Spring 2011

How Secondary Mathematics Teachers Are Incorporating Literacy In Their Classrooms And To What Extent?

Robyn A. Steinhilber
St. John Fisher College

How Secondary Mathematics Teachers Are Incorporating Literacy In Their Classrooms And To What Extent?

How Secondary Mathematics Teachers are Incorporating Literacy in their Classrooms and to What Extent?

Robyn A. Steinhilber
St. John Fisher College
GRDG 690 – Spring 2011
Dr. Gloria Jacobs

Abstract

Is it possible to integrate literacy learning in a mathematics classroom? In this paper I investigate the different aspects of literacy that can be presented in the mathematics classroom, ways in which literacy skills can improve mathematical understanding, and the reality of current practices. Based on the research, the definition of literacy is limited being limited to reading, vocabulary, and word problems. In order to effectively integrate literacy and mathematics we must overcome this limiting definition many current mathematics teachers provide.

Introduction

Past the elementary grades the instruction of literacy is dramatically reduced? Teachers in secondary grades focus on content, or subject matter, and not language skills. With the current state of adolescents and their literacy skills, should literacy education continue past the lower grades? Kester et al (2009) would stress that we would be ignoring the benefits of continuing literacy education for today's adolescents and therefore should not stop. How can secondary teachers manage teaching the content and helping students develop their literacy skills? What impact will this have on the students if teachers tried to weave the two areas together? Specifically, what motivation do mathematics teachers have for including literacy instruction in their classroom?

In 2000 the National Council for Teachers of Mathematics (NCTM) released an updated list of national mathematics standards (nctm.org). Unlike the previous 1989 edition, the standards now included communication, organization and expression (Thompson & Chappell, 2007). This modification to national standards expressed the need for teachers of all subjects to be teachers of literacy. Mathematics teachers were now responsible for teaching communication in their classroom, something that not every one had done before. What does this look like? Is it simply adding a writing assignment to every class? Is it possible to teach math and literacy while still preparing students for the state tests?

But what are current math teachers doing to teacher literacy skills in the classroom? Are the successful in doing this? What impact is this having on students learning of the content and in development of literacy skills? Tovani (2004) explains the barriers that stop math teachers (and other content area teachers) from teaching literacy skills in the classroom. These barriers include the way the teachers view (or do not view) literacy as a tool for teaching math and the

training the teachers received around integrating literacy skills into mathematics. She emphasized that these teachers were asked to take one the challenge of helping their students develop these skills but were not told how to do this or how to assess it. These teachers felt frustration, fear, and anger towards the new challenge. She discovered that many teachers did not realize that students even read in the classes. Reading, according to Tovani, is the act of deciphering a text, not necessarily reading a book. New Literacy Studies, NLS for short, is built on the idea that literacy learning is not limited to formal studies, but "occurs in interaction as tools for building and maintaining social relationships" (Larson & Marsh, 2005, p 18). This supports Tovani's statement because in many content areas, reading the content is not just reading a book. For example, reading in mathematics can be broken down to understanding a system of equations and what each formula and the solution represent. In order to succeed in mathematics and build a mathematical relationship you have to be able to read and understand the language of mathematics. Asking a math teacher to teach literacy does not mean that the teacher need to help students understand poetry; the teacher should know how to help the students understand ways to approach the text (formula, text book, symbol, etc.), and understand it in the mathematical context it was presented so that the student can communicate mathematically.

Theoretical Framework

Kucer discussed the four dimensions of literacy and how we move through them to be fully literate. In the sociocultural dimension the idea of social identities in emphasized. We examine "how various groups use literacy to negotiate and critique their interactions with the world" (Kucer, 2009 p.7). There is not just a single literacy; the world is made up of many literacies. For example, mathematical literacy is more than just being able to solve equations. It

is recognizing the language of mathematics and its symbols, understanding what is being represented, and being able to explain (through solving or words) how to solve the scenario presented.

