence becomes more meaningful than the answer.

Writing is a process that develops a deeper understanding of mathematics and encourages the use of reflection. Students need to use their own ways to explain what they learn in class. Writing in math can have a very positive effect on learning and a student’s development of number sense, patterns, and relationships. Organizing prior knowledge, current ideas, and combined strategies lead to independent thinking and leads a student beyond just a correct answer. Hiltiwanger and Simpson (2013) promote writing in math education. They believe that “allowing students to write in mathematics class can promote critical thinking, illustrate an awareness of mathematical connections, and result in clear communication as they share ideas comfortably with peers” (p. 492).

Why is Math Comprehension Important?

Math comprehension helps a student unveil what a question is asking by understanding the terminology. To some, math is another language and there is an alignment between language and math skill. Understanding the vocabulary and being able to use the vocabulary to make sense of a problem is the foundation of being engaged in deeper learning.

A solid foundation in mathematics develops the skills of analyzing problems, reasoning with numbers, designing experiments, recognizing patterns, and solving problems successfully. Math comprehension is important because it aids in creating a stronger student who can think and learn creatively and critically, no matter what career path they select.

What does Reflective Writing in Math Look Like?

Reflective writing can take on many forms. Reflective writing encourages students to build on their prior knowledge and make connections that will lead to a rich and complete understanding of mathematics (Brozo & Crain, 2018). Ntenza (2006) investigates a variety of forms of writing. Journal writing is one form that allows learners to write about their feelings, problems, objectives, and suggestions on some of the mathematics topics they have learned. This creates opportunity for students to think, reflect, and formulate logical detailed solutions on paper that creates evidence a teacher can use to provide feedback.

Santos and Semana (2015) viewed multiple types of written representation. Throughout the written tasks, the students gradually included more relational justifications, instead of vague statements, rules, or procedural descriptions. Students' independently combined more skills to make meaning and solve problems. Incorporating drawing and multiple revisions of writing expanded the students' knowledge in a more in depth manner.

How Can Reflective Writing Impact Math Comprehension?

Writing about math concepts can help students see real problem connections. Writing aids students in communicating their thinking in an organized and coherent manner and encourages them to see mathematics as interconnected concepts, helping to make connections between classroom content and real-life situations (National Council of Teachers of Mathematics, 2000).

The art of writing combined with math leads to a rich path of learning. Mathematical writing is not only a good way for students to represent their thinking through pictures, language, or symbols freely and privately, but also a useful channel for students to communicate with each other and their teachers. Reflection helps foster number sense, helps teachers investigate student understanding and feeling about lessons, and gives them a way to formulate their thinking. Extending beyond math concepts, it is important to increase engagement of disengaged students and find strategies to develop meaning for them.

Reflective writing in a mathematics class can impact math comprehension. Consistently incorporating reflective journals in math class promotes learning from a different angle. Students experience math on a deeper level and not just view the subject as memorizing or getting the answer quickly. Students spend time exploring their mathematical thinking, exercise their conceptual understanding, set goals, and use content specific academic language. The reflection reinforces the student's sense of competence and accomplishment while simultaneously helping them recognize their areas of weakness.

Research over the years has confirmed the benefits of using journal writing as a tool for supporting student learning (Harford, 2008). As students communicate new ideas and concepts in their own words and illustrations, they are able to establish personal connections with the content

while creating lasting associations that may be used for new and complex situations and problems.

Summary

Teaching for understanding of concepts and why something works is important in math. This understanding takes practice. Often students pick up math mechanics; however, explaining a concept is more complex. Through the process of reflective writing, students clarify their own understanding of mathematics, communicate more clearly, and make deeper connections with math skills. The process of writing allows for students to organize their ideas and thoughts in a progressive manner. This active practice allows for a robust body of evidence and a succinct answer or conclusion.

CHAPTER III

METHODS

The goal of this research was to determine the effects of reflective writing in a seventh grade Pre-Algebra math class of ten males.

