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Incorporating Literacy Strategies in High School Courses: Implications for Implementing Common Core Standards

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Abstract

With increased attention to critical thinking and problem solving required by the Common Core State Standards, secondary math teachers face challenges in regards to integrating literacy skills into the math curriculum. Without an infusion of literacy skills students will be unable to handle the conceptual requirements mandated by the new standards. The study will apply two different literacy strategies in a mathematics secondary classroom setting in which students will be surveyed in order to see if they found the literacy strategies effective in helping them communicate their mathematical ideas both orally and written. The study will attempt to ascertain what considerations high school math teachers have in regards to incorporating literacy strategies in secondary classrooms.

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Chapter One: Introduction

Literacy across the curriculum has always been an important controversy in education because not everyone agrees that literacy needs to be taught in every content area. In the 1990's there was strong advocacy for literacy instruction in all content areas (Braselton and Decker 1994). It has continued to become a more prominent idea as the new Common Core standards have begun to transition into classrooms, specifically in mathematics classes. The problem mathematics teachers face is a lack of support and professional development involving specific literacy strategies for mathematics. Friedland, McMillen, and del Prado Hill (2011) claim that in order to get mathematics teachers to buy into the idea of literacy they must learn to collaborate with literacy coaches and increase their motivation and engagement about literacy instruction.

This problem occurs throughout our nation, and we continue to see the lack of support and quick implementation of mathematical literacy without proper training. This problem has plagued educators since the 1990s; Braselton and Decker (1994) discussed the fact that some of the mathematics texts are often one, two, and sometimes even three years above the intended population's reading level. Now not only do students have to be able to interpret these texts, but they are now required to justify and prove that their thinking is correct or explain why someone else's work is incorrect (National Governors Association, 2010).

For me personally, I grew up as an English learner with Spanish being my first language. To me literacy was in every subject, however, most of my teachers did not realize that there were strategies they could have employed to help me be more successful in the subjects they taught. Knowing the effect it had on me as a learner has made me more sensitive to the need to imbed literacy in my instruction at all times. I am always looking for ways to help my students be more successful in math. Moreover, the Common Core State Standards are now asking for students to

communicate their ideas in writing and for them to make sense of more applicable problems to the real world. Simple answers on a multiple choice test no longer indicate the problem solving students will need to compete in the 21st century. Therefore, my aim, emanating from my personal experience and expertise, is to create or implement literacy strategies that could help my fellow math teachers successfully implement common core standards.

Problem Statement

The review of the literature revealed that there is a lack of teacher participation in the implementation of literacy strategies because there is a need for more specific strategies for mathematics classes. According to Shanahan (2008) high school content area teachers were reluctant in embracing the idea of literacy instruction for content area disciplines. The research also suggests that teacher education programs need to specifically target literacy across beginning teachers' content areas. If teachers are not fully trained to implement literacy in their content areas, then the students suffer and do not receive the education necessary to succeed and communicate in the workforce. This is especially true for mathematics. Therefore, there is a need to investigate some strategies that would be helpful in a secondary classroom when it comes to the new implementation of Common Core. There is also a need to research reasons why mathematics teachers are hesitant to implement strategies.

Purpose of the Study

The primary purpose of this study is to examine the literacy strategies that would be most effective in supporting implementation of the Mathematics Common Core Standards. The intent is to help students: (a) develop deeper understanding of the content, (b) give students' stronger reading, writing, and speaking skills, and (c) correctly utilize mathematical vocabulary. The Common Core standards are having students communicate their thoughts, ideas and use

evidence. These strategies will be very important transitioning into Common Core standards and hopefully will have a significant impact on new assessments.

A secondary reason for this line of research is to ascertain the emotional component related to the inclusion of literacy strategies in secondary math classrooms. Although secondary math teachers realize that to ensure robust instruction commensurate with the implementation of the Common Core standards, infusing literacy strategies is imperative, they may lack confidence and the skills to incorporate said strategies. Are they afraid? Do they feel it takes too much time? Whatever the reason may be I want to find out why this is and what we can do to convince more teachers that incorporating literacy in math class will help our students in the long run and will help them become more successful in math and in other subject areas as well.

Research Questions

1. What literacy strategies can best support with the transition of the Common Core state standards?
2. What considerations do high school math teachers have in regards to incorporating literacy strategies in their courses?

Theoretical Model

According to Draper (2002) since the 1940's literacy instruction across the curriculum has been a primary focus in educational research and application in education. Consequently, it has been a controversial subject among educators in all content areas, especially mathematics. As a result, constructivist theories began to reform the way mathematics education was taught; and they continue to be prominent influences today. Constructivist theories assert that new the learning is based on prior knowledge and the experience of the learner. These theories stem from

the work of Vygotsky (1962) and Wittgenstein and have been a dominant presence in mathematics education ever since (Ernest, 1994).

As with Vygotsky's theory, Jerome Bruner (1960) began to develop an important concept of scaffolding for instruction. Meanwhile, others criticized the behaviorist approach that were being used in education because this approach was believed to be too narrow and isolated (Mayer, 1996). Ausubel (1960) and von Glaserfeld (1992) were also advocates for "discovery learning" in which teachers create a problem-solving environment that allows students to question and explore their ideas.

The theory of cognitive constructivism is believed to have come from the work of Piaget (1959). Piaget believed that children from infancy are always engaged of making sense of their surroundings. Piaget's idea realizes that humans are not just meant to input information into their brains and regurgitate that information back out. This idea gave educators new roles that did not require them to feed information into student's brains. The role of the teacher now became to facilitate learning and conversations about mathematics. Teaching should be about allowing the learners the wonder of discovering the knowledge themselves (Hopkins, 2010).

Literacy instruction in the mathematics secondary classroom ties into these theories because literacy allows students to think and communicate their ideas and then justify to one another what they are thinking. This process is a step in the discovery learning process where students are able to learn from their experience by bringing in their own ideas from previous knowledge that they have acquired and using them in order to create new ideas and build the knowledge on their own. This is a key idea of the common core standards; the foundation of the common core standards is to enable students to be able to cite evidence, analyze situations, and compare ideas. Without literacy and the discovery process, these things will not be easy for

students to accomplish. Therefore, mathematics instructors need to be willing to implement these ideas and theories in order to help prepare students for the rigorous demands of the common core standards.

Researcher Background

As a fourth year secondary mathematics instructor, the transition to Common Core has been a tough one for me and my colleagues and we have experienced many challenges, but we have also had some successes as we have moved forward. As I mentioned before, I grew up as an English learner with my first language being Spanish. I began a bilingual education where I slowly became immersed into an all-English class in the 4th grade. For me, literacy was always a part of every single subject area that I studied growing up. As an English learner I learned very quickly that I needed to figure out how to communicate my ideas in a way that everyone would understand me; not only because I had a language barrier but because I was a student who always wanted to be clear and thoughtful towards all the ideas that I was sharing with my peers, I wanted them to see clearly what I was thinking and for them to know that I also had something to bring to the table even though my first language was Spanish.

As I was going through my undergraduate education in mathematics I realized that I wanted to work with English learners and wanted to focus on having them be able to express themselves in a mathematics class because that's always what I had trouble with growing up. I was always very intelligent and finally when I learned more English and learned how to communicate I was able to flourish in mathematics. I want not only my English learners, but all my students to know that they are capable of having great mathematical ideas and that they should share the different ways that they are seeing the problems.

The beauty of the Common Core State Standards is that it is having students read problems, make sense of them in their own ways and explain their mathematical thinking. The problem we face as educators is that sometimes students do not have the skills to decode what the problem is asking them to do and it is also hard for them to show why their reasoning works in the particular problem. Having said that, the goal is to find some strategies that will be helpful for my English learners but also for my English only students. In the end, CCSS is asking that all of our students have the skills to persevere in problems, and explain their mathematical ideas using different models and by writing out their ideas. Lastly, I am investigating this because there are so many teachers that are hesitant about the CCSS and I want to be able to share some ideas that might help them be more open to the CCSS.