Before asking someone to teach literacy we must first examine what literacy is and what it means to be literate in a content. Gee (1989) asks: What is Literacy?" Gee discusses acquisition and learning and how the combination of the two allows one to communicate. Lankshear and Knobel (2007) add to this by defining literacy as the "socially recognized ways of generating, communicating, and negotiating meaningful content through the medium of encoded texts (p224). Being powerfully literate is having "control and fluent mastery" (Gee in Lankshear and Knobel, 2003, p.12). Freebody and Luke (1990) include that a reader participates in four roles. In order to be a successful reader one must be a code breaker, text participant, text user, and text analyst. The code breaker decodes the letter-sound relationship to understand vocabulary; the text participant integrates the new text with their background knowledge to build connections; the text user communicates the information of the text; the text analyst makes meaning from the text. Gee (1989) would agree with this because being literate is being able to use and critically examine the text.

What is the purpose of doing mathematical problems over and over again? One can assume that if you plug-and-chug your way through the same type of problem repeatedly you will understand how to complete the mathematical steps. Just because a students knows how to use the order of operations to solve an equation does not mean they understand why they have to follow it. Can we consider this student, who may have missed zero questions on a worksheet literate if they cannot explain why they follow those steps or what happens if they mix them up? Lankshear and Knobel (2003) explain that being literate is more than knowing how to operate

the language system. Gee (1989) reminds us that critically examining the text (or formula) allows one to have a deeper understanding of why there are steps to the problem and what each step means.

How do students become literate? We acquire language from being emerged in it where learning language is a more analytical process (Gee, 1989). Both acquisition and learning are necessary for becoming literate, after all "literate" requires a vast knowledge of the content, or language (Lankshear & Knobel, 2003). Heath (1982) describes three types of explanations that we evolve through. In the elementary grades students and teachers focus on what-explanations or the right-there answers. Only after mastering these can students move onto reason-explanations and affective-explanations. In fact, according to Heath, teachers do not focus on developing the reason-explanations until the upper grades. (Affective-explanations come from the extra-credit questions.) If literacy instruction drops off after sixth grade, how can we expect students to reason affectively? Once again, understanding how to complete the steps is one thing, but reasoning, justifying, and critiquing the text show true comprehension.

Research Question

Secondary education teachers, according to national standards, are required to help students develop literacy skills (specifically communication). With this added requirement, mathematics teachers are trying to weave literacy skills into the lessons they are teaching. How are these secondary mathematics teachers incorporating literacy in the classroom and to what extent?

Literature Review

Mathematics and Literacy are two very different entities. This is the claim of many mathematics teachers around the country (Siebert & Draper, 2008). The idea of mathematical

literacy is limited to the ability to *do* math. According to the Programme of International Student Assessments, or PISA, mathematical literacy includes knowledge of mathematical elements, procedures, operational skills, and terminology (Matteson, 2006). The latest edition of mathematical standards, released by NCTM in 2000, includes a statement that "instructional programs… should enable all students to use the language of mathematics to express mathematical ideas precisely (p. 402). Therefore, being able to solve an equation is not enough anymore; students need to be able to express their understanding, and that is where literacy comes in.

The revised edition of NCTM's standards include explain the various literacy elements (NCTM, 2000). The representation strand requires students to use different representations to "organize and communicate" mathematical thinking and to translate among different representations in order to solve various problems (NCTM, 2000 p.67). NCTM (2000) suggests that teachers should "pose questions to engage and challenge" students to think and for teachers to ask students to clarify or justify an answer (p.35). Students are expected to show organization through communication with peers and teachers and "use language of mathematics to express mathematical ideas" (NCTM, 2000, p348). With these revisions the importance of integrating mathematics and literacy is evident. NTCM not only provided expectations but ways in which teachers can ingrate math and literacy skills.

The 2004 National Report Card reported that 64% of forth grade students failed to demonstrate "proficient" level for mathematics (Hart & Petrill, 2009). Math tests today are not just measuring mathematical skills but also reading comprehension and writing skills (Thompson, 2007; Rutherford-Becker & Vanderwood, 2009). For example, on a grade 12

California standardized test students had to write a verbal description of a geometric figure. Only 39% of students' answers were scored as "Satisfactory" or better (Thompson, 2007). On the Texas TASK test in 2003/04 70% or more students answered only 42% of questions represented verbally correctly (Matteson, 2006). Most of these students missed more than half of the questions. The algebra portion of the test was compiled of 50% verbal questions (Matteson, 2006). Today's standardized tests require students to "read, create, use, and comprehend numerous mathematical representations as a way of demonstrating mathematical literacy" (Matteson, 2006, p.205).