Design

A pre- and post-test and a pre- and post-survey quasi-experimental design is used in the study. The study included a class of ten seventh graders taking Standard Pre-Algebra. The Pre-Algebra book by Holt, Rinehart, Winston was used. Paper and pencil were used throughout the lesson. Reflective writing was used twice a week for four weeks with feedback given once a week on the students' writing. The unit assessment and the survey were created by the teacher for research purposes. The independent variable was the reflective writing instruction. The dependent variables were the students' achievement on the pretest and posttest, as well as the pre-and post-survey responses.

Prior to the pretest, a survey was given with questions ranging in topics of math, writing, and student opinion's towards math and writing. Students decided through selecting with a range of stars if they strongly disagreed, strongly agreed, or felt somewhere in between. After the posttest, the same survey was given. The results of the survey were compared with the first survey the students took prior to the pretest, the reflective writing assignments, the lessons, and the posttest.

Participants

The school in which the study was conducted is a private school near Baltimore, Maryland serving kindergarten through twelfth graders. The school seeks to be an inclusive community where all who come onto campus feel welcomed and embraced. Boys and girls are

separated in the middle and high schools. Approximately 210 males are in the middle school, fifth through eighth grades. The seventh grade class serves 54 students. This study includes 10 students in standard Pre-Algebra. The class has been intact since the beginning of the 2018 school year. The class is of an average ability. All of the students received the same sixth grade curriculum by the same teacher, which included the basic foundations for ratios.

Instrument

The instrument used to measure achievement for all of the participants was an assessment designed by the teacher for the seventh grade standard Pre-Algebra ratios unit.

Procedure

The research was conducted during one math unit of the 2018-2019 school year. The students attended the same school in sixth grade and had the same sixth grade math teacher. The study began on March 28, 2019. The class met between two and four days a week for four weeks. At the beginning of the unit, students completed a math survey. The students also completed a pre-assessment that encompassed all of the skills in the unit. The assessment consisted of 18 questions. Some of the items required students to show their work and explain their answers through constructed response questions.

Every lesson was taught using teacher created worksheets, the textbook, white board exercises, reflective writing prompts, classroom discussion, and an overhead projector so that the students could take notes modeled by the teacher. If students are struggling in class, the teacher has the opportunity to spend one-on-one time during class because of the overall smaller class size.

At the end of the unit, students completed a post-assessment that was identical to the pre-assessment. The students ended the unit with an identical survey. The results of the mathematics

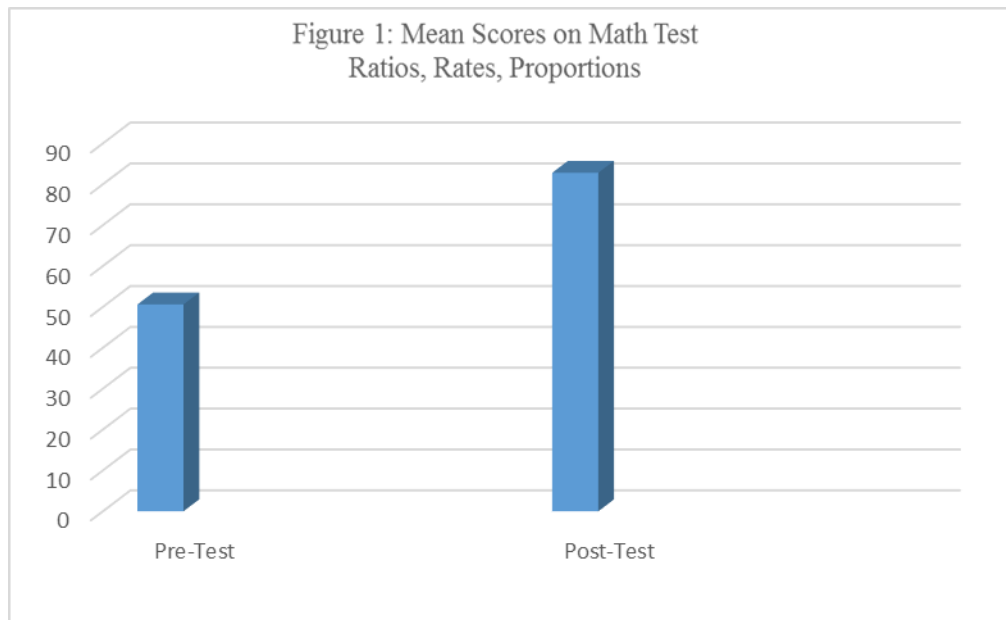
pre-assessment and post- assessment for both the experimental and control groups were collected and analyzed by the researcher. The survey was analyzed as well.