Definition of Terms

- **Common Core State Standards (CCSS):** The Common Core is a set of high-quality academic standards in mathematics and English language arts/literacy (ELA). These learning goals outline what a student should know and be able to do at the end of each grade. The standards were created to ensure that all students graduate from high school with the skills and knowledge necessary to succeed in college, career, and life, regardless of where they live.
- **Discovery Learning:** This is an inquiry-based approach that has the learner draw from their own experiences and existing knowledge in order to discover facts and relationships and new truths to be learned. Students explore and interact with objects and manipulate them along with wrestling with questions and controversies.
- **Eight Mathematical Practices:** The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in

their students. These practices rest on important "processes and proficiencies" with longstanding importance in mathematics education. The 8 mathematical practices are as followed: 1) Make sense of problems and persevere in solving them, 2) Reason abstractly and quantitatively, 3) Construct viable arguments and critique reasoning of others, 4) Model with mathematics, 5) Use appropriate tools strategically, 6) Attend to precision, 7) Look for and make use of structure, 8) Look for and express regularity in repeated reasoning.

- **English Learner (EL):** This is a student who is learning the English language along with knowing another language that is native to them.
- **English only (EO):** This is a student who only speaks the English language.
- **Integrated Mathematics:** This means that in a mathematics course it is integrating many topics and/or strands of mathematics throughout the year. Each math course will cover topics in algebra, geometry, trigonometry and analysis.
- **KWL:** This K-W-L Chart, which tracks what a student knows (K), wants to know (W), and has learned (L) about a topic, can be used before, during, and after research projects.
- **Literacy Instruction:** This goes beyond just teaching the content area, it is more about how students are learning. The ultimate goal of literacy instruction for me is that I want my students to build comprehension, articulate their thought processes in writing and also be able to orally communicate their mathematical ideas using correct vocabulary and ideas.
- **Literacy Standards for Common Core:** The standards establish guidelines for English language arts (ELA) as well as for literacy in history/social studies, science, and technical subjects. Because students must learn to read, write, speak, listen, and use language

effectively in a variety of content areas, the standards promote the literacy skills and concepts required for college and career readiness in multiple disciplines.

- **No Child Left Behind:** The federal No Child Left Behind (NCLB) Act of 2001 aims to bring all students up to the proficient level on state tests by the 2013-2014 school year, and to hold states and schools more accountable for results. NCLB requires all districts and schools receiving Title I funds to meet state "adequate yearly progress" (AYP) goals for their total student populations and for specific demographic subgroups, including major ethnic/racial groups, economically disadvantaged students, limited English proficient (LEP) students, and students with disabilities.
- **Think- Write- Pair- Share:** This strategy incorporates writing into the thinking process. As students think about the question, they also write their response to the question using a variety of techniques: webbing, words, pictures, numbers, and examples. Teachers might start with a prompt poster that students can use for reference when they don't know where to start.

Chapter Two: Literature Review

Introduction

The importance of embedding literacy strategies in mathematics instruction has recently taken a more prominent role because of the new Common Core Standards. The question presented here is: Are there any effective literacy strategies that can be incorporated into the communicating part of the common core standards for Mathematics? Specifically, how will these effective strategies help students be successful with the 8 mathematical practices of the Common Core Standards? Through the years, there have been differing points of view on this topic has shown that the most common reasons that mathematics instructors have trouble implementing literacy are: the lack of specific literacy strategies for mathematics (Adams, 2003), the lack of teacher buy-in and need for collaboration (Draper, 2008), and the fact that teachers are not trained in pre-service and credential programs to incorporate literacy into their content areas (Friedland, McMillen & del Prado Hill, 2011).

Researchers like Draper (2002) and Adams (2003) have found that incorporating literacy into mathematics will help students develop a deeper understanding of the content, give students' stronger reading, writing and speaking skills and they will be able to better utilize the vocabulary that is involved in mathematics. Regardless, too few mathematics teachers have been implementing literacy strategies and there has been a problem with teachers buying into the idea that literacy will help bring student understanding. The purpose of this literature review will be to (a) give a list of suggested effective literacy strategies for a mathematics class, (b) talk about the need for collaboration amongst literacy and mathematics teachers, and (c) discuss the need to train pre service teachers to incorporate literacy into their content area.

Mathematical Literacy Strategies

In the 1990's there was a huge push for literacy instruction in all content areas, Braselton and Decker (1994) discuss the idea that the reading level of mathematics texts are often one, two, and sometimes even three years above the intended population's reading level. According to their research, reading teachers were more successful at teaching students to solve word problems than mathematics teachers (Braselton & Decker, 1994). A strategy that the authors proposed was the use of graphic organizers to improve the reading of mathematics. In order for students to effectively use the graphic organizers, the teacher must model it using a "Think aloud" model in which the teachers show the students how the graphic organizer is used with a word problem. Once this process is done the students will then begin to use this systematic approach to solving word problems, in which the students will benefit from.

Braselton and Decker (1994) also presented student samples in which they claim that the students were required to slow down and think through the problem and it gave them a deeper understanding of the concept. Since the specific student sample is unknown, and the student population/demographics is also unknown it is hard to decide if the graphic organizer will work for all students; therefore this is an important aspect to think about as the literacy strategies are being presented throughout this literature review.

That being the case, another strategy found in the research is the use of an iteration of the K-W-L chart where four steps are introduced in order to help with problem solving: (a) gathering the information and understanding the problem, (b) create a plan connecting previous learned strategies, (c) carry out the plan and lastly, (d) look back and determine whether the answer is reasonable and consider other ways to solve the problem. Friedland, McMillen and del Prado Hill (2011) noted that mathematics educators would not likely include this reference as a

strategy, therefore when researching the K-W-L model it would not be found under a literacy strategy (Friedland, McMillen & del Prado Hill, 2011). However, there is a lack of agreement when it comes to the definition of a literacy strategy, this is another debate in itself, this will be discussed later on a different section. By way of contrast, this famous four-step problem solving process created by George Polya (1945) is also mentioned in other research involving reading strategies in mathematics and it is a prominent idea in mathematics education.

As literacy in mathematics continues to be a problem for both teachers and students, Adams (2003) discusses the fact that mathematicians limit the amount of reading mathematics to the following: (a) reading biographies of mathematicians, (b) the history of mathematics, and (c) reading mathematics word problems with real life contexts. Adams discusses that reading mathematics requires the reader to acquire comprehension and mathematical understanding and gain proficiency through reading of numerals, symbols, and words.

Adams also claims that the reader must develop meaningful, correct, and applicable definitions of mathematical terms (Adams, 2003). This strategy will help the reader understand and demonstrate the understanding of the formal definitions, which is key in justifying and proving mathematics. Adams also discusses the use of journal writing prompts to develop understanding of words that have homophonic partners. She claims this technique to be effective because it gives students a way to process and write down their ideas; again Polya's problem solving strategy is mentioned in this article as being an effective literacy strategy to be used in mathematics classes which goes back to the question, can we call the four-step problem solving strategy a literacy strategy? As has been mentioned, Polya is well known for this idea and this strategy is one that is well known and utilized in mathematics education.

One key finding is that although there are many examples of literacy instruction in mathematics there are very few articles that are based on evidence. The ideas brought by Dougherty (1996) are of using journal writing in a first year algebra class. Most of the research gathered states that journal writing is an effective literacy strategy for a mathematics class. Additionally, Dougherty (1996) states that writing will force the students to think more deeply because there is a need for more oral communication in class. Dougherty (1996) also claims that writing creates context in which students have to integrate algebraic concepts in order to communicate their ideas more clearly.