"When am I ever going to need this in life?" This is the question that teachers face every day and usually reply an answer related to graduation requirements. But individuals who are proficient in mathematics make, approximately, 38% more money than their counterparts who do not have mathematical proficiency (Rutherford-Becker & Vanderwood, 2009). Mathematical deficiencies limit educational opportunities and, in turn, employment opportunities as well (Rutherford-Becker & Vanderwood, 2009; Baker, Street, & Tomlin, 2006). Being able to reason mathematically can get you more than just a high school diploma. Social justice and equality are affected by job opportunities (Baker, Street, & Tomlin, 2006).

Justification for Integration

Students need to have an understanding of the vocabulary of mathematics if they are expected to learn math in general (Miller, 1993). Literacy strategies can help students with the language aspect of mathematics. Literacy can be used one of two ways: to practice procedures and rehearse the material or to observe, identify patterns and relationships, clarify, justify, synthesize, or construct meaning (Adams, 2010). Literacy strategies are not limited to vocabulary but also include writing skills. Writing can help students understand and with

problem solving skills (Adams, 2010). In the mathematics classroom it is important to make material real. Infusing literacy strategies into the lessons may help to create reality in the mathematics (Adams, 2010).

Mathematics is a language all its own. Miller (1993) describes math as a "language consisting of carefully defined symbols that represent fundamental concepts" (p.311). The language of mathematics defines various concepts and theories and also provides a means to represent and manipulate these concepts to help one understand. (Adams, 2010). Mathematical language is used to make sense of new information as well as organize and communicate thoughts and understanding (Adams, 2010). Your level of mathematical understanding is correlated to your ability to use the language of math.

According to Rutherford-Becker & Vanderwood (2009), students' mathematical performance is influenced by both computational skills and reading comprehension. Students need to be able to manipulate symbols (understand objects and relationships) just as much as they need problem representation skills, or the ability to translate between verbal and graphical representations (Matteson, 2006; Adams, 2010). These problem representation skills, or language skills, are what are holding students back the most (Matteson, 2006; Rutherford-Becker & Vanderwood, 2009). If a student is struggling with both mathematics and reading focusing on the reading skills first may fix both problems (Rutherford-Becker & Vanderwood, 2009).

Method for Integration

Studies have shown that content-area teachers often resist teaching literacy in their classes because they believe it is not their job or responsibility, they are not trained to do it, or there is not enough time to teach that and the content (Siebert & Draper, 2008; Phillips et al,

2009). It is not logical to ask a mathematics or science teacher to teach reading and writing in the style of an English or ELA teacher, but asking the teacher to integrate literacy into their lesson in order to support content learning is reasonable. Matthews & Rainer (2001) defines integrating as making whole or complete by bringing together separate parts. For example, teachers could encourage students to explain the meaning of words when using mathematical vocabulary terminology (Miller, 1993). Many mathematics words represent concepts rather than objects such as quotient, factor, and dividend (Miller, 1993). Students are better at using symbols, diagrams, or examples that words to define vocabulary (Miller, 1993).

When integrating mathematics and literacy, what goals should teachers strive to attain? Miller (1993) suggests that teachers should link familiar language, real-world concepts, formal mathematical language, and symbolic manipulation. There are many terms that teachers can use to encourage mathematical discourse. These terms are not limited to "use appropriate language," "describe," analyze," "evaluate," and "make a summary statement" (Matteson, 2006, p211). According to Adams (2010), "being able to describe what you are doing mathematically in words is helping you retain it more" (p.383).

