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IMPLEMENTING READING AND WRITING
IN SECONDARY MATHEMATICS

by

Mari E. Eisenhart

A Research Project Presented in Partial Fulfillment
Of the Requirements for the Degree
Master of Education

REGIS UNIVERSITY

December 2010

Russell Henderson

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ABSTRACT

Implementing Reading and Writing in Secondary Mathematics

Literacy in secondary mathematics continues to be difficult for many. Mathematics teachers and researchers continue to develop support documents for secondary math teachers. It is important to utilize the literacy strategies already established by other content areas. It is feasible to adjust these strategies to suit the needs of mathematics students. Literacy across the content areas is a relatively new idea in education, but literacy in mathematics is even more foreign. It is necessary to use the available literacy strategies to develop materials applicable in the secondary mathematics classroom.

Chapter 1

INTRODUCTION

The continued out-cry for educational reform has brought to light many areas where schools can invest time and energy to improve student achievement. Improvement in content literacy may well be the means by which we increase student achievement. Teachers in content areas such as English and Social Studies find the implementation of reading and writing to be much easier than teachers in mathematics. The information students are expected to read in these content areas differ greatly from the material in technical courses, such as mathematics (Alexander & Jetton, 2004). It is imperative that the implementation of reading and writing be integrated in the instruction addressing mathematical standards, rather than being viewed or taught only as a separate skill. The ability to demonstrate mathematical literacy through writing and reading demonstrates students' mastery of content, including a higher cognitive level of understanding and the ability to communicate thought processes. The implementation of reading and writing into secondary mathematics, although challenging, is crucial in improving student achievement. Developing these skills will aid in the students' conceptual and procedural knowledge (Huang & Normandia, 2007).

Background of the Problem

Laura Robb's book titled *Teaching Reading in Social Studies, Science and Math* (1993), guides educators in the successful implementation of content area literacy. Robb provides surface-level guidance for mathematics teachers in comparison to the guidance provided to educators in other content areas. The techniques and strategies used

in content areas such as Science and Social Studies are applicable in a mathematics classroom, but mathematics teachers must approach these techniques from a different perspective, using a mathematical lens. It is important to realize the extent to which students are expected to rely on printed materials and content area literacy to further develop content area expertise (Alexander & Jetton, 2004). Literacy among students continues to receive a great deal of attention due to low scores and their inability for many students to thoroughly communicate their knowledge and understanding of mathematical concepts in order to write more than a few pages (NCTE, 2010). Based on this fact, it is intuitive to conclude more emphasis and focus needs to be placed on literacy across the content areas, specifically in mathematics.

Statement of Problem

Literacy implementation across content areas continues to grow, but the need for more resources to support these efforts in mathematics increases continuously. Due to the lack of resources, it is necessary to reevaluate the current research in order to develop a more meaningful approach for educators in secondary mathematics. It is necessary to keep the abstract nature of the content in mind throughout the development of these materials. The implementation of reading and writing into mathematics should enhance the content and mastery levels rather than detract from the essential content. In conversations with current secondary mathematics teachers, mastery of mathematics is not only in the traditional relaying of facts but the ability to explain the topics using strong mathematical vocabulary (Grant, 2010). Developing user-friendly and easily accessible materials for mathematics teachers is critical at this stage in educational reform. Literacy materials must be adapted to the content area first and foremost.

Ongoing professional development and training must also be implemented to encourage teachers to use literacy-based materials. Vacca and Vacca (2008) reiterate the reality that a teacher's attitude toward content area literacy, in terms of comfort, directly influences the successful implementation. This project will aid in the transformation from limited literacy in mathematics to the implementation of literacy across all mathematics classrooms.

Purpose of the Project

In this project, the author will examine the key components necessary to successfully implement reading and writing into secondary mathematics without detracting from the necessary content or acquisition of standard proficiencies. The purpose of this project will be to increase teacher confidence and proficiency in implementing reading and writing in secondary mathematics classrooms. The author will analyze current educational and literacy research to synthesize implementation strategies for the secondary mathematics classroom. The difficulty in implementing literacy strategies into secondary mathematics classrooms will be resolved by providing teachers with clear cut examples, instructions, guidance and real-world application in the form of an informal training using a PowerPoint presentation and its slides as the handout.

According to Metzler and Ziemba (2006), literacy exceeds the bounds of basic reading. In developing materials easily accessible to secondary mathematics teachers, it is the author's mission to assist in transforming the current perceptions of content literacy from negative to positive and increase willingness to implement content-specific literacy. The most common misperception among secondary math teachers is that teaching literacy is not their responsibility but that of English teachers; the extent to which even

mathematics teachers can improve literacy among students is larger than many think (Metzler & Ziemba, 2006). By analyzing and synthesizing the current literacy research the author will address both misconceptions and the successful implementation of literacy in mathematics using research based approaches and techniques.

Chapter Summary

The push for the implementation of literacy across content areas and the existence of numerous literacy-based standards increase the need for additional training and resources for mathematics teachers. A great deal of the information currently available is geared toward other content areas, but is being adapted for mathematics classrooms. The members of the National Council of Teachers of Mathematics (NCTM, 2000) and other researchers in the mathematics education field have now begun to publish information about content area literacy, primarily reading and writing, specifically for the mathematics classroom. The author of this project will analyze and synthesize this research into a manner convenient and accessible for the secondary mathematics teacher. In doing so, the author will provide teachers with the necessary information and training materials for successful implementation of literacy strategies in mathematics classrooms.

Chapter 2

REVIEW OF LITERATURE

Introduction

In 2000, the National Council of Teachers of Mathematics (NCTM) once again placed literacy among its standards for students in all grades (Chappell, 2007).

Communication in mathematics, which includes speaking, writing and reading, remains a major research and education reform topic as it has continuously shown to improve mathematical aptitude and mastery. The traditional mathematics classroom focuses on the regeneration of calculations demonstrated by the teacher. However, throughout the recent reforms, the types of questions on various standardized assessments (i.e. SAT, ACT, etc) have changed to include questions demanding higher levels of thinking. These questions require students to demonstrate an understanding reaching far deeper than the traditional mundane calculations (Matteson, 2006).

With the existence of literacy in the current standards established by NCTM (2000) and the standards proposed by Common Core (Common Core, 2010), it remains imperative for mathematics educators to embrace literacy-based techniques in their classrooms. An increase in students' mathematical aptitude in classrooms where reading, writing and speaking have been implemented continues to be demonstrated across the board.

Types of Literacy

Literacy encompasses all forms of communication, including reading, writing and listening. Mathematics, through equations, variables and symbols, tends to be considered

a language in-and-of itself (Miller, 1992). The language of mathematics is crucial to the education of students, and using literacy helps develop this language and increase student understanding (Capps & Pickreign, 1993). Unlike native languages, however, mathematics is often not a part of everyday conversation, making the practice of mathematical literacy in the classroom even more important. Professionals in the educational field continue to require the implementation of literacy into mathematics as an aid in the development of understanding, while simultaneously building an appreciation for language in mathematics. Many teachers implement literacy on a daily basis but fail to realize it, simultaneously causing a failure in deepening the extent to which literacy is an integral part of their classroom (Berman, Koichu & Moore, 2005). When teachers realize they already utilize the literacy based strategies shown to improve mastery, mathematics teachers will begin to fully embrace literacy.

Impact on Mathematical Knowledge

The question of whether or not (and to what extent) literacy impacts mathematics education continues to be a focal point for research. The increased research centered on mathematical literacy stemmed from the development of an additional separate standard focused on literacy by the National Council of Teachers of Mathematics (NCTM, 2000). The current, available research has produced results in favor of implementing literacy in mathematics classrooms, but convincing teachers of the importance of literacy and the need for implementation remains a challenge (Olson & Truxaw, 2009). The level of mastery and understanding is often determined by a person's ability to explain the topic at hand to other individuals (Denman, 2010). To emphasize these points, Miller (1992) quotes teachers as having said their level of understanding strengthened once they began

teaching. Research, including these comments from teachers, continues to substantiate one fact: literacy is crucial in mathematics.

Through the analysis of observations and written assignments, Huang and Normandia (2007) were able to confirm the higher number of knowledge structures used in written communication, the higher a student's level of related knowledge. This analysis yields an important finding: the amount of time allotted on an assignment dictates the depth of thought. The time provided to students and teachers for oral discussion is limited in comparison to the amount of time allotted for assignments such as the writing assignment used in analysis for this study. Regardless of permitted time, however, the study revealed the importance of explaining mathematical answers and processes.