Dougherty (1996) believes that writing in mathematics is a part of the process of learning, teaching, evaluating, and assessing. Students are able to analyze their arguments, compare and contrast ideas, and synthesize information from tasks that involve the writing to form their ideas (Dougherty, 1996). In fact, CCSS Math Practice #3 says that students will construct viable arguments and critique the reasoning of others, which is what Dougherty (1996) claims journal writing will help students do. Using the writing tasks will help give students the time to reflect before they are to share their ideas with the class, therefore enhancing the class discussions because they have had time to think about a mathematical concept and vocabulary. This technique is widely used in mathematics and other content areas as something that is known as a "Think-Write-Pair-Share" in which students write their ideas down before trying to engage in discussion. Dougherty (1996) has also emphasized the idea that the journal prompts given to students have multiple solutions and multiple approaches. This idea encourages students to use their own problem solving strategies and allows them to defend their positions and encourages multiple solution strategies. As a final point, Dougherty (1996) gave a few student samples but did not emphasize what types of students who wrote the samples, or how large her sample size

was in general. Although there are many strategies and ideas being presented there is a lack of evidence in the research, which is one of the themes found in the research concerning mathematical literacy. As presented in the next example, there are ideas that could be implemented into secondary education but there is a lack of evidence to support that the strategy is easily implemented into all mathematics classes.

Cara and Pamela Halpern (2006) present the idea of using creative writing and literature in mathematics classes. They claim that there is evidence on how and why to introduce literature into elementary mathematics education but that there is a lack of use of literature in secondary mathematics education. Halpern (2006) expresses that in her first year of teaching her goal was to branch out beyond the traditional materials; the idea was for students to create stories in which they would be introduced to mathematical concepts and would help them learn and understand the vocabulary for the particular math concepts that were being addressed (Halpern & Halpern, 2006). Again, this is a strategy that only was used in her mathematics class and although there is a student sample, which clearly shows comprehension of the concepts; the article also has examples of stories that were created from students who clearly did not understand the concepts. Halpern (2006) also discussed that although the student created an incorrect story and misunderstood a concept she was now able to use this as an assessment tool and reteach the concept to the students who had the misconceptions. This is an effective way of using the strategy that was implemented in order to generate more student understanding of the concept. As these strategies are presented one must begin to look at the principles for using reading strategies (Davis & Gerber, 1994).

According to Davis and Gerber (1994), using reading strategies in mathematics classes can help students understand mathematical concepts, which is the overarching theme amongst

the research. Humans process information by using language as they read, speak, write, and listen (Davis & Gerber, 1994). They claim that although mathematics relies on symbolic language that both teachers and students prefer using symbolic language versus written language in order to express their ideas and thinking. In order for secondary mathematics teachers to begin to incorporate strategies they need specific guidelines to follow, therefore, Davis and Gerber (1994) introduce five main principles for teachers to follow: (a) determining students' prior knowledge, (b) helping students organize information before and during reading, (c) students processing the text further after reading it and applying it to mathematical problems, (d) students discussing and writing about the content, and lastly (e) using the new learning to create information. These are all strategies that have been talked about in the research that was discussed in this literature review. Furthermore, these principles are based on the idea that we must first determine what background knowledge students have, give students organizational strategies, have students process their ideas and apply it to mathematical concepts, have students discuss and write, and finally students creating new information from the information that they gathered. Above all, these basic principles are the core of what the research provides when it comes to literacy instruction in mathematics classes. Unfortunately, there are many studies that indicate literacy strategies were not effectively being used in science and mathematics classes.

By way of contrast, Adams and Pegg (2012) studied the importance of attending to various ways in which teachers enact these strategies. These authors studied 26 teachers in the field of science and mathematics; they studied the enactment of content area literacy over the period of two years. The authors summarized the patterns that were found amongst these teachers using the Frayer model and Anticipation guide. The Frayer model is a way in which students write vocabulary words in a graphic organizer and have definitions, characteristics,

examples and non-examples of those specific vocabulary words. The Anticipation guide is used in order to help students to thoughtfully read and interpret the text that is presented to them. Although the teachers were using the strategies described, they were not using them correctly. A key finding was that they found two different patterns amongst these teachers. The first pattern was termed the Rehearsal pattern and the second was the Reorganization pattern. These patterns are most effective when used in conjunction with collaboration.

Collaboration

Literacy and Mathematics Teachers must work together.

Adams and Pegg (2012) discuss that literacy strategies were seldom used in secondary mathematics classes. The study they were involved in as summarized above involved 26 mathematics and science teachers and what they found was that the teachers in the study were merely using the strategies and were not emphasizing the deeper understanding of the concepts while using the Frayer Model and Anticipation guides. The patterns they found were termed the Rehearsal pattern and the Reorganization pattern; the Rehearsal pattern meant that the teachers were primarily using the literacy strategies to revisit and rehearse the content whereas the Reorganization pattern meant that teachers were incorporating literacy strategies with the goal of supporting students in developing deeper conceptual understanding, this supports students in reorganizing their conceptual knowledge to include new understandings that come from the specific learning activities. Those teachers that were observed having the Rehearsal pattern were said to have been influenced by: (a) prior teaching practices, (b) teachers' learning goals for their students, and (c) pressures from limited classroom time (Adams & Pegg 2012). Although these teachers worked together for two years and went to professional development to help them

integrate literacy strategies in their classes many of them did in fact found themselves using the Rehearsal pattern.

Friedland, McMillen and del Prado Hill (2011) found that high school content area teachers working together with literacy specialists in order to learn to integrate literacy strategies has a positive impact on long-term collaboration. The research they found was that in order to facilitate student learning of literacy integration into mathematics, the mathematics and literacy teachers must collaborate in order to help each other become aware of each other's goals (Friedland, McMillen & del Prado Hill 2011) The ongoing problem is that there is a lack of agreement when it comes to definitions and coming up with the goals for students, both involving content and literacy. The authors examine the fact that without explicit suggestions regarding implementation, a literacy teacher may not know the mathematical concepts therefore they would not be helpful in guiding the mathematics teacher to implement literacy strategies effectively.

Draper (2008) discusses her professional journey as a content-area literacy teacher educator and how she later began to collaborate with a group of teachers in which her own understanding of her role and definitions of content area literacy began to change. Draper suggests that there should be an increase in collaboration between literacy and content-area specialists. Just as Friedland, McMillen and del Prado Hill (2011) discovered Draper (2008) agrees that the increase in collaboration with literacy and mathematics or any other content area would benefit the students and would make it easier to implement literacy strategies if they worked together and helped each other get a better understanding of each other's goals and content (Draper, 2008). The problem with getting literacy and mathematics teachers to collaborate with each other is that there is a lack of mathematics teacher buy-in and until they

can buy into the idea and see proven research that collaboration will increase student proficiency, they will be hesitant to collaborate.

Teacher Buy-in.

Friedland, McMillen, and del Prado Hill (2011) claim that in order to get mathematics teachers to buy into the idea of collaboration there must be first an increasing motivation and engagement in learning about literacy. If mathematics teachers are not motivated in wanting to learn about literacy then they will not engage in doing this. Similarly, Shanahan and Shanahan (2008) found that high school content area teachers were reluctant in embracing strategy instruction as a literacy strategy for content area disciplines. The reading strategy was new to most of them so they were uncomfortable trying to incorporate the strategy into their own practice. This uncomfortable feeling is similar to what Friedland, McMillen and del Prado Hill (2011) claimed; that among most math teachers, that there is little motivation and engagement in learning about literacy and applying it.