Writing and vocabulary development are key components for integrating mathematics and literacy. Writing in math is a chance to reflect on the work and clarify thoughts (Adams, 2010). It helps you remember and focuses the learning; it can be a reflective tool (Adams, 2010). When having students write to learn the students' ideas occur and form as they are writing (Adams, 2010). Writing is also linked to the NCTM (2000) process standards. Students can practice writing to learn when writing about patterns or relationships; generalizing, inferring, or predicting; communication, summarizing, or interpreting; or when they reflect on or justify an idea or concept (Adams, 2010). In comparison to writing to learn, writing to record can help

students remember details, steps, and important definitions. With writing to record, students compile accurate and factually correct information for reference (Adams, 2010). This can be a great final draft of notes.

There are different purposes for writing in the content areas. The two main goals are writing for rehearsal and writing for reorganization; Adams (2010) defines both of these terms. Writing for rehearsal occurs when a teachers asks students to fill out a graphic organizer to review the test material or when a mathematics teacher has the student write the steps for solving a problem to help the students memorize. Rehearsal writing is for revisiting material, reviewing, or putting concise definitions/procedures on paper (Adams, 2010). Writing for reorganization is more of a thinking tool. Students take note of theories, ideas, and questions they have. They write their thought process out in hope of making connections and building an understanding (Adams, 2010). Both of these techniques can help students not only with writing skills but also to understand the concepts being taught.

Literacy skills can be taught through more than just writing. Vocabulary can challenge students across all content areas. There are two different methods for teaching vocabulary, concept definition and concept image (Adams, 2010). Concept definition requires students having a precise and fixed definition, usually written down in notes or referenced in a textbook (Adams, 2010). This is the verbal definition that students memorize and reproduce when asked. Concept images allow students to construct a definition using their own words (Adams, 2010). Students generate this definition after exposure to images, processes, examples, etc. Every student will not have the same definition and the students will build their definitions as the processes/concepts are learned. Students will arrive at a definition at their own speed. Ability to define a concept and the depth of the definition show the teacher the level of understanding the

student has achieved. For example, having a student describe a concept (adding variables with coefficients) may lead to definitions ranging from "just add the numbers in front of the letters" to "add the total of all numbers in front of common letters, remember to add 1 when there is no coefficient on the variable." The same concept applies to vocabulary words. At the beginning the definition is simple, but as understand increases the definition becomes more valuable.

In a study conducted by Adams (2010), two teachers used similar concepts to teach vocabulary. The first teacher, Ned, used the Frayer model and provided textbook definitions for the students to memorize, an example, a non-example, and facts/characteristics (p 380). He used the chart of the Frayer model was used as a review, to organize previously learned material. The second teacher, Christine, chose to use a Visual Verbal Word Association (VVWA) chart instead. The strategy she implemented allowed the student to create a visual representation, personal association or characteristic, and a definition (p 382). The definition was the last part added to the chart and added after the students had time to "discover" the meaning throughout the lesson.

Frayer Model and VVWA are similar in the fact that both are graphic organizers used to display the meaning of a vocabulary work in multiple. The Frayer Model is built to be used as a tool for teaching a concept that students revisit and try to memorize. The VVWA, which includes "personal association or characteristic," (Adams, 2010, p. 382) allows students to build more connections and own the vocabulary word. Students need to use a vocabulary word, or term, in different ways and often to fully understand it. This exposure must include more than just definitions, which is why strategies like the Frayer Model and VVWA can be beneficial to content area teachers. Ned's approach involved repeated exposure in order to memorize and Christine used multiple approaches to the topic to develop an understanding.

Theoretical Connections

Justification for integrating literacy skills with the mathematics concepts comes, ultimately, from NCTM. The council not only requires that this happen, but provides ideas for teachers and explanations for the change. It is stated in NCTM's *Principles and Standards* "algebraic competence is important in adult life, both on the job and as preparation for postsecondary education" (p. 37). Competence is more than knowing but being able to explain and defend what you know. Students need communication skills to "reason, defend, or understand the conceptual basis of mathematics" (Matteson, 2006, p. 228). Math and language skills go beyond the classroom; they are needed to succeed in life.

Mathematical and literacy skills do not start the first day of school and take a break over the summer; these are skills that start at birth. One of the more obvious resources for children to learn both mathematics and language is books. Children's books often contain numbers, counting, sequences and patterns, and rhymes (Wade & Moore, 1998). When children have an early start with books they have practice reading and engaging with the books and they are motivated to use books (Wade & Moore, 1998). But not every child has books.