The results of this study suggested a relationship exists between the development of content knowledge and the use of literacy strategies. The findings align with the intuitive idea confirming writing in mathematics strengthens the development and mastery of content. This notion supports other research in that literacy-based learning increases student ability, or aptitude.

Aptitude Test Scores

The implementation of literacy into mathematics has been shown to increase student scores on math sections of aptitude tests such as the SAT. A study by Berman et al. (2005) demonstrates this phenomenon as it replicates the general findings of previous research. In the study, researchers established a relationship between the use of heuristic literacy and an increase in standardized test scores for mathematics. Researchers consider heuristics to be approaches to certain mathematical problems, including but not

limited to think from the end to the beginning or to decompose a problem. These heuristic strategies enable students to differentiate their approaches based on the individual's ability (Richardson, 2010). Researchers have been studying these heuristics for approximately three decades, but the results have not always been entirely conclusive due to the difficulty in implementing these tactics. The purpose of the study at hand was to validate the relationship, from a cause and effect standpoint, between the use of heuristics and SAT scores on the math section of the test. Additionally, researchers addressed the hypothesis that weaker students in the experimental group would increase their test scores more than the stronger students.

Embedded in the overarching goal of this study were three sub-goals researchers thought crucial (Berman et al., 2005). The first sub-goal focused on providing teachers and students with the opportunity to develop heuristic literacy through the use of vocabulary. Secondly, researchers encouraged students to use these heuristics to aid in the solving of difficult problems (Lee, 2010). The third and final sub-goal was to develop the ability to use the idea of heuristics in all situations, familiar and unfamiliar. While addressing the questions and sub-goals mentioned above, researchers rationalized and supported the following: implementing heuristic literacy is in fact feasible and necessary; the existence of a cause-effect relationship between literacy and SAT scores; and 'weaker' students improved their SAT scores more than 'stronger' students (based on definition of weaker and stronger stated below).

Implementing Literacy

In the last decade, educators and researchers alike have realized the importance of literacy in mathematics classroom. Mathematics continues to be abstractly systematic,

resulting in the need for systematic approaches to the content. Berman et al. (2005) refer to these approaches as heuristics, and ascertain these heuristics, in terms of literacy, can improve the aptitude of mathematics students. These literacy-based problem-solving strategies may be foreign to some individuals, but the researchers utilized instructional coaches to help teachers develop heuristic lessons. The task of implementing literacy strategies into mathematics appears quite daunting, especially when comparing to literacy implementation in other content areas. However, seeking the help of instructional coaches and other individuals well trained in content area literacy can decrease anxiety. Instructional coaches can help teachers build upon the content literacy or literacy strategies already present in many lessons, similar to the role of the coaches in the study.

Mathematics teachers must help students develop a collection of heuristically based approaches. The ability to apply and effectively use literacy based heuristics aids in the development of mathematical aptitude among students (Berman et al., 2005). Heuristics include problem solving strategies as such but not limited to decomposing a problem or approaching the problem from the solution and working backwards to the beginning. Decomposing a problem involves determining the various pieces of the problem, engaging in the strategy of 'self questioning,' and applying previously learned techniques to the pieces. Approaching the problem from the end result, however, encourages students to work a problem backwards (Berman et al., 2005).

In many content areas, especially mathematics, vocabulary is already present but building this vocabulary is crucial (Miller, 1992). Mathematics contains vocabulary terms unique to mathematics or terms possessing different definitions than in other realms. The development of content specific vocabulary goes hand-in-hand with

improved student achievement. Since vocabulary development is ongoing, additional literacy must be implemented simultaneously.

The heuristic approaches and the development of vocabulary are the first steps toward implementing literacy based instruction in the mathematics classroom and increasing student achievement in mathematics. In addition to heuristics and vocabulary, research suggests literacy based instruction can be implemented in mathematics in various other formats, such as writing, reading and speaking.

Writing

Implementing writing into mathematics is not entirely different than doing so in other content areas. It is not until a student can explain their thinking that a teacher can determine what students know (Miller, 1992). When a writing assignment is given to students, it is imperative to enforce the standard writing conventions (Lee, 2010).

Research suggests teachers should provide students with an opportunity to reflect on their experiences in mathematics, as those reflections can help guide instruction and the transformation of attitudes (Chappell & Thompson, 2007).

To stimulate the writing ability of students, teachers can provide students with writing prompts for their journals or papers (NCTM, 1999). Providing students with a prompt will aid in the gradual transition from the current fear and phobia of writing in mathematics to a point where students are as comfortable with writing in mathematics as they are in other content areas (Denman, 2010). Using writing in mathematics increases student understanding and allows students to demonstrate high levels of thinking and understanding through their writing (Bossé & Faulconer, 2008).

Papers

The use of formal papers, much like those required in language arts, requires students to not only perform the calculations but explain the topics they have learned. It is through these explanations that students are able to demonstrate the extent to which they understand the material while looking at the big picture instead of the individual pieces (Denman, 2010). When writing a paper in mathematics, it is important to follow the same conventions as if the paper were written for a Language Arts or Social Studies class. After all, mathematics is simply a collection of ideas, utilizing its own vocabulary in conjunction with that of the native language (Lee, 2010). Students often struggle with writing in mathematics due to the non-existence of such activities in most mathematics classes. However, students must use their writing abilities and combine them with their knowledge of mathematics to demonstrate their understanding of the content at hand (Denman, 2010).

Mathematics teachers can develop any prompt for students to use to demonstrate their knowledge. For example, many topics in mathematics have multiple approaches to the process. To encourage students to engage in higher level thinking, a mathematics teacher may ask students to compare and contrast two different processes or properties. Using a simple compare and contrast technique, students must demonstrate their ability to synthesize multiple pieces of information (Denman, 2010).

Journals

Miller (1992) refers to journals as ‘think books’ for students to record their thoughts throughout the learning process. Journals are used daily by many people in order to document events, vent frustrations and hold various thoughts or ideas from any

given day. Why would a journal in a mathematics classroom be any different? The information written in these journals can be used to guide instruction based on the level of understanding discussed in student journals. The use of a journal can promote self reflection for both students and teachers. The journals can be used as an indicator of student understanding (Carter & Norwood, 1994). By utilizing a journal, students can reflect on not only the positive and negative aspects of the topics but on areas in which they are weak and/or strong (Chappell & Thompson, 2007).

To implement journals in mathematics, teachers may wish to use this activity as either a warm up or closure activity (Richardson, 2010). Encouraging students to summarize the class prior to leaving will allow students to think about the day's content and any areas of weakness or strength. These exit journal entries (or any journal entry) will provide the teacher with instant feedback on the successes and failures of each class period. Students can utilize these journal entries to measure their own growth throughout any given period of time.

Prompts

The use of open-ended writing prompts encourages higher level thinking while simultaneously providing the teacher with an understanding of student knowledge (Denman, 2010). Open ended questions, such as asking students to list as many ways as possible to achieve a particular sum, enable students to demonstrate their genuine knowledge by allowing them to answer the question in multiple ways. Additionally, providing students with open-ended questions helps increase student comprehension (Winstead, 2004). Many questions in mathematics allow for more than one approach to a solution. Providing students the opportunity to consider strategies demonstrates a

student's depth of understanding of the content approach behind the problem, while building higher-order thinking.

Reading

In order to be successful readers of mathematics, it is important to continuously develop vocabulary (Chappell & Thompson, 2007). Without the necessary vocabulary, students will struggle with any mathematically based reading. Vocabulary development includes rote definitions, diagram interpretation and development and example development based on the previous two items (Chappell & Thompson, 2007). Diagram interpretation is defined as the ability to decipher information based on a given question and graph or figure. Additionally, the development of examples involves the ability to create another problem based on the knowledge of vocabulary and previous diagrams related to the topic. Providing students with related questions or reading guides prior to assigning the reading will help to develop a structure for the students to read for meaning and further develop the students' mathematical knowledge and comprehension.

Students must be able to decipher a math text, which entails determining what is known and unknown, and using part of the popular know-want to know-learned strategy (K-W-L) aids in this task (Bach, Bardsley, Brown & Phillips, 2009). The K-W-L strategy allows students to document the information they know prior to the reading (K), what they wish to learn (W), and the information learned from the reading (L). Using this strategy will help both the student and teacher determine what information is familiar and what needs learned. In addition to utilizing the KWL reading strategy, encouraging students to use the "before-during-after" strategy while reading mathematical texts will

help structure discussions and further development of mathematical understanding through reading (Draper, 2002).