Davis and Gerber (1994) also agreed that there is a lack of confidence and a feeling of inadequacy when math teachers attempt to prepare reading lessons, but they also discuss that there is a lack of specific examples for mathematics literacy implementation strategies (Davis & Gerber, 1994). The idea that mathematics teachers seem to feel uncomfortable with incorporating these strategies is another theme that is seen in the research. Once mathematics teachers begin to feel more confident they will hopefully begin to incorporate some of the ideas especially since Common Core standards will need students to communicate their ideas clearly. Draper (2002) also suggests that it has been 75 years since literacy teachers have been trying to get mathematics teachers to incorporate literacy instruction in their content area, but that again there is a lack of mathematics teachers wanting to be a part of the cause. She discusses the fact that teachers are

being asked to change their way of teaching which goes back to the same idea of mathematics teachers feeling uncomfortable with the changes (Draper, 2002).

Ness (2009) investigated and asserts that every teacher must be a teacher of reading. Ness found that that message seems to have been ignored by educators for years and that there is much room for improvement with regards to literacy integration in math, science, social studies and the fine arts. Furthermore, her findings suggest that teachers see literacy integration as a burden. Similarly to the previous researchers in this section, Ness (2009) agrees that there is no teacher buy-in when it comes to integrating literacy into other content areas. The problem is that teachers do not see literacy integration as providing support for reading comprehension for students, and do not see it as an effective way to improve student understanding and retention of content. Therefore, Ness (2009) agrees that content area teachers need to be encourages to reshape their understanding of reading and writing across the curriculum (Ness, 2009). Therefore, in hopes that more teachers will begin to incorporate literacy strategies into their content areas there must be a push in training teachers in pre-service programs to incorporate these strategies into their content areas.

Pre-Service Teacher Training

Friedland, McMillen and del Prado Hill (2011) found in their research that pre service and in-service mathematics teachers are more likely to use strategies that are generalizable across content areas. More importantly, this goes back to the idea of teachers buying into the strategies and making them applicable to the specific content, in this case mathematics. Similarly, Adams and Pegg (2012) believe that professional development and pre-service courses will supply opportunities for teachers to use the strategies and the content material. After allowing these strategies to be implemented there can be some focused observations of lessons using the

strategies and discussions on what was observed. Using this tactic will then create a better vision for effective use of strategies within the disciplines.

In a like manner, Shanahan and Shanahan (2008) also agree that it is important to prepare a teacher to deliver the needed instruction for their content area and that this must be done in collaboration with literacy and content discipline teachers. The problem with these ideas of training pre-service teachers is that most programs do not even make them take a literacy course, and some courses that are offered are very minimal; therefore, starting this training/implementation with pre-service teachers would prove to be effective and will bring some more teacher buy-in.

According to Borko et al. (2000) the challenges that teacher education programs face are greater than most suggest. In mathematics education, pre-service education programs are being asked to give models of good mathematics teaching, help the teachers develop their knowledge of mathematics and the pedagogy, provide multiple perspectives on students, and provide them with opportunities for teachers to develop their own identity as a mathematics teacher (National Council of Teachers of Mathematics, 1998). That being the case, these authors suggest that pre-service education programs are trying to implement and mold teacher education programs to be able to support these beginning teachers and equip them with the knowledge and models for them to succeed (Borko et al., 2000). In contrast, Borko et al. (2000) suggests that pre-service programs are already faced with lots of challenges and have a lot on their plate; therefore the question is, what is more important when it comes to mathematics education? Should there be an emphasis on literacy across other content areas?

Conclusion

Throughout the years there has been a lack of use of literacy strategies that are incorporated into mathematics classes. There has been differing points of views and the research found was that mathematics teachers have trouble implementing strategies because there are a lack of specific strategies specifically for mathematics (Adams, 2003), the lack of teacher buy-in and need for collaboration (Draper, 2008), and lastly the fact that teachers are not trained in pre-service and credential programs to incorporate literacy into their content areas (Friedland, McMillen & del Prado Hill, 2011). The fact that the research was all anecdotal based leads to believe that there is more room for work in this area of incorporating literacy into mathematics classes.

In particular, the research found lacked the evidence to prove that the literacy strategies have been effectively integrated into mathematics classes. The Common Core standards will force teachers to begin to use some of the strategies that have been presented throughout the years and will hopefully increase the amount of research that is found on more evidence based strategies implemented into mathematics classes.

In particular, mathematics teachers will also have to begin to incorporate the eight mathematical practices which involve students making sense of problems, using problem solving skills, being able to create their arguments both orally and written, model the mathematics, and looking for and expressing repeated reasoning amongst the mathematics. Because of this mathematics teachers will have to begin to incorporate more literacy into their classes in order for students to be able to assess using the new smarter balanced assessments, which will ask students to do all of these things.

Nevertheless, literacy being incorporated into mathematics will be a strategy that will continue to be a part of the debate in our educational system; the question is how we get more teachers to want to make this happen and collaborate with each other. Once people are willing, more changes will be evident in the approaches that are created and tested.

Chapter Three: Methodology

Introduction

I will be doing a mixed methods design, which involves both quantitative and qualitative data that will be gathered from my classroom. I will describe the methods I will be using to gather and analyze data to answer the research questions I proposed. I am really interested in how we can help students better communicate their ideas in mathematics classes therefore my first question I will be researching is: What literacy strategies can best support with the transition of the Common Core state standards in secondary mathematics classes?

My second area of interest for this project is the considerations that mathematics instructors have about what literacy strategies are and if they find them useful in a mathematics classroom. Since we will know be asking students to communicate their ideas, will they be using more strategies to promote communication in class? Have they been using strategies already and how? Therefore my second research question is: What considerations do high school math teachers have in regards to incorporating literacy strategies into their courses?

Because of the Common Core transition the methods I propose will help serve mathematics teachers with some strategies that would be helpful for them to implement and to get their students ready for the Smarter Balanced Exams that are taking place of the California Standardized Testing. My hope is that the research-based approaches I have decided to implement will be helpful to share to my staff and especially to my mathematics department.

Research Methodology

Overall Research Design. I am using a mixed method action research because, per the California State University Monterey Bay master's program handbook, it is the ideal research plan to help teachers assess and improve their own teaching process. Having this action research

plan will therefore help me improve my own practice and will help serve our students become more successful when they take the smarter balanced assessment in years to come.

Specific Research Plan. In this research, the type of action research I am using is practical classroom action research, I am using this because this type of research is designed specifically for teachers who want to improve their teaching by studying and applying research based practices. These practices are research based and these are easily applied to curriculum, instruction and/or assessment issues that need to be improved.

Procedures

Setting. The teacher action research will be conducted at a high school campus located in an agricultural community in central California. The school has a population of about 2700 students, which is much larger than other high schools. Of the 2700 students, 63% of them are eligible for free or reduced lunch. The percentage of White/Non-Hispanic students is about the same percentage of Hispanic students at the school. The research will be conducted in two of my math 2 classes.

Participants. Students: All of my students in my regular math 2 sections will be a part of this action research project. Most of the students are 10^{th} graders with about 6 students that are 11^{th} or 12^{th} graders. There is a population of English learners in these 2 sections of math 2. Both periods will be receiving the same literacy strategies.

Focus Group: I will be using the literacy strategies inside of periods 5 and 6 ONLY.

Teachers: This study will involve both me and other teachers in the district. I will be a part of this since it is my students I will be trying the literacy strategies on. The other teachers will be involved because they will be sent a survey. See Appendix.