The sociocultural theory supports that different backgrounds of students effect the acquisition of mathematics (Baker, Street, & Tomlin, 2006). Exposure to numeracy events, or an "occasion in which a numeracy activity integral to what happens," at a young age will provide children with an introduction to mathematical skills will help them throughout schooling (Baker, Street, & Tomlin, 2006, p. 290). A numeracy event may occur when an individual gets change in a store or using money manipulatives in school to "buy" a toy.

Students come from all different backgrounds and this effects how the react to mathematics and literacy. It is important that students not only are able to learn mathematics but

able to communicate and reason with it. This will allow the students to own the mathematics and to connect to it (Miller, 1993). This ownership will empower them. Moreover, just as exposure to mathematics or literacy at home can help students in school, conflicts between home and school mathematics or literacy can be just as detrimental. Sometimes the purpose or rules of numeracy at home are not the same as at school. When using money at home to purchase an object the individual is giving up money to gain a possession. In schools, teacher use money manipulatives to teach adding and subtracting; this decontextualizes the event. The students may understand the change they get back when making a purchase but they cannot connect this to sliding plastic coins around on their desk.

Methods

Context and Participants

Research for this study occurred in a suburban high school. Participants, all current mathematics teachers in their 40s, volunteered their time, input, and lesson plans on the topic. The participants, Mrs. Labe, Mr. Sorge, and Mr. McKenna (all pseudonyms), have been teaching in the mathematics department at this high school since the school opened in 2001. Mr. McKenna has taught in four school districts and has been teaching mathematics for over twenty years. He also is certified to teach physics and middle school science. Mr. Sorge has been teaching in the same district his entire career (since 1989), which is also the district he grew up in. Mrs. Labe started as a community college professor before finding a teaching job in the school district 20 years ago. All participants identify themselves at white, as do 94% of the students (according to the NYS Report Card from 2010).

Researcher Stance

For this research I be interviewed the participants on their views of literacy in their own classrooms, examined lesson plans, and observed how they do or do not integrate literacy skills into their instruction. I am currently completing my master's degree in Literacy (grades 5-12) and have a bachelors degree in Mathematics with a certification to teach adolescent education (grades 7-12). All participants were my former high school mathematics teachers who I have also worked with during my undergraduate studies.

Method

I met with each teacher for the interview portion on the research for 30-45 minutes. Before meeting with each I sent them a list of questions (Appendix A) I was going to ask, so that they would have time to reflect on what I was asking. During the interview I asked each participant about how literacy skill development have been implemented in their classrooms (or has not been), if there are literacy requirements from administration, and if they have received professional development around the implementation of literacy in the mathematics classroom.

After interviewing each participant I looked over some lesson plans they believe do not include any literacy skill development and some they believed they have included this development. I also observed a lesson to see what ways the participants were presenting literacy skills (ex. write a summary paragraph). I observed the teaching methods being used, not the students in the classroom or they way the students react to the teaching methods.

To ensure credibility, or "the ability to take into account the complexities that present themselves in a study and to deal with patterns that are not easily explained" (Mills, 2000, p104), I implemented a few strategies. First, I collected a "slice-of-life" as Mills describes, or a collection of raw material including lesson plans and materials used in the lessons.

Secondly, I tested their interpretations of implementing literacy strategies against their actual lesson plans and observations of lessons. Lastly, the comparison of lesson plans to actual lessons and to interviews allowed me to practice triangulation of the data. To ensure confirmability, or the objectivity of the research, I triangulated the data (as described earlier) and reflected on the assumptions that I as a researcher have towards mathematics and literacy. Dependability was ensured through the examination of lessons the participants claim teach literacy skills and those they claim do not, and by comparing the interview questions to actions taken when teaching a lesson.

In order to obtain informed consent from the participants I first emailed each participant with an overview of what I was asking of them. I explained my background with mathematics and literacy and why I had chosen the topic. In the request I also attached a copy of the consent form that I will bring wit me to the initial interview. Before the interview I revisited the consent form and reminded each participant that they could choose not to answer any question or end the interview if they chose.