Since mathematics is a language of its own, making connections to the English language (or other native language) will help students master the mathematical language (Chappell & Thompson, 2007). Many of the vocabulary terms and symbols in mathematics can be found in other content areas. Identifying known roots, prefixes and suffixes in the reading is a valuable technique in reading in mathematics, as well as in other content areas. The symbols in mathematics remain equally important as the vocabulary, placing an increased importance on accurately interpreting and reading these symbols so as to maximize learning.

Speaking

The use of student-teacher and student-student discussions is a well-tested approach to encourage mathematical conversation (Chappell & Thompson, 2007). The use of a questioning approach to instruction encourages students to think about the information presented in order to develop or construct ideas rather than awaiting answers from the teacher. With this approach, the teacher presents an idea or problem to students before asking students how to approach the problem. This simple approach incorporates content literacy as students must verbally explain mathematical concepts while simultaneously emphasizing a student-centered classroom. When students verbally engage with each other and the teacher, they increase the extent to which the information is committed to their long term memory (Winstead, 2004).

The term speaking does not necessarily mean out loud conversations but rather written conversations, which contribute to the implementation of literacy geared toward

increasing student achievement (Richardson, 2010). To encourage a more verbally based discussion among students, implementing the *think-pair-share* technique provides students with individual time to process the problem, group time to brainstorm among peers and share their findings (Marzano, Pickering & Pollock, 2001). All of the above techniques, among others, encourage students to discuss topics with teacher and peers, thus deepening their understanding of the topic. When students are encouraged to speak or explain their thought processes, they are demonstrating the extent to which they do or do not genuinely understand the topic at hand (Chappell & Thompson, 2007).

Chapter Summary

Literacy is a necessity in all content areas. The available research not only continues to support the importance of literacy based instruction in mathematics but provides teachers with strategies to successfully implement literacy, such as reading, writing and speaking, into their classrooms. Students must be able to explain the topics verbally and in written form. It is through these two forms of literacy that students are able to demonstrate the depth of their understanding of the mathematical content beyond their ability to engage in simple mathematical computations.

Mathematics, often considered its own language, can be combined with similar literacy conventions from other content areas. It is feasible and beneficial for mathematics teachers to utilize the use of reading, writing and speaking in their classrooms through the use of papers, journals and small group-whole group discussions, thus encouraging the use of the mathematical language. As with any language, a person becomes literate in that language when they are able to accurately communicate thoughts and ideas using the conventions of the language at hand. Research continuously supports

the importance of literacy based instruction in mathematics as it aids in the increase of student understanding and mastery of mathematical concepts.

An analysis of current research supports the need for direct literacy mathematics instruction. The requirement of this implementation, based on changing standards and assessments, leads to the deeper mastery of mathematics among students. Pupils who engage in literacy based activities and instruction develop a deeper level of understanding of mathematics than those who do not (Berman et al, 2005). Additionally, those students in literacy based classrooms score higher on aptitude tests (such as the SAT) than students in classrooms focused on the more traditional approach (Berman et al, 2005). The following chapters will develop a project to provide secondary mathematics teachers with applicable techniques and strategies to implement literacy techniques verified in the research above.

Chapter 3

METHOD

This project focused on the development of applicable resources for mathematics teachers to aid in the successful implementation of reading and writing. The resources provided to teachers consisted of a PowerPoint presentation. The PowerPoint presentation in its entirety was designed as a training module to provide teachers with a classroom based approach to literacy within content.

Target Audience

The project was designed primarily for secondary mathematics teachers. However, administrators and other staff members may find the material useful and adaptable to their content. The teachers participating in the project were employees of Laramie County School District #1. The experience of these teachers ranges from first year to twenty-five years of experience. Administrators in Laramie County School District #1 were invited to participate in the training as well.

Organization of Project

Since the implementation of standards established by the National Council of Teachers of Mathematics (2000), literacy in mathematics has been a topic in conversations and pedagogical changes. This project was designed to aid teachers in recognizing the use of literacy based strategies already in practice, adjust current instruction to focus more strongly on literacy (which includes all forms of communication) or build a repertoire of strategies from the ground up. This project was

chosen due to the minimal information available that focuses purely on literacy in mathematics.

To provide teachers with the necessary information, a PowerPoint was developed. This PowerPoint synthesized the information found in research so as to provide teachers with a concise and succinct training on implementing literacy in mathematics. The information ranged from the need for vocabulary development to providing teachers with specific writing/discussion prompts and strategies ideal for encouraging literacy in mathematics.

The PowerPoint began by introducing the topic of literacy and defining what it means in context of mathematics. Following the introduction, the author articulated the various types of literacy. The PowerPoint presented the research ascertaining that math aptitude increases with literacy. The author provided teachers with the information in terms that each teacher can understand and relate to. Following the presentation of facts and data, the author detailed the steps necessary to implement literacy in their classrooms.

Peer Assessment Plan

Experts in the field of education and mathematics were asked to evaluate the project in its entirety to determine its strengths and suggestions for improvement. This panel of experts consisted of teachers and administrators. The peer assessment panel determined the validity of this project based on its applicability to Laramie County School District #1's strategic plan, curriculum, standards and benchmarks. The panel utilized open ended questions to determine the efficacy of this project.

Following the conclusion of the training and distribution of material, teachers were asked to evaluate the project using a combination of rubric scale questions and open response questions. Administrators in Laramie County School District #1 were invited to participate in the evaluation as well. The individuals assessing the project prior to, during and after the implementation were different when at all possible.

Chapter Summary

The materials in the project were designed specifically for secondary mathematics teachers and classrooms. The purpose of this project was to provide secondary mathematics teachers with applicable and easy to access support in implementing reading and writing in their classroom. The information presented consisted of the facts, approaches and strategies deemed most important and effective by the author. The project helped implement literacy in secondary mathematics so as to continue striving for higher education and mastering the standards established by Laramie County School District #1.

The administration of this training project consisted of a PowerPoint presentation, with an accompanying script. This PowerPoint provided secondary mathematics teachers in Laramie County School District #1 with the necessary information pertinent to the successful implementation of literacy in mathematics classrooms. The presentation provided teachers with well-tested and supported literacy strategies, techniques and ideas easy to implement in a mathematics classroom without sacrificing the content. Teachers were provided with the hard copies of the PowerPoint and script, as well as a handout.