As the researcher, I am a female Hispanic/Latina with four years of teaching experience at the secondary school level where I have taught Mathematics of all levels (Algebra 1, Algebra Standards, Geometry, Math 1, Math 2, Math 2 honors, and Pre-Calculus.) I have a Bachelor's degree in Mathematics and a single subject teaching credential in Mathematics and a supplemental credential in English. The other teachers involved will be mathematics teachers from my district. I want to have teachers at the middle school level and at the high school level answer my survey.

Data Collection Procedures

Intervention. The intervention consists of implementing literacy strategies that would be most helpful for students using the Mathematics Vision Project curriculum (MVP), which is a curriculum that our district has adopted for all the high schools which comes from authors in Utah, and with the new integration of the Common Core standards. The strategies that I have chosen to implement for my research are:

- Journal Writing (Summaries)
- Graphic Organizers

These literacy strategies will be implemented during semester 2 of the school year for approximated 4-6 weeks. The periods consists of five 55 minute periods per week with the exception of collaboration days which are once a month and make it a 45 minute period instead.

Implementation

Before any implementation happens all my surveys and assessments will be ready for my students and the teachers that will be a part of my study. See Appendix A and Appendix B for a copy of these surveys and assessments. Prior to the semester I will have to take time to look at

the curriculum and decide which lessons best lend themselves toward using the specific strategies I am targeting.

Once the semester starts the students will receive a pre test which ask them to use lots of academic language and ask them to clearly state their ideas and justifications of their thought processes. During the implementation process of the strategies in the classroom I will also be sending out the survey to the teachers

Data Collection and Sources

Quantitative Data.

- Test data: I will be recording scores from the pre tests and then from the end tests in order to see if any of the strategies were helpful for the students. These scores will then be placed on tables and graphs using either EXCEL or SPSS in order to nicely show the data visually.
- Questionnaires/Surveys: I will be asking items where students have to rate from 1-5 the level of entertainment, the level of helpfulness of the strategies, and if they would be likely to use some of the things they have learned. For the teachers taking surveys I will be asking similar questions where they will be answering on a scale to see how comfortable they are with literacy strategies. Again the quantitative data that is gathered will be recorded into EXCEL or SPSS and I will then be creating tables and graphs in order to visually present the results that are found from my research action plan that was followed.

Qualitative Data.

- Questionnaires/Surveys: These questionnaires that students will be taking will also have some open ended areas for questions to be answered. These surveys will be done online

using the chromebooks in the classroom and they will be done using Google forms or on their own time (for the teachers who are taking the surveys).

- Journals: I will be reading the students journals on a daily basis and recording in my own journal the results I have found from their writing. For example, is their communication of ideas improving or has it stayed the same by using the strategies.
- Classroom observations: I will also be observing the types of behaviors in the classroom that are created through the use of my strategies. I will have my journal in order to collect this information.

Data Collectors

All collection will be done by me.

Limitations/Threats to Internal Validity

Although the efforts will be made in order to minimize the threats of internal validity there are still some threats and limitations that could influence the research I am trying to create:

- Bias: Since I am the researcher and the data collector there will obviously be some bias because I already associate certain students in certain ways, in order to minimize my bias I will try to blank out the names ahead of time of papers/journals they might be turning in or assign a number to each student and just view them as a number.
- Implementation fidelity: Since I am implementing new strategies in my classroom that I have not tried before it is obviously not going to be perfect. I will try to have one of the instructional coaches come in and observe the strategies that I am using and get some feedback from him/her in order to make my transition smoother.

- Diffusion: I think that students in one period will talk to the students in the other period and will therefore skew my observations or results because they might begin talking about the methods that are implemented into the classes.
- Time: With these action research plans time is a huge limitation because I wish I could work on these strategies and record the data for more than the 4-6 weeks.
- Student Participation: There may be students who are not interested in being a part of my research. There also may be parents who would not let their students participate merely because of the fact that they are against the Common Core transition.

Summary

In conclusion, this chapter provides detailed information on the research methods that will be happening in the specific setting for this research project. This provides a clear path in which the researcher will be conducting for the 4-6 weeks of implementation. The data collection plan is clearly stated and will be summarized in Chapter 4 of this action research project. Finally, there will be a discussion of the results in Chapter 5 of this project.

Chapter Four: Findings

Introduction

This chapter will present the results of my action research that I focused on for four weeks inside of my math 2 classes this semester. During this study I focused on two different research questions; the first one focused on trying to find some literacy strategies that would best help my students express their mathematical ideas so that they would be more successful with the transition into Common Core. The second part of my research placed an emphasis on teachers and the considerations that they have in regards to incorporating literacy strategies into their mathematics courses.

During this study there was both qualitative and quantitative data that were collected (i.e., pre-test, post-test, surveys/questionnaires, journals, class observations). After analyzing my data there were some discoveries:

- The percentage of student scores that went up or stayed the same surpassed the percentage of student scores who went down.
- There were more improvements in period 5 than in period 6.
- Students are not exactly sure what the mission that Common core is trying to accomplish and are having trouble adapting.
- Most teachers were not trained in their credential programs to implement literacy strategies into their mathematics classes.
- Most math teachers want to receive training to implement literacy into the classroom.

Nevertheless, the graphs, figures, and tables below will present the data that was collected during this four-week period of implementation in my math 2 classes during this semester and will also present the data that was gathered from the survey that was sent to

mathematics teachers in the district. Note: Not every math teacher in the district answered the survey; therefore there is a small sample size.

Student Data Gathered

Below the first set of data that will be presented will be that of the student's data that was gathered during the four-week period of implementation of literacy strategies, specifically journal summaries and graphic organizers.

Table 1

Summary of Pre and Post-tests

	Score 1	**Score 1.5**	**Score 2**	**Score 2.5**	**Score 3**	**Score 3.5**	**Score 4**
Period 5 Pre-Test	7	3	6	4	4	1	3
Period 6 Pre-Test	10	0	9	3	7	1	2
TOTAL Pre-Test	17	3	15	7	11	2	5
Period 5 Post-Test	2	1	9	2	8	1	3
Period 6 Post-Test	8	2	5	2	10	3	2
TOTAL Post-Test	10	3	14	4	18	4	5

Note. This was an assessment that showed how well students could describe their mathematical ideas and thinking with the use of words and vocabulary.

Table 1 reveals that 42 of 59 students or 71% of the students scored a 2.5 or below on the pre-test which would not be considered a passing score out of a 4-point rubric. On the post-test the number of students who scored a 2.5 or below was 31 out of 59 students or 53% of the

students. Therefore, the percentage of low scores decreased by 18% in just a four-week period of implementation. The number of students that got a 3 or above also increased from 18 students to 27 students during the four-week period of implementation. Overall, the table summarizes the students' scores on the pre-test and post-test, which both can be found in Appendix C.

Next there is a pie chart which shows the percentage of students who got a better score after the pre-test, the percentage of those scores that stayed the same, and finally the percentage of students who got a lower score on the post-test.

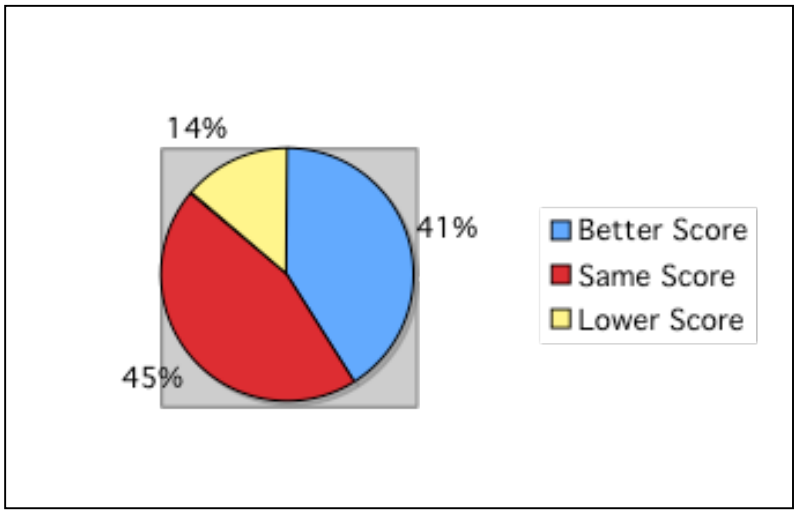

Figure 1. Post- test results

The pie chart above shows the results from the pre-test to the post-test. As you can see 41% of the students got a better score on the assessment. 45% of the students got the same score as the pre-test and finally 14% of the students got a lower score on the post-test. This means that 41% of the students who did better the second time around actually improved at communicating their mathematical ideas through writing. Again, copies of these assessments are located in Appendix C.