The paired t -test was used to measure the amount of change from pre-to-post for each dependent variable, since the design was one-group pre-and-post. The null hypothesis was that despite sample pre-to-post changes, there was no change in the population mean from pre-to-post. The customary .05 level of significance was used as the threshold to determine if the null hypothesis could be rejected. Due to the small sample size that limited the power of the statistical test to detect a true population pre-to-post change, effect sizes were also calculated. Effect size measures the amount of standardized change regardless of sample size and can assess the strength of the treatment that may be masked by the sample size.

CHAPTER IV

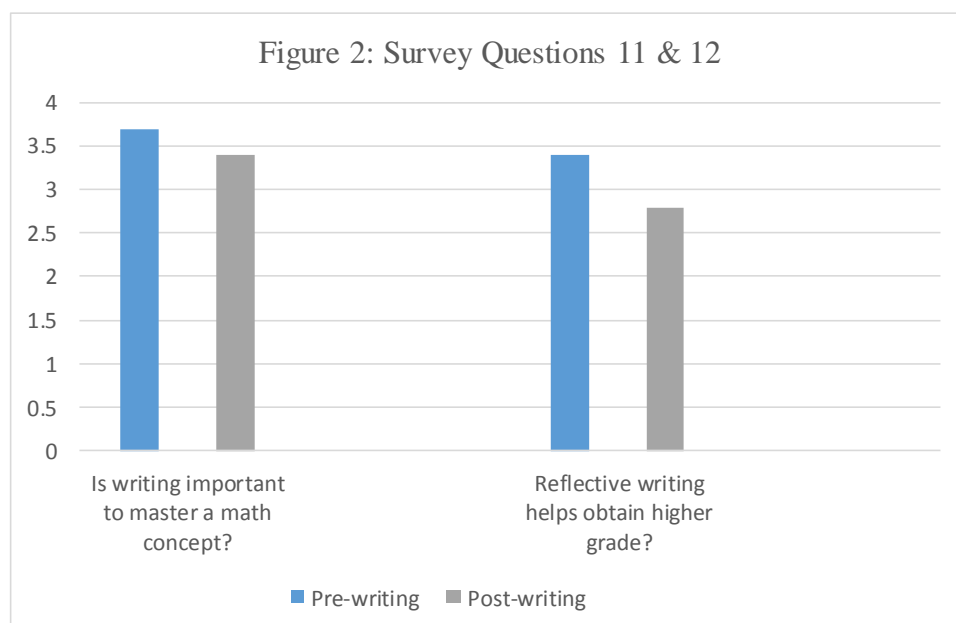
RESULTS

This study examined the effect of reflective writing on math achievement. A seventh grade Pre-Algebra class of 10 males incorporated reflective writing assignments for approximately twice a week for four weeks. Achievement was assessed using a pre- and post-test. The researcher found a significant difference between the pre- and post-test overall mean scores. Figure 1 provides a graph of the overall mean scores for pre- and post-test data. According to the analysis, the mean score for the math pre-test was 50.600 which significantly increased to 82.800, $t(10) = -7.76$ $p < 0.0001$. The t-test is negative only because the post was subtracted from the pre.



On average math test scores increased by a statistically significant amount from pre to post. The 32.2 point gain translated to an effect size of “huge” on a scale of none, very small, small, medium, large, very large, and huge.