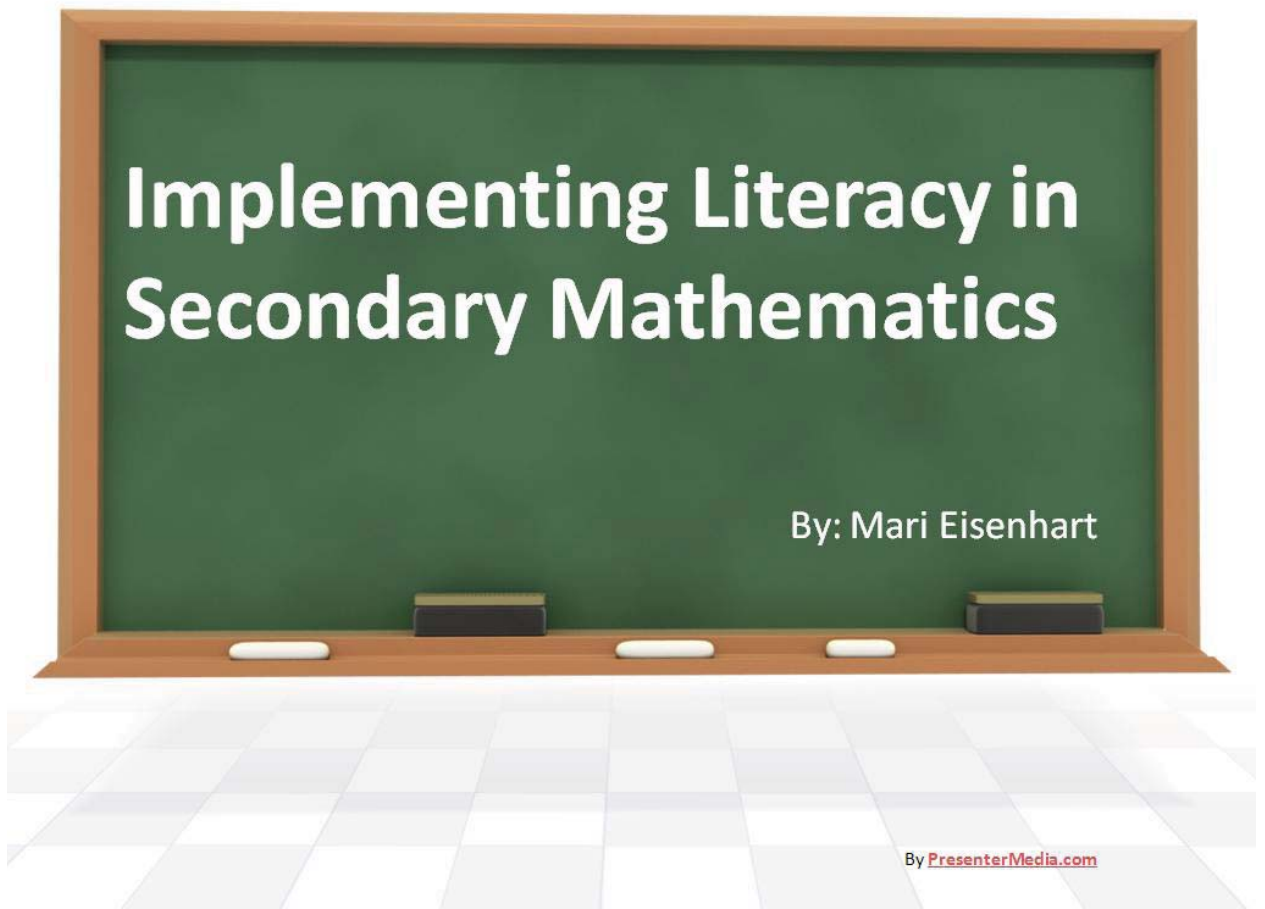
Chapter 4

RESULTS

Introduction

Despite popular belief, it is possible to relatively easily implement literacy into secondary mathematics. In fact, utilizing literacy as an instructional strategy is highly recommended as it increases knowledge and mastery for students in classrooms that successfully implement literacy. The difficulty, however, continues to be ‘how’ to implement literacy techniques. Up until the past few years, reading and writing was not typically a part of mathematics. With the many changes in education, standardized tests and curriculum/standards as a whole, implementing literacy is a must.

A large amount of the anxiety among mathematics teachers lies in the development of literacy techniques that do not detract from the content but enhance learning. The secret to successful implementation of literacy in mathematics is to utilize the strategies already in place. It does not matter if these strategies are used primarily in English or Social Studies classes; it is easy to adapt existing techniques for mathematics.



<This slide will be on the board as participants enter the room>.

<Hand out slides while going through introduction of myself>.

Good morning/afternoon! It's a great day to learn how we can revamp our math classrooms! My name is Mari Eisenhart, and I am a math teacher at Carey Junior High in

Cheyenne, Wyoming. The presentation we are about to go through was done as the project for my Master's in Education. I have a degree in mathematics and a degree in psychology from the University of Wyoming. I completed my secondary licensure program through Regis University, where I also completed my Master's degree.

<Change slide-as 'completed my Master's degree' is being said>.

• Agenda

Introduction



Purpose & Rationale

Background



Problem & Research

Types



Writing, Reading & Speaking

During this training session, we will begin by discussing the purpose and rationale behind this entire project. Why are we all sitting in this room? Why is this topic so important? There is a huge problem at hand that needs to be resolved using the research currently available. In discussing the resolution to the problem at hand, we will discuss the three types of literacy most pertinent to the classroom: writing, reading and speaking.

<Change slide-as 'writing, reading and speaking' are being said>.

• Agenda (cont)

Impact

Test Scores, Conceptual & Procedural

Application
& Examples

Strategies & Implementation

Conclusion

Summary & Evaluation

The use of literacy in the mathematics classroom has been shown to have considerable impact on the aptitude of our students. This research based idea makes the use of literacy in the mathematics classroom even more important. Many of you are probably saying to yourself “Well, yea, I understand it’s greatly beneficial but how in the world am I suppose to do that?” We will discuss the ways in which literacy can be implemented into *any* mathematics classroom without sacrificing content. This implementation will be such that the curriculum is enhanced. You will not need to throw away every lesson you have planned already, so do not panic. You will be able to take the hard work you’ve already done and simply tweak it to include literacy as an integral factor.

At the end of the presentation, I'll ask each of you to complete a short survey about the efficacy and usefulness of this presentation. I'll use these responses to improve this presentation in the future.

<Change slide-as 'an integral factor' is being said>.

• Introduction

- Reforms mandate achievement improvement
 - Must implement literacy in mathematics
 - Align with standards
- Activates higher level thinking
 - Improves procedural and conceptual knowledge

Over the past decade, educational reforms have placed increased emphasis on the need for literacy across content areas. Through these reforms, educators have adjusted standards and content accordingly. Based on these new standards, mathematics teachers must implement literacy in the forms of writing, reading and speaking.

By implementing literacy, mathematics teachers are able to activate higher levels of thinking. This higher order thinking improves both the procedural and conceptual knowledge in mathematics.

<Ask the group for the definitions of procedural and conceptual knowledge-have a group discussion about these two definitions>.

<Change slide-as 'conceptual knowledge in mathematics' is being said>.

• Statement of Problem

- More difficult than other content areas
- More support for mathematics teachers

Currently, mathematics teachers lack the resources necessary to effectively implement literacy. Other content area teachers, such as Social Studies and English, have almost endless resources available. It is essential to begin developing resources for mathematics teachers. Without the applicable resources, it is virtually impossible for mathematics teachers to effectively implement literacy around the current content in an effective and beneficial manner.

<Change slide-as 'effective and beneficial manner' is being said>.

• Purpose of Project

- Develop guide for literacy in mathematics
- Transform perceptions
- Provide applicable strategies
- Provide applicable techniques

The purpose of this project is to transform the currently negative perceptions while simultaneously providing teachers with a guide for implementing literacy. This guide for teachers will provide mathematics teachers with applicable strategies and techniques to successfully implement literacy.

<Change slide-as ‘successfully implement literacy’ is being said>.

• Background

- Use techniques from other content areas
- Rely on printed materials everywhere
- Kids not proficient in communicating knowledge

When thinking about implementing literacy into mathematics, do not begin to panic that you must construct new and original literacy techniques. Other content areas have done the hard work for us! Why should we spend more planning time that we already don't have? Use those techniques already developed. In doing this, the only aspect we have to keep an eye on is how applicable techniques are for our end goals. Not every technique used in English or Social Studies is applicable in mathematics.

Keeping this in mind, we are increasing mathematical aptitude while simultaneously building students' ability to read the printed materials they must rely on everywhere in day to day life. As it stands, our students cannot explain what they do and do not know. They have spent too much time in the illusion 'but this is mathematics.'

Any person can be taught how to do the computations and calculations, but be honest:
How many people can actually *explain* in strong mathematical vocabulary what is going
on in this abstract world?! As it stands now, our kids cannot do this. It is time for us to
fix this problem so that when our students leave us, they are stronger individuals.

<Change slide-as 'they are strong individuals' is being said>.