Next, we examine some qualitative data from students who offered comments on the survey that they were given, one particular thing I was interested in finding is just how they feel about common core and what they know about it and what the new expectations it has for them as students. Here are some responses:

Table 2

Qualitative data gathered from students: Common core feelings

Student #1	"I know that common core math is just introduction to different types like math statistics, algebra, geometry, and trigonometry that doesn't give you time to master a single subject which I consider pretty useless since they introduce it to 'prepare us for the coming years' but now require it for all of high school."
Student #2	"Common Core math has been forced upon the school districts across the US because the president threatened the government funding of schools who don't accept it."
Student #3	"Common core is supposed to make you think more and work out the problem more thoroughly. However it has made math much more confusing by making students teach themselves how to do things."
Student #4	"I know that common core math is from k-12 grade. That a lot of parents find it difficult, because they haven't learned this, all that much. Also, the standards they give help the students gain, evaluate, and present complex information, and ideas through speaking and listening. Some mathematics practices is: make sense of problems and persevere in solving them. Also, create valuable arguments to support your answer, and reason with others. Finally, my math teacher has taught us a lot about common core math, which I thank you for it."
Student #5	"It ruined everything I knew about math. Now I have to explain why I know it, not just that I know it."

As you can see the responses above, students have mixed feelings about Common Core and about its implementation in our school district and in the United States. The reason why I put this in the survey was to see if students would be hesitant when I began to implement new strategies to help with Common Core. As you can see the responses vary with each student, a lot of the other responses were mostly "no feelings or understanding on what Common Core is."

Figure 2 is a pie chart, showing student responses to the prompt, asking students if they had ever used a graphic organizer in a mathematics class before my class, and the results are shown below:

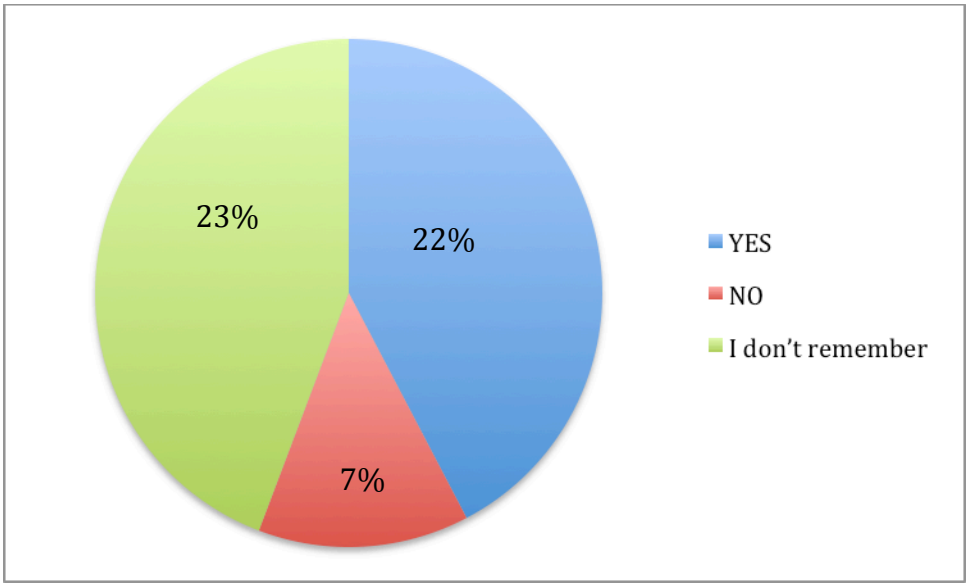

Figure 2. Graphic organizer usage in math classes

According to the pie chart above, 22% of students have in fact used graphic organizers in their math classes at a previous time. This means that not very many mathematics teachers have been implementing this strategy. Next we examine the survey information that was gathered from the mathematics teachers in the school district who teach middle school or high school.

Teachers' Data

Although the survey was sent to almost all the mathematics teachers in the district the level of response was very low and there were only 22 teachers who responded to the survey after several attempts at trying to get them to answer the quick survey questions, which you can view on the Appendix B of this thesis. The first question in which I was interested in learning about how mathematics teachers defined what math literacy, here there are some responses:

Table 3

Qualitative Data Responses: What is math literacy?

Teacher #1	"The ability to comprehend, read, write, explain, evaluate, and justify mathematical reasoning orally, written in words and written in mathematical notation."
Teacher #2	"It is vital for students to be able to read and follow directions. I feel that being able to read word problems is less important than being able to solve the problem once the context is clear. But reading directions is crucial."
Teacher #3	"Not only the ability to calculate the correct answer, but understand the answer in context of a real world problem or word problem. Math literacy would encompass a students ability to transfer a math concept to other applications."
Teacher #4	"It is the ability to read mathematics, its is the second after language literacy and it means also number sense, it implies the ability to solve problems utilizing math modeling and representation through tables, charts, graphs, equations and words."

The table above summarizes what most teachers wrote about what they felt what math literacy in fact was. For the most part it seems like everyone agrees that it is going beyond the ability to just use an algorithm to calculate a mathematics problem, it is about understanding the concept and being able to explain why it works. From the responses I saw, these were the one's

that captured the majority of what all 22 teachers were trying to say in their definition of what they thought math literacy was.

The next part of the research focused on was the percentage of teachers who were actually trained in their teacher preparation programs to implement literacy strategies and/or just literacy in general into their mathematics course, what I found is below:

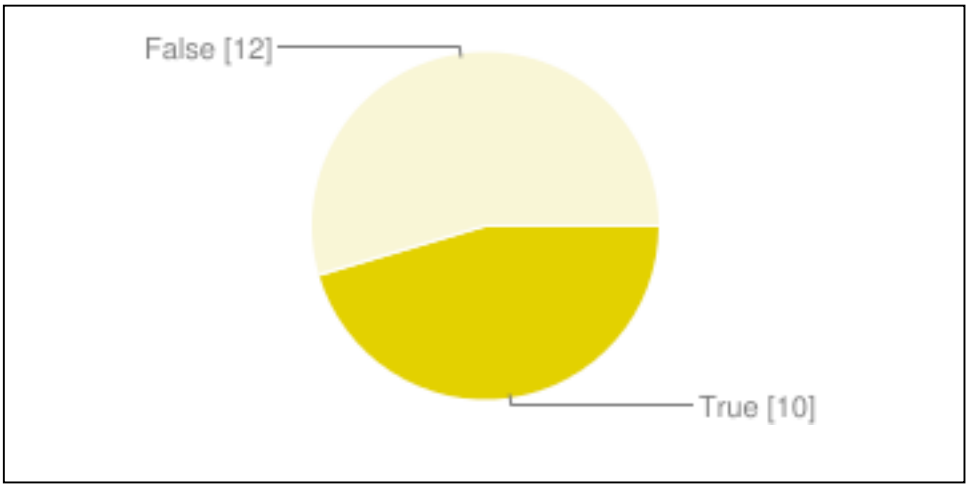

Figure 3. 45.5% of responding teachers were trained and the other 54.5% of them were not trained in their credential programs.