Data Collection

For this research I focused on three pieces of data to collect. The first is the interview so that I could understand the thoughts of the participant about literacy in their classroom. The second was the lesson plans. I chose to look at plans the participants feel did not include literacy to help understand what it is that they do not consider to be literacy skills. The plans that did include literacy will show me what literacy skills they were trying to develop with their students. The third data collection is the observation of how the teacher prompts students to use and develop literacy skills in a mathematical setting. I looked for the participant to prompt for explanations, clarifications, and for peer discussions. Literacy skills

such as having students take notes, write summaries, and provide short (1-3 word answers) were also be noted.

Findings

After interviewing the three participants, looking at sample of lesson plans, and observing a few lessons I have identified a few similarities and differences among the teachers. There were questions in which the participants described similar views of literacy and others where a particular teacher's views differed dramatically. In general, the teachers' views of literacy were limited to reading texts (books and word problems) and defining vocabulary; only one teacher expanded this to include reasoning and communication.

When asked why students struggle with math, all participants agreed that basic mathematical, or algebraic, skills were lacking. Students have become calculator dependent and trust whatever answer the calculator provides. Both Mr. Sorge and Mr. McKenna agreed that students focus on memorizing steps or vocabulary rather than understanding the concept. They also stated that the language of math was difficult for some students. The problems are presented in words that have to be converted to labeled diagrams and then into formulas filled with notations only relevant in the mathematical world.

The three teachers admitted that many of their students struggle with word problems. All three described methods they use to teach word problems that included underlining, color-coding, and/or circling parts of the text. They demonstrated how they start with reading the word problem, pulling out these key parts to label on a diagram. Once the diagram is complete they work on converting the diagram into an equation, which students already have learned how to solve. Once solving the equation they refer back to the word problem to ensure they answered

the right question and evaluate if the answer makes sense. This last step is the one most students skip, according to Mrs. Labe.

The last theme that all participants agreed upon revolves around the textbooks. When asked how the students understand how to read a textbook all three explained process done at the beginning of the school year. The textbooks authors use bold text to represent vocabulary words (which are also defined in the back index of the book), headings and chapter titles provide a preview to what will be discussed, there is a table of contents in the front for easy reference, and problems later in a chapter usually have an example earlier that students can refer to. These are the parts that all three teachers demonstrate to their classes within the first month of every school year. According to one of the participants, it is the mathematics teacher's job to show the students how to use the book, but the English teacher's job to teach them to read it.

When it came to vocabulary each teachers had a different way of approaching the topic. Mr. Sorge preferred the textbook definitions that he provides for students to write down in their notebooks. Mrs. Labe starts with the textbook definition when first introducing the lesson but summarizes unit vocabulary on a chart containing the term, picture, and a student-generated definition. Mr. McKenna placed laminated, color-coated copies of the year's vocabulary words across the top of the classroom walls. They were grouped so students could build connections and placed in order. He also used "vocab cards on a ring" which had the term on one side and a picture on the other. He used this strategy most with his struggling students, as a way to differentiate the lessons. When defining words he helps the students build an understanding of the concept through examples and diagrams before having them write their own definition in their notes.

	What is Literacy		Word Problems		Textbooks		Vocabulary
Mrs. Labe	Reading textbooks Word Problems Vocabulary		Do: underline, color code, or circle parts of text. Change from words into diagram into equation. solve equation, check answer.	Skip the "check" most often	Show use at beginning of year: headings, bolded vocab, glossary / dictionary in back, index	Odd answers in back, can use as reference	Textbook definition to start. Review with term, picture, and student-generated definition
Mr McKenna		Communi-cation Reasoning		Students are too calculator dependent ▪ Need it for simple math ▪ Always believe its answer		How to use examples: asking "why" for steps	Year's vocab colo rcoded and sequenced around room Vocab on a ring Definition comes after teaching the concept (student-generated definition)
Mr. Sorge						Math teacher: how to use the textbook English teacher: how to read it	Textbook definition copied into note book

This chart summarizes the data collected from research participants during interviews. Names appearing above are pseudonyms, to