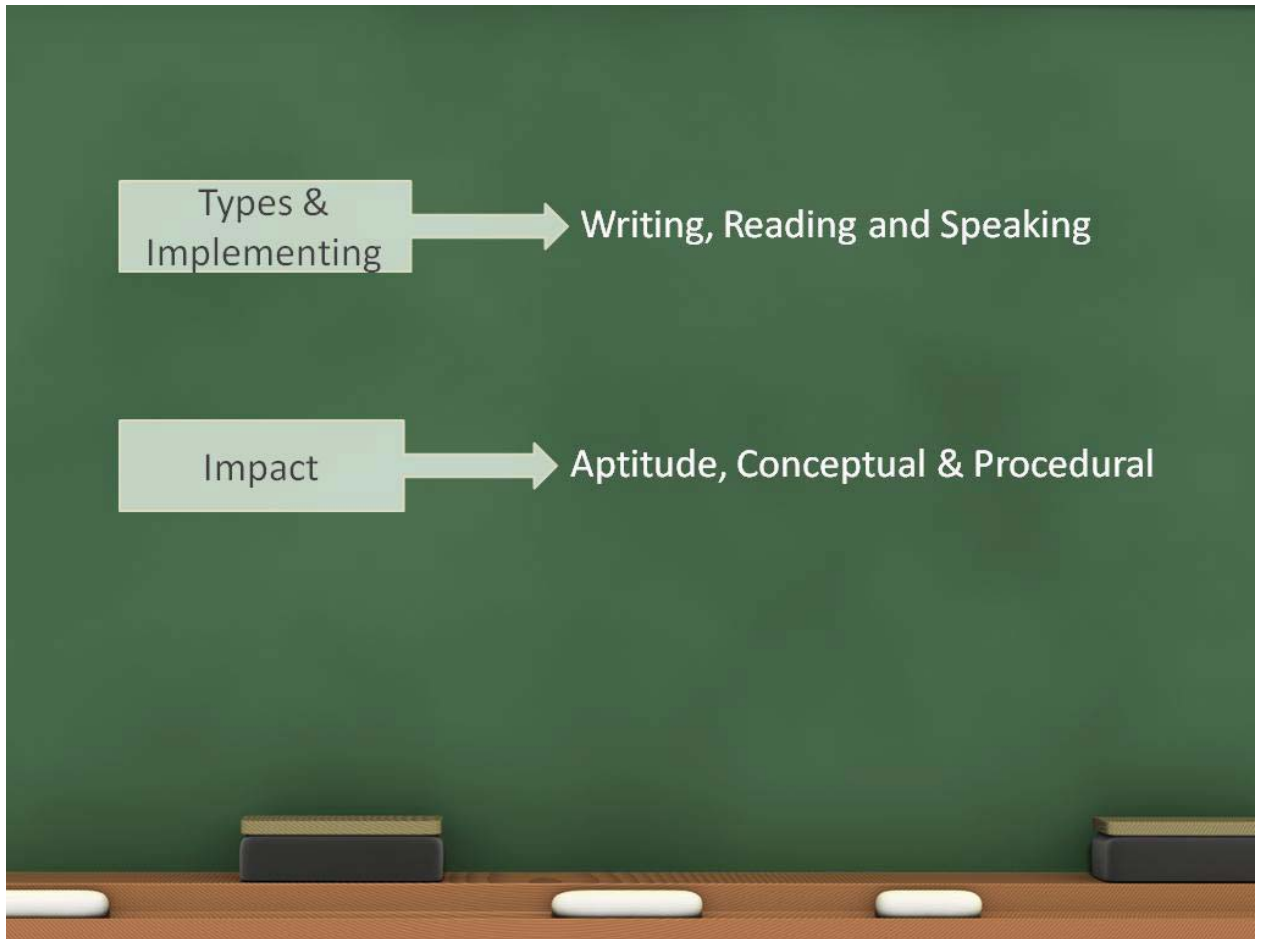
• Research

- NCTM (2000) communication standards
- Transition from traditional classroom
 - Changing standards
 - Changing standardized test
- Continual vocabulary development

The National Council of Teachers of Mathematics once again placed communication, which is the same idea as literacy, among its standards. In fact, communication is a standard in and of itself! I don't know about you, but that tells me this might be a little bit important! In order to ensure our students are proficient or advanced proficient in this standard, we must transition away from the traditional classroom. There are way too many changes in our standards and standardized testing to remain complacent and set in the traditional ways. We must focus on literacy while simultaneously developing the vocabulary that is so crucial to mathematics. We have to keep in mind that mathematics is a language by itself. Some of the vocabulary is found in other content areas, but many of the terms we expect our students to know are unique

to our content area. Drill and kill does not develop our students to the depth that is necessary.

<Change slide-as 'depth that is necessary' is said>.



As we transition into the more application based information, keep in mind the research and importance of literacy in mathematics. Literacy can be divided into three main categories: writing, reading and speaking. Each of these three should be viewed as separate entities that we must intertwine with one another for maximum effect. If done correctly and appropriately, writing, reading and speaking will easily connect.

We are not simply meeting standards and teaching to the test, but ensuring our students are drastically stronger in mathematics, thinking and communicating as these skills are crucial to being successful, productive members of society.

<Change slide-as 'members of society' is being said>.

• Implementing Types of Literacy

Writing

- Higher levels of thinking and understanding
- Papers
 - Standard writing conventions
 - Combine writing and mathematics
 - Deep analysis



Although the three types of literacy should be implemented holistically, let's look at writing first and foremost. When posed with a writing assignment, I've often heard kids say the all too famous 'but we're in math' statement. My response is always "Ok, what's your point?" The reality is that writing is everywhere in mathematics. Writing is a way to take one's knowledge and explain it to someone else.

The use of writing, allows us to activate higher levels of thinking and demonstration of understanding. The standards are kids are held accountable for are based on this higher level of thinking. We have to increase our student's abilities to verbalize their knowledge.

To do this through writing, remember: we can use the approaches from other content areas. It is 100% acceptable and perhaps even expected, to write papers in mathematics. When doing this, we must hold our students accountable for the standard writing conventions. This may take a bit more planning on our parts to ensure we are at least proficient in these conventions, but given the amount of writing done in our daily lives this is not an insurmountable feat. Writing in mathematics requires students to use two different languages: native speaking language and the language of mathematics as they deeply analyze a topic.

<Change slide-as 'analyze a topic' is being said>.

• Implementing Types of Literacy

Writing

- Journals
 - Encourage reflective thinking
 - Self evaluation
 - Allows adaptation of instruction

In addition to utilizing papers as a writing strategy in mathematics, we can encourage the use of journaling. Students can journal in a variety of different places: warm-up, brain break, daily closure, closure of a unit, etc. The options are endless! The important factor to keep in mind is the purpose behind journaling. As with anything we do in class, we must ensure it has a purpose. Journal writing encourages student to use and build their reflective thinking abilities. In this reflective exercise, students are able to evaluate themselves periodically. By placing their thoughts on paper, they will be able to self correct many things. It is likely they will identify the areas in which they struggle and seek help on those topics. Additionally, students may realize the errors they had been making. Sometimes when we rethink things, write out our thoughts and say things

to ourselves we realize what needs to be fixed. For teachers, we can use these journals as check points. If students indicate a consistent area of weakness, we would be able to reinstruct as necessary.

Students often have some form of anxiety, fear and/or stress toward mathematics. If we as teachers are aware of this, we can find ways to combat these negative emotions to the best of our abilities. By encouraging students to journal, we are able to see the thoughts and feelings often not demonstrated through homework, quizzes and tests. Think about how much more we could be doing for our students!

<Change slide-as 'doing for our students' is being said>.

• Implementing Types of Literacy

Writing

- Prompts
 - Open ended
 - Multiple responses indicate mastery
 - Guide thinking

The third form of writing in mathematics that can be incredibly beneficial is the idea of prompts. We can provide students with prompts that are designed to elicit specific responses, but we can engage students at such a higher level with open-ended prompts. Open ended prompts allow students to not only answer the question but apply their knowledge to a deeper level. For example, we may give students the prompt:

“In 2 minutes, list as many ways as possible to make the number 25.”

This would demonstrate the extent to which students understand the basic mathematical operations-addition, subtraction, multiplication and division-and their number sense.

By using prompts, both specific and open-ended, we are guided student thinking without taking away their right to think. Mathematics is so much more than rote computations and calculations. When we do not engage our students to a higher level, we are doing them a disservice in not aiding in their development of advanced mathematics skills. We should not only be teaching them math but how to use it, which requires familiarity and skills in advanced thinking. Similar to journals, we can use these prompts in any fashion necessary-for journals or papers, warm up activities, closure, etc.

<Change slide-as 'warm up activities, closure, etc.' are being said>.

• Implementing Types of Literacy

Reading

- Vocabulary
 - Continual development
 - Simultaneous development
 - Language of mathematics
- K-W-L
 - “Know”
 - “Want to know”
 - “Learned”



The implementation of reading in mathematics is much more difficult than other forms of literacy, and incredibly difficult when comparing to reading in other content areas. The one area we must continuously focus on is the development of vocabulary. We often fall into the same trap the students do: once we test on it, we are done. The problem is that students forget these vocabulary terms when they do not see or use them often. We can incorporate this continual development of vocabulary into our ever day instruction by placing vocabulary on a warm up or ensuring we use strong mathematical vocabulary as we speak. Instead of using ‘plug it in’ what should we use? <Participants respond with ‘substitute’>. It is important to remember we MUST develop our mathematical language, just as we develop our spoken language each day.