In the literature review I discovered that teachers were saying that it would be helpful to have some specific literacy development strategies for mathematics. This is worth investigating further.

The next figure will focus on literacy strategies that mathematics teachers have in fact used in their classrooms at some point. In the survey, teachers were asked if they had ever implemented: graphic organizers, sentence frames, reading out loud, journal summaries, and think-pair-shares.

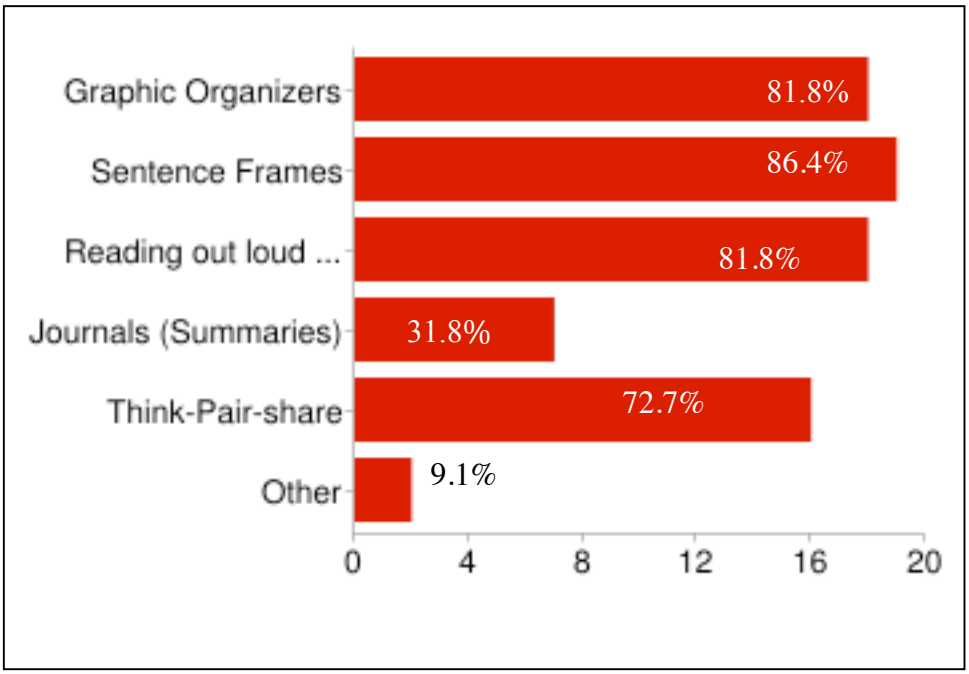

Figure 4. Strategies implemented by teachers in mathematics classes

Additional data that I gathered from the survey that the teachers filled out was: a) If I had the choice, I would have further training in implementing literacy strategies that are specific to mathematics classes. The survey found that 81.8% of them agreed with that statement and 18.2% of them disagreed with that statement. Next the teachers were asked b) I feel that incorporating literacy into a mathematics class is irrelevant. The survey found that 2 teachers felt they agreed with that statement and 20 teachers felt they disagreed with that statement.

Finally, teachers were asked about how they felt about math literacy; most teachers said in some form or another that it was "important." An important response that I find necessary in sharing is:

> I believe that helping our students develop literacy skills is a shared responsibility among all teachers not just ELA/ELD teachers. All teachers across content areas should be incorporating literacy in their classrooms. Language is found in all content and students

should develop their communication skills to express their learning in both written and oral form. If we expect our students to communicate their learning with mathematical terminology and to have a command of the concepts then we need to build the support systems in our classes to meet them half ways. We must give our students multiple opportunities to express their learning both orally and in written form.

Lastly, the final response I would like to share is, "It is hard thing for students to do (expressing their mathematical thinking). It is a very important aspect of math that is often overlooked. It is not 'the answer is _____.' It is more of 'this is my answer and I know it is correct because _____.'" Therefore, teachers are an integral part of communicating what Common Core is and what the goal is in order for students to understand what the new goal of a mathematics teacher is.

Conclusion

In conclusion, the research that was conducted in my classroom during a four-week period was shown in the sections above. Overall, there were some interesting patterns and we saw that students for the most part in fact did a lot better when I began to implement the strategies into the class. I also gathered data from mathematics teachers in my district and found some interesting patterns as well; all this will be discussed in further detail in the next chapter of this thesis project.

Chapter Five: Discussion

Introduction

In this chapter I will discuss the findings of this research project and the results for my research questions which are: (a)What literacy strategies can best support with the transition of the Common Core state standards for mathematics? And (b)What considerations do high school math teachers have in regards to incorporating literacy strategies in their courses? This study was performed in two of my math 2 periods for a month long time period. I will be summarizing the purpose of the study and the main ideas from the literature review and how it relates to the findings from my study. I will also be discussing my overall findings and my personal thoughts based on the data that was shared in the last chapter. Finally, I will finish this chapter with the limitations that were discovered as the study was being performed and some recommendations for future implementation into my future mathematics courses.

Discussion

Student Data. As the data displayed in the last chapter, 42 of the 59 students who were going to receive new strategies in the class scored a 2.5 or below on the pre-test based on a four point rubric. The part I find interesting is that all of these students were in Math 1 last year; therefore it is not the first time they are seeing new Common Core curriculum based instruction. Perhaps these students scored low on the pre-test because they are still not used to the new ways they are being asked to learn mathematics. Another reason I believe that the students scored low is because teachers are still in the middle of being trained on Common Core and their new role in the classroom; it seems as though the new role of the mathematics teachers is to be a facilitator of mathematical discussions. I am not sure all mathematics teachers know what this looks like

and honestly I am also trying to find a way to get more training on what this looks like and how a mathematics classroom needs to be run for the Common Core.

After one month of implementing journal summaries and graphic organizers in the class the amount of students who scored a 2.5 or below was 31 students out of the 59. The percentage of low scores decreased by 18% in just this four-week period. The percentage of student scores that went up or stayed the same surpassed the percentage of student scores that went down. The number of students that got a 3 or above also increased from 18 students to 27 students during the four-week period of implementation. This shows that small changes of things that are implemented into a classroom can make a difference when students are trying to explain their understanding of a concept. The review of the literature included studies supporting the role of graphic organizers, and after implementing these strategies I found that they in fact helped the students.

At the end of the four-week period I chose a couple of students who scored low on the pre-test and asked them a couple of questions in an informal interview after school. During the questioning I found out that the strategies were helpful to them. One girl in particular stated,

> I don't know exactly what this Common Core is having us do, but it is making my brain hurt. To be honest, when we were doing all those journals I didn't understand why you were doing it. Why do I have to write about what I am doing in math class?! But after getting used to them, it forced me to think about what I was doing in class and forced me to think about what we were learning and if I even understood what was going on.

This conversation I had with this student was very powerful, it revealed that this student is starting to understand what the new Common Core standards are asking her to do and secondly the fact that the journals seemed to be annoying at first, but eventually they served the purpose I

was trying to accomplish. In the end, I was trying to get students to write out their thoughts and ideas about the mathematics problems they were being challenged with and in the end even if the answers weren't fully correct she was thinking in my class. In her words, "…forced me to think about what we were learning and if I even understood what was going on," this is big and it is exactly what my hopes were when conducting this study.