In addition to the pre- and post-test, the same 10 students completed a survey, before and after, the exercise of writing in the unit. The surveys were identical. Question 11, in the survey, displayed the students opinion of the importance of believing writing in math class, explaining a problem with words, correct math vocabulary, numbers, and symbols is important to master a concept at a deeper level. The average response to survey item 11 declined from 3.7 to 3.4 on a 5-point scale of strongly disagree (1) to strongly agree (5). The loss, however, was not statistically significant at the .05 level. The effect size was 0.24 in the category of “small”. Question 12, in the survey, displayed the students opinion of believing reflective writing in math class helps obtain higher grades. The average response to survey item 12 declined from 3.4 to 2.8 on a 5-point scale of strongly disagree (1) to strongly agree (5). The drop between pre- and post was not statistically significant at the .05 level. The effect size was 0.34 “small”. Figure 2 provides a graph of survey items 11 and 12. Since there were 10 students responding to a 5-point scale, tabulating the frequencies of the scales 1, 2, 3, 4, 5 was not a feasible way to analyze the data. Hence the t-test compared pre and post mean responses to the survey items by the 10



students.

Lastly, mean scores on the 8 Reflective Writing Tasks, were analyzed. On average, reflective writing scores reached the mid nines by task3, declined to the mid sevens by task 5, and increased to the high elevens by the final task 8. The growth from task 1 to task 8 was 2.8 points, which was borderline significance ($p=.0569$). The effect size was .69 in the medium category. The lack of statistical significance was largely due, therefore, to the small sample of 10 students rather than to a weak treatment effect. Table 1 outlines the data.

Table 1.
Mean Scores on the Reflective Writing Tasks 1 through 8

Writing Task	Mean Score (out of 12)
1	9.10
2	9.85
3	9.45
4	8.40
5	7.65
6	8.55
7	8.70
8	11.90
Total	73.60

All students showed significant improvement between the Pre- and Post-Test. Hence the null hypothesis of no significant difference between math comprehension scores of seventh grade males after they complete consecutive reflective writing assignments on a unit focusing on ratios was rejected at the 5% level of significance.

CHAPTER V

DISCUSSION

The null hypothesis stating there will be no significant difference between math comprehension scores of seventh grade males after they complete consecutive reflective writing assignments on a unit focusing on ratios was rejected. A seventh grade Pre-Algebra class of ten males incorporated reflective writing assignments for twice a week for four weeks. There was significant positive improvement between pre-and post-test scores. Reflective writing was used as a tool with feedback, in the unit of Ratios and Proportions in order to have students align vocabulary and skills and gain more meaning within a unit.

Implications of Results

In this study, there was significant positive improvement on assessment scores from the beginning of the Ratio unit compared to completion of the Ratio unit. Twice a week for four weeks, reflective writing was used as a learning tool to enhance math comprehension. A significant increase in all assessment scores was noted as compared to the scores of the pre-test. Thus, the null hypothesis that there would be no significant difference between pre-and post-test after they complete reflective writing assignments was rejected. The use of this writing tool in math class appeared to impact all of the students. It is reasonable to assume that students learning by incorporating a writing tool in math class to increase math comprehension will have increased assessment scores if they practice math vocabulary and making skill connections with reflective writing assignments.

Theoretical Consequences

This study supports the theory that reflective writing in math improve students understanding of math. Students often quickly work through math problems in their heads.

Middle school boys want to have a single number answer to write on paper and don't want to take the time to think about a math process, steps, justification, or labels. Researchers, such as Schoenfeld (1992) have studied math students and what makes for successful problem solvers. His research has focused on thinking, teaching, and learning. Students are more engaged in their learning if they take the time and think about process, reflect, and write in order to make connections to prior knowledge before moving forward. When students can make sense of vocabulary and use resources and tools available to enhance their learning, they spend more time digging deeper with their understanding of math. Previous research has indicated that students that use these tools find success. In the current study, students were given writing prompts in class and asked to describe, explain, connect, or justify Ratio and Proportion questions. The students practice these writing pieces twice a week for four weeks. These results support the theory that a reflective cognitive writing strategy is an impactful learning tool.

Threats to Validity

This experiment has several threats to validity that may have affected the results; specifically, sample size and characteristics. The study sample was small and convenient. A class of ten seventh grade middle school males participated. The ten males had a preexisting relationship with the researcher because the researcher was their current teacher for all and advisor and coach for a few of the students at the independent school. The sample leaned toward a homogeneous group of males.

Another threat to validity was prior opinion and experience in writing. Motivation to write in math class came naturally to some students and not to others. It was noticeable of the students who were open to freely brainstorm and write compared to those that disliked writing. Also, the researcher set the prompt each time, instead of having the students select from a variety

of prompts per writing assignment. Perhaps choices would have generated more interest from some of the males. Time was also a factor because reflective writing is a tool that could be used all year in a content area and this tool was only used eight times.