When we assign reading, which may be from the textbook or an article pertaining to the topic at hand, we can utilize some of the same reading strategies used in other content areas. The language of mathematics can be difficult to decipher is the same fashion old literature can be difficult to understand. The reading strategy K-W-L is a great way to structure reading. The “K” stands for ‘Know,’ which means we are activating their background knowledge. What could we activate in this part of the K-W-L? <Participants provide ideas, including vocabulary>. The “W” stands for ‘Want to Know.’ This part of the K-W-L would be the objective or learning target we are focusing on. Students would use this section to document key components they need to learn more about. At the end of their reading what do we usually want the students to do? <Participants should respond with answers such as reflect, analyze, synthesize, formalize learning, etc.>. The “L” provides students with the opportunity to document what they learned and synthesize the information. This strategy structures their reading in such a way we can make sure they obtain all the necessary information from the reading.

<Change slide-as ‘information from the reading’ is being said>.

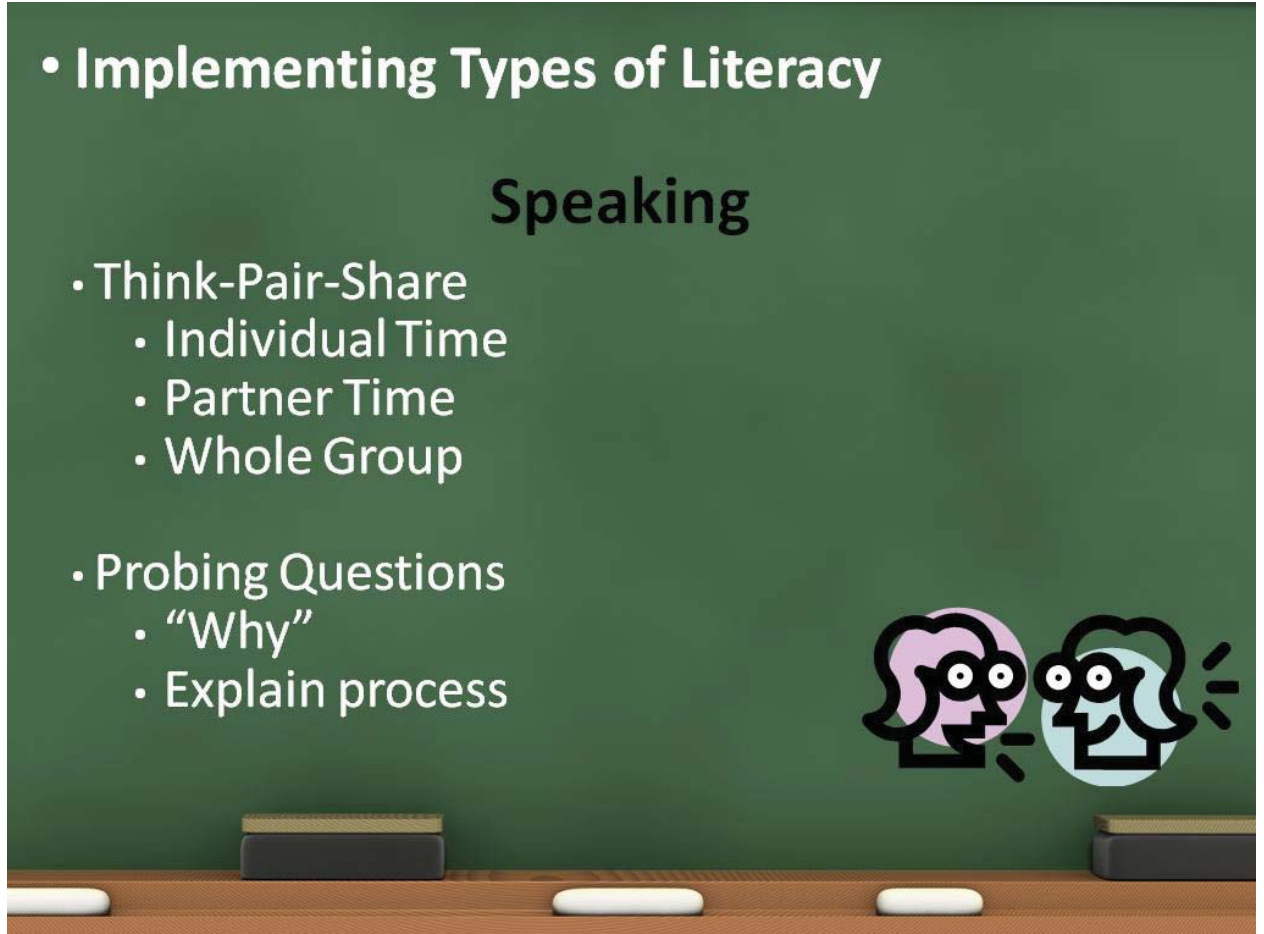
• Implementing Types of Literacy

Reading

- Reading Guides
 - Focus reading
 - Develop analysis skills
 - Develop structure and logic

In addition to K-W-L, we can develop reading guides for students. This strategy will require more front-end preparation on our part but can produce amazing results for students. We can focus their reading to a greater extent than with other strategies, such as K-W-L. In doing this, we provide students with an intensely structured guide to following throughout their reading. We've all used these as students, in the form of study guides consisting of questions. By providing students with pre-designed questions, we aid in the deep analysis of information while simultaneously helping students develop their analysis skills. Although reading is a much more difficult form of literacy to incorporate in mathematics, using these types of strategies can decrease the tedious nature often associated with reading in our content.

<Change slide-as ‘with reading in our content’ is being said>.



• Implementing Types of Literacy

Speaking

- Think-Pair-Share
 - Individual Time
 - Partner Time
 - Whole Group
- Probing Questions
 - “Why”
 - Explain process

The image shows a green chalkboard with white text. At the bottom, there is a wooden ledge with three pieces of chalk. On the right side of the board, there is a cartoon illustration of two people with large eyes and open mouths, appearing to be in conversation. The person on the left has purple hair, and the person on the right has blue hair.

The third form of literacy included in today’s presentation is speaking. As we all know, this is an integral part of learning mathematics. Our students participate orally on a regular basis, sometimes in a structured manner while other times it’s more sporadic. Either way, when students are engaging in conversation they are improving their mastery and activating their high level thinking.

We can facilitate speaking in a plethora of different avenues, including think-pair-share and the use of probing questions. Think-pair-share, as many of us may know, targets the use of individual think time, partner time and whole group discussion. We can implement this as we scaffold through various any given topic. We can ask students to

work through an example on their own before doing one of two things: moving on to a more difficult problem or asking students to share their work with a partner. If we move on to the next scaffold, we want to make sure students utilize working with a partner for the next example. By utilizing the second option, the collaboration and ‘speaking’ is immediate. Once students collaborate with their partner, we as teachers can randomly call on multiple (if not all) partners to share with the entire class. What purpose does this strategy serve? <Participants answer with peer tutoring, gauge of understanding, student centered learning, etc.>.

Probing questions tend to be done more by the teacher than the students, but it keeps the learning centered on the student. Simply asking the students that infamous two year old question “why” encourages students to think beyond the answer. Literacy is intended to deepen understanding, which requires thinking more about the process and application over simply acquiring an answer. By essentially forcing students to explain their thoughts, we are activating the part of the brain needed for higher level thinking. In doing this, we are engraining the concepts in their long term memory more than if we accepting simply an answer.

<Change slide-as ‘accepting simply an answer’ is being said>.