Another response I received from a student was about the use of the graphic organizers in class. His response was, "I thought they were cool. At first I felt like a little kid filling them out, but then I figured out it made my thinking clear and it like helped me organize my thinking and helped me understand the problem better. I guess at first I felt like I was in like English class." Here, we can see that the student interviewed also saw the value in using the graphic organizers in class to help structure his thinking. At times, students do not know what is being asked of them and I can see how the graphic organizers can structure their minds and what they are learning. Again, this was another goal of my research, to find if these graphic organizers were in fact helpful to students when trying to explain their reasoning, which it seems as though the students I interviewed all agreed that in the end it helped them clear up and structure the mathematics problem.

After looking at the data closely I noticed that my period 5 improved more than my period 6 class, I thought this was interesting because my period 5 has less students than period 6, therefore it seems that the class size was helpful because I was able to go around more and check for understanding more than I was able to do in period 6. This in itself is another study that could be created, so I will not focus on this but it is worth mentioning that my smaller class had more advantages when learning to incorporate these strategies into their way of learning mathematics in my class.

All in all I believe it is important to note that my research question was focusing on implementing the two strategies and to see if it would be helpful for students and if it would help increase their communication skills. In the end, it did help somewhat but it is important to note that the implementation process only happened for a month therefore that isn't too much time to notice a huge change. Ideally, I would love to have been able to do this study for a whole school year and to gather data during that time in order to see if there was a real impact in student achievement.

Teacher Data. The second part of my research placed an emphasis on the teachers and their feelings towards implementing literacy into their classrooms. In the review of the literature I found information that teachers need to be trained in their credential programs to implement literacy into their classes. I looked at this research because I always hear negative things about mathematics teachers not ever wanting to be a part of the conversation when it comes to literacy across the curriculum. After looking at the data there is a substantial percentage of teachers that were not trained in their credential program in the first place and after talking to several teachers after they filled out my surveys, they were interested in knowing what I found out about this. When looking at the data more closely, those teachers that were trained in their credential programs were newer teachers who have been teaching 5 years or less, therefore we can see that credential programs are beginning to include this more as a part of their programs. I think this is a good first step to training our teachers to help our mathematics students think, write, explain, justify and persevere in solving mathematics problems that are more applicable to the real world.

Mathematics teachers want to be trained in using useful strategies for literacy in a mathematics class. They are eager to learn and to implement some strategies that are in fact specific to mathematics. The survey found that 81.8% of the teachers want to learn and want to

implement literacy strategies into their classroom but they do not know how. At my school site there is an assumption that mathematics teachers do not want to be a part of this movement. Implementing literacy is going be important as we continue in the next coming years with the transition into Common Core. Common Core is scary to mathematics teachers because this is in fact a very new way of teaching mathematics at the secondary level. Teachers are hoping that Common Core will bring our students a deeper understanding of the concepts. We want to see our students do more than just apply algorithms in our class. In the end, I believe that Common Core will help our students but teachers will need to get more training and we're going to need to find more strategies that mathematics teachers can implement into their classes.

Nevertheless, teachers have the power to help students succeed on our new assessments that will be given by our state. Students can in fact be successful in communicating and their knowledge of mathematics. There is much work to be done to get teachers trained and to get students to understand and be comfortable with the new transition. Together, there could be a positive change if we continue to make our students be the center of what we do. The goal is to have strategies that are helpful to students as they begin to learn in new ways and begin to have to apply the eight mathematical practices that Common Core is asking them to have.

Limitations

The first limitation I had was the fact that I could not use all of my periods for my study. In the beginning I had permission from all of my students, but then parents began to complain about Common Core and that I wasn't teaching my students mathematics and was doing too much writing therefore I had to leave my periods 2-4 out of my study. These periods were my math 2 honors classes whose parents refused to let me use their students as a sample.

Another limitation is the fact that Common Core is controversial. It has been really

unfortunate that there has been so much negativity around Common Core that it has affected how people treat my study and my class in general. The range of students in my study was mostly just Hispanic/Latino population, English Learners and Special Education students. Therefore, I do not have data from students that have an English only background which means that's another limitation to my thesis project. I did not have a diverse population of students; therefore I am not certain the strategies would have been helpful for other students as well.

The last limitation was the brief time period for implementing the strategies. Since it was only a month, I am not sure how confident I would feel in the data; if I had implemented the strategies for a longer period of time I may have found more results to my research questions, even though overall I found some answers to them. Therefore, after discussing these limitations we can note that this cannot be generalizable to the broader population of mathematics secondary classrooms.

Recommendations for future implementation

After doing this research project I have a couple of recommendations for people who may want to do a similar project. I would make sure that parents understand the goals of the project. Everyone needs to understand Common Core, the goals of Common Core and what you are trying to gain from going through this experience.

Next, I recommend that this project or study be longer than just a month; it would be a great experience to do it for a whole year and to see if students are progressing throughout the year. I would have more than just a pre-test and a post-test, I would include lots of mini-assessments in order to check for understanding and to see if students are progressing throughout the whole year. It would also be helpful to try to implement a couple of other strategies that are research-based and can be included as a part of this.

Finally, data recording needs improvement. I used excel for most of my data gathering but I realized that Google forms has a lot of much easier ways to record data and it can even display the data easily for you with graphs and tables. I know that students can be successful in mathematics and I feel that I can make a difference with students if I just continue to push for understanding, communication, and continue to try to make mathematics classes a fun place to be without it placing a burden on students. I want to improve their knowledge, and I want them to feel successful when they are applying the eight mathematical strategies of Common Core.

Conclusion

As the teacher and researcher of this project this study has allowed me to study and reflect on my own teaching practices. I learned that in order to make changes in our education system we may have to start small and begin one period at a time in a school. As I continue on with my career as an educator, I will continue to fight for students' education and equality in their instruction of mathematics. Nevertheless, if teachers were trained to use literacy across the curriculum then there would be a better understanding of what teachers are required to accomplish in their classes when it comes to that requirement of the Common Core standards.. As I move forward, I will continue to share my findings and work with others and collaborate in order to create something useful for a mathematics teacher to use where they can feel successful. One day I will be able to stay that because of this research I created something bigger, this is not the last you will hear about mathematics literacy from me.

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Appendix A

Teacher survey:

In my opinion, math literacy is _____

Common Core is asking our students to communicate their ideas more and more in writing. Do you agree with this statement? *

- Yes
- No

I feel confident that my students are able to explain their thought processes and reasoning in written form and orally. *

- True
- False

I have used the following in my mathematics classes when teaching: *
Please be honest about this... I need real research

- Graphic Organizers
- Sentence Frames
- Reading out loud (for word problems)
- Journals (Summaries)
- Think-Pair-share
- Other:

I was trained in my credential program to incorporate literacy strategies in my math classes. *

- True
- False

If I had the choice, I would have further training in implementing literacy strategies that are SPECIFIC to mathematics classes *

- True
- False
- Other:

I feel that incorporating literacy into a mathematics class is irrelevant. *

- True
- False

How I feel about math literacy is _____.

Appendix B

Student Survey:

Common Core math has helped me communicate my ideas more clearly in WORDS. *

- True
- False

Have you ever used graphic organizers in a math class? *
For example: flow charts, kwl charts, etc...

- Yes
- No
- I don't remember

I think it is helpful to read the tasks/problems out loud as a class before attempting the task *

- True
- False
- Other:

Math is... *

- Easy
- Hard
- Sometimes hard
- Other:

I have written journal summaries at the end of a math class before. *

- True
- False

If you answered "TRUE" to the last question, describe the journals and tell me when you did these journal summaries (which grade). *
If you said false, type in "N/A"

What do you know about Common core math? Use as much detail as possible. *

Appendix C

Pre-Test and Post-test Question:

A rectangle is 6 feet long and has a perimeter of 20 feet.

What is the width of this rectangle? Explain how you solved this problem.

Appendix D

Sample Graphic Organizers: (taken from teacherspayteachers.com)