The researcher created and scored the assessments, created and scored the writing prompts, instructed the students, and gave feedback. There is a chance that the researcher could have unconsciously been manipulating the experiment during the experiment because she was hoping for a certain outcome. Also, there is no statistical validity or reliability data for the measures. The researcher determined the authenticity of the measures' content informally.

Lastly, because there was a pre-and post-test and reflective writing assignments with only one group, this design didn't allow for comparisons relative to a control group. It is not true to state that positive effects from pre-to post-tests were caused only by the treatment.

Relationship to Similar Research

Prior to this action research study, other studies have revealed concepts that implemented reflective writing tools in math to study the effects of learning. Positive influence in learning was a result of correctly using the consistent exercise of reflective writing pieces. Components of this experiment are very similar to the study performed by Bixby (2018). Bixby began regularly incorporating writing into his math classes. His findings are desirable and note that there is a benefit to the students as well as the teachers. He states, "I have seen how math writing tasks require my students to go deeper with the mathematical content and build their metacognitive abilities. At the same time, as a teacher, I have realized that I can learn more about my students' reasoning from these tasks than from any other tasks we do (p.146)".

Bixby's study (2018) had students use journals to work through the process of math problems. The relevance of this exercise is so that the student has to explain and show how to

solve different parts of a problem, make connections to other math concepts, and clearly approach the problem correctly using math vocabulary and express mathematical thinking and argumentation. This task of writing helps with avoiding a single number answer and becomes a road map and guide to thinking as opposed to leaving a blank paper for some students. Another math researcher, Pugalee (1998), comments on how after reading a student's writing, the teacher has a better understanding of what and how a student is thinking as well as that student's mathematical knowledge. The teacher can more effectively give the student helpful feedback and clear up misunderstood information in a positive manner. Bixby (2018) found that it is important to use writing in math class throughout the academic year. It is a skill that needs to be practiced. He found that using a rubric with scores of 1's and 2's in different categories was effective in order to give productive feedback.

Other researchers, such as Haltiwanger and Simpson (2013), have incorporated writing in their math class for many years. Connections between mathematical topics and real-life situations were gained and students' improved critical thinking skills and practice clear communication skills. With journal writing students have the ability and feedback to rise to the level of expectations that improved their comprehension.

Implications for Future Research

Results from this study showed that a statistically significant increase between pre-and post-assessment grades is likely one of the effects of incorporating reflective writing as a tool for deeper learning of Ratios and Proportions. An educator is a facilitator that is able to use different tools to help engage the students and have them develop meaning of content. Instruction should expand beyond direct instruction and an isolated topic. Students learn from a variety of tools in the classroom and ways to explore in order to self-discover and have the inner motivation to seek

more knowledge. With writing in math, students also need a lot of guided practice in order to effectively use this tool to enhance math depth.

Future research would benefit from using the entire academic year to research one topic. Also, applying the treatment to the entire seventh grade that includes three levels of math, and not just one class would provide more comprehensive data. Additionally, more practice with reflective writing in earlier years of math and not just in English and Advisory programs would be beneficial, more natural, and lead to less questioning from students of why do we have to write in math class? Incorporating a control or contrast group into the research design would provide a better gauge of the treatment effects. Assessing the validity and reliability of the outcome measures could lead to more precise instruments.

The researcher would be interested in studying the relationship between the emotions of writing to math comprehension.

Conclusion

This study provided significant evidence that reflective writing in math led to a significant increase in post-test scores. Although there were many threats to validity with the study and the results could have significant biases, study findings and researcher observations support reflective writing in math to increase math comprehension. It is imperative that students feel comfortable with brainstorming prior knowledge, make meaning of current knowledge, and incorporate strategies to engage and motivate new ideas. Through writing, the researcher learned that even though not all students enjoyed writing in math and shared in their pieces that they didn't enjoy it, all of the students created an exciting reflective writing question that the researcher could use for her upcoming seventh grade males in the 2019-2020 academic year.

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