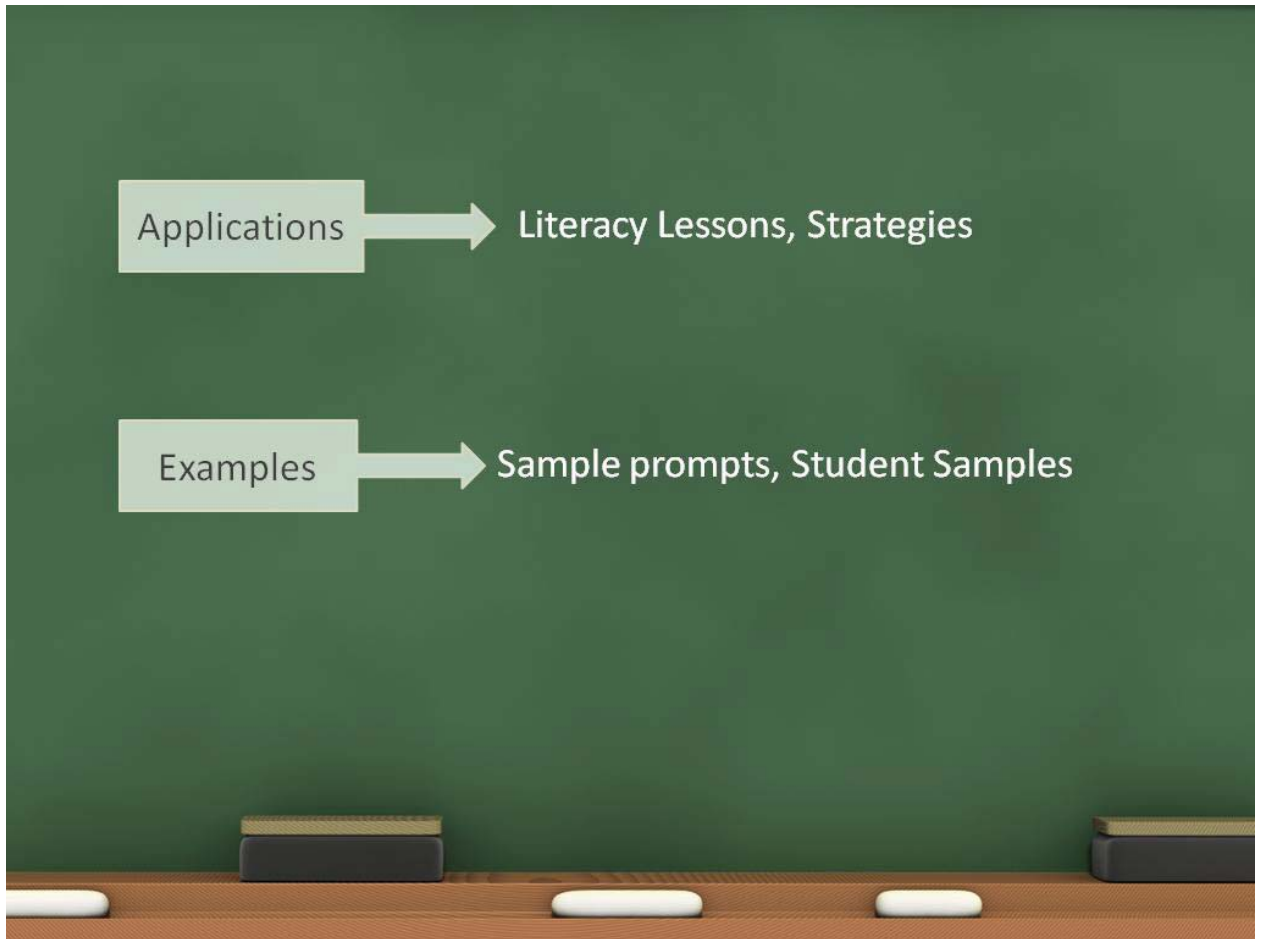
• Mathematical Impact

- Test Scores
 - SAT
 - Standardized
- Conceptual and procedural knowledge



By implementing literacy using any and all strategies previously mentioned, we are taking education to the next level. By doing this, student test scores have been shown to increase. Not only are we going to see an increase in scores within our own classes but on standardized tests as well. Literacy improves both the conceptual and procedural knowledge, which in turn allows students to perform better on tests. The implementation of literacy allows students to develop the ability to apply the concepts, which is how many standardized tests are structured. If our students are going to be tested on the application and higher level of thinking, then shouldn't we be doing everything we can to help them develop these skills?

<Change slide-as 'them develop these skills' is being said>.



Okay, now that we have the technical information on the table, let's move into what we've all be waiting for: the answer to the questions 'how does this apply to me' and 'how can I implement this in *my* classroom, not this theoretical classroom?' Let's get into the dos and don'ts for a literacy based lesson and some applicable strategies. I'll even show you some actual writing samples done in my eighth grade class this year.

<Change slide-as 'eighth grade class this year' is being said>.

• Literacy Based Lessons

DO



- Focus on content
- Modify current lessons
- Utilize strategies from other contents
- Use guides, outlines, structure
- Hold students accountable
- Make students explain answers

DON'T



- Ignore curriculum
- Go page by page
- Avoid writing assignments
- Monopolize discussion
- Give students answers

As with any instructional strategy, there are certain things we want to do and other items we may want to avoid. This same idea applies to literacy. In the end, we must still ensure we are focusing on the content. Any of the literacy based activities we choose to implement cannot detract from the content our students must learn. Ignoring the curriculum will have adverse results and only increase the frustration among students and us as teachers. As teachers, we already have a great deal of work to be done day in and day out. There is no need to reinvent the wheel or develop our own repertoire of literacy activities. Use those already available to us! Sure we may need to slightly tweak the activity to focus on our content, but those minor adjustments are far easier than

developing from the ground up. Regardless, we can no longer avoid literacy based activities (including writing assignments).

Many of the dos associated with literacy we already incorporate in our classrooms. Raise your hand if you do 3 or more of the items listed under the 'do' column. <Participants raise hands accordingly>. The amount of change necessary to fully embrace literacy is not astronomical like we once thought. In all reality, the biggest hurdle we must overcome is our own mental and emotional hesitancy toward literacy. Hopefully reiterating to each of you the importance of literacy and the extent to which you already incorporate literacy based instruction will lessen the anxiety.

<Change slide-as 'instruction will lessen the anxiety' is being said>.

• Example Activities

• Warm Up

• Instructional time

- Small and whole group discussion

• Closure

- Unit closure with writing assignment
- Class period closure

To incorporate literacy, we do not have to spend every class period writing, reading or in constant (and I mean constant) conversation. We have students use the first 3-5 minutes to journal or write on an open-ended prompt as a warm up activity. This type of activity gets the students thinking about mathematics without simply doing calculations. During instruction, why not utilize a great deal of small and whole group discussion? I'm going to go out on a limb, here, and say most of us already incorporate this level of discussion. If you wish to focus the warm-up on the calculations associated with the topics at hand, switch the writing time to be a closing activity. Either way will incorporate writing into mathematics; if we're lucky, they won't even realize they are "writing in a mathematics class."

In addition to using writing as a daily closure activity, we can use it to tie up loose ends and close out a unit. What better ways to bring closure to a unit than to have students analyze and synthesize all the information? The first couple of writing assignments we give the students, we are going to hear A LOT of whining. However, they will soon come to grips with writing in mathematics, and whether they know it or not their aptitude is going to increase.


Let's take a quick look at a couple of student samples.

<Change slide-as 'couple of student samples' is being said>.

Examples of an open-ended question

This student used more of a visual and table approach to solve the problem.

Honors Algebra 2 Name: Student M

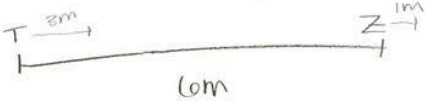


10/10

Solve:

A tiger is chasing a zebra. The zebra is 6m ahead of the tiger. For every 3m that the tiger leaps, the zebra bounds 1m. How many leaps and bounds will it take before the tiger catches the zebra?

G: Undefined
 ASKED - CIRCLED
 SKETCH



Connection:

zebra: $x+1 \rightarrow 6+1=7 \quad +1=8 \quad +1=9$
 Tiger: $x+3 \quad 0+3=3 \quad +3=6 \quad +3=9$

ANSWER - 9m = 3 leaps

Remember, open-ended questions allow students to approach the problem from their level of understanding and thinking style. We are not dictating the complexity or type of approach. The assignment was to solve the following problem:


A tiger is chasing a zebra. The zebra is 6m ahead of the tiger. For every 3m that the tiger leaps, the zebra bounds 1m. How many leaps and bounds will it take before the tiger catches the zebra?

This student chose to illustrate the problem with a visual representation and more or less build a table of values. This approach falls more into the guess and check category, but it

none-the-less forced the student to think outside the box and determine which way the problem should be solved.


This student developed two equations and used the process of substitution to solve.

Honors Algebra 2 Name: Student H



10/10

Solve:
 A tiger is chasing a zebra. The zebra is 6m ahead of the tiger. For every 3m that the tiger leaps, the zebra bounds 1 m. How many leaps and bounds will it take before the tiger catches the zebra?



$y = \text{distance}$

$3x = y + 6$

after 3

c) $3x = y$ $x + 6 = y$

$3x = y + 6$

$2x = 6$

$x = 3$

a) $x = 3$

10) They would meet after 3 leaps

This student took a more advanced approach and utilized a strategy that would later be discussed in this unit: solving a system of equations by substitution. The purpose of this activity was not necessarily to elicit a specific approach and answer but to encourage students to use their background knowledge to think outside the box. When we do these kinds of activities, we often hope our students will stumble onto the intended approach. However, we have to remember the purpose. Regardless of whether or not students stumble onto the approach, we can build on what they do to further develop their knowledge.

• Conclusion and Summary

- Literacy is possible in math
- Build literacy around content

- Fill out evaluation form



Now, keep in mind nothing is instantaneous. We cannot do a literacy activity on Monday and expect our students' test scores on Tuesday to be higher than before. The implementation of literacy must be continuous and from the beginning in order for us to see the results we wish to see. We may not even see the fruits of our labors, but deep down we know our students are going to be stronger math students when they leave our literacy based classrooms. Don't be afraid to enhance the literacy you already use from time to time. It is perfectly acceptable and highly encouraged to utilize some form of literacy in each class period.

Don't forget that to incorporate literacy does not mean we have to assign an elaborate, extensive paper. Making students explain their process and answers is a

form of literacy. Think-pair-share is a form of literacy. Many of the instructional strategies and activities we already utilize are forms of literacy. We just need to incorporate more of these strategies and deepen the level to which students must think while using literacy based strategies.

<Ask for and field any questions>.

Thank you for attending today. I hope you were able to see that literacy really is possible in mathematics without increasing the amount of planning we must do. If you would take a few minutes to complete this survey, I would greatly appreciate it. The survey is completely anonymous and will be used to further develop this presentation to meet the needs of teachers. Additionally, this survey will be used for further research into this topic and any other areas you think are necessary to better our classrooms, instruction and mathematical aptitude of our students.

<Hand out surveys>.

Chapter Summary

The main focus in implementing literacy in secondary mathematics continues to be on the content. Rather than viewing literacy as a separate entity, math teachers should utilize literacy as a supplemental strategy to enhance their content. Mathematics teachers can easily adapt current literacy strategies to mathematics. It is important to accept the reality that not every literacy strategy can be adapted to mathematics, but at the same time there are several ideas or concepts that can be used in mathematics classrooms. Each of the strategies discussed, such as journals and prompts, can be used both as formative and summative type assessments. By implementing literacy, mathematics teachers can gain a better understanding of how much their students actually know. A

significant part of mastery in mathematics is the ability not only recreates the calculations but explain the process. The use of literacy allows teachers to evaluate the extent to which students have mastered the material. With the changes in expectations and curriculum, a deeper mastery of mathematics is necessary. Implementing literacy assesses the mastery and aides in the development of a deeper mathematical knowledge base.

Chapter 5

DISCUSSION

Contribution of the Project

The purpose of this project was to develop training materials in an attempt to better educate secondary mathematics teachers on the importance of literacy and strategies to implement literacy on a regular basis. This project was intended to aid in the progression and development of materials designed specifically for secondary math teachers. Literacy continues to appear in many content areas, but the support and training available for mathematics teachers is still minimal. Other content areas, such as Social Studies and English, receive applicable training and support materials. In an effort to help secondary mathematics teachers, the author developed a project consisting of the most important facts and techniques.

This project is not the end-all-be-all for training secondary mathematics teachers on the implementation of literacy. However, the main goal and purpose was accomplished: to establish a guide to help teachers with the implementation of literacy. The training materials developed consist of simple guide filled with the basics associated with literacy in mathematics. The information provides teachers with not only a definition of what literacy looks like but specific strategies and techniques identified as efficient approaches to literacy. In addition to the definition and explanation side of these strategies, the presentation includes student samples. The inclusion of these student samples was to illustrate what literacy actually looks like in mathematics. By doing all of these things, the author was able to partially accomplish the goal established in the

project. Further research and development of this topic will be necessary to further accomplish this same goal.

Peer Assessment Results

To assess the quality of this project, eight individuals were given a post-training survey inquiring about the strengths, weaknesses and areas of improvement for literacy in mathematics. Participants were asked to answer these questions anonymously and as honestly as possible after receiving the training. Each of the teachers currently implements literacy on an occasional basis but still possess some of the reservations and anxiety about successfully and effectively implementing literacy. Consequently, they do not have the confidence or knowledge of literacy necessary to fully utilize these strategies. All individuals used possess a master's degree.

After receiving the training, all of the participants were able to breathe a sigh of relief once they realized it is not necessary to recreate all strategies from scratch. The participants all increased their confidence and willingness in implementing literacy due simply to the fact that they can utilize strategies already developed. The idea of using journaling intrigued many of the participants, regardless of what format the journaling was done in.

Strengths

One of the most valuable pieces of information learned, according to the questionnaires, was that it is absolutely necessary to incorporate literacy in mathematics. Additionally, although literacy in mathematics looks different than in other content areas, we can still utilize the same strategies to help students better learn the language of mathematics. The reviewers appreciated the training demonstrating the use of journaling

and open ended questions, along with reinforcement of utilizing current strategies. The majority of the reviewers avoided literacy due in large part to the misconception that in order to incorporate literacy in math they must design their own techniques.

Limitations

The research used for the development of this project was not entirely designed specifically for secondary mathematics. Instead, the research was literature based research that was adapted to secondary mathematics education. Additional limitations to this study include the lack of conclusiveness on its effectiveness. The presentation was administered to and evaluated by eight secondary teachers, six of whom are mathematics teachers while two reviewers were instructional coaches. Although the research utilized supports the implementation of literacy, the project cannot conclusively conclude that literacy improves mathematics education in all students.

Additionally, the use of more empirically based studies specifically for secondary mathematics is necessary. Adapting current research is sufficient but additional research is necessary to make explicit and generalizations. The type of participants used in this project are not a limitation to the project, as each of the six mathematics teachers has been a teacher for fifteen or more years and possesses a master's degree. The two instructional coaches have worked closely with secondary mathematics teachers for five or more years, possess a master's and have been classroom teachers. Further research in this area and further administration of this project must occur to better exclusively conclude literacy effectiveness.

Recommendations for Further Study

Looking at the big picture, every area of literacy in mathematics needs further development. Literacy has started being implemented through the standards and standardized tests, but the actual use of literacy in mathematics is still very new. In doing this continued research, more information on ‘how’ to implement literacy can be made available to teachers. Participants who received and evaluated this training were eager to receive more training on the ‘how’ part of implementing literacy in mathematics, since it is very different than other content areas. It is necessary to further research the data associated with increasing test scores through the use of literacy, as this information will aid in the development of more aids for teachers.

One point proposed by a participant was grading. While grading math homework and assessments, mathematics teachers look at the process as much as the answer. They typically grade each problem based on the number of points that problem is worth. The question, however, is how to grade literacy based assignments. When grading the papers many math students are assigned, rubrics are often used. Each of the participants recognizes this fact, but all are unsure how to develop an effective rubric for these various literacy strategies. A rubric for an extended response problem may not be an appropriate rubric for a journal, open ended question or paper.

Project Summary

The author chose this topic as a focal point as it continues to become an integral part of education. Standards, curriculum and expectations have changed drastically in the last decade. Consequently, classroom practices and instructional time have to be restructured in order to ensure students are receiving the education they need and deserve. Currently, few mathematics teachers embrace the use of literacy in mathematics because

of the lack of support materials and training thus far. Teachers currently possess a great deal of anxiety towards literacy in mathematics because of its unfamiliarity. This project was designed to reduce this anxiety and provide teachers with a quick guide to use in implementing literacy.

Other content areas, such as English or Social Studies, utilize a plethora of literacy strategies on a daily basis. Up until recently, these strategies did not blend over into mathematics. However, given the current state of education we must welcome this idea into mathematics. No longer can we leave the reading and writing to English teachers. Mathematical mastery is often defined as the ability to not only recreate calculations but explain the process involved. It is through this explanation process that our students transition into higher levels of thinking and mastery. The ability to activate this higher level of thinking targets the kind of thinking mandated by the new standardized tests.

In summary, it is crucial and necessary to implement literacy in mathematics. The current research, although we are in need of additional research, supports the notion that literacy increases mathematical aptitude and mastery levels. Mathematics teachers must transition away from the anxieties currently associated with literacy into a mindset that embraces literacy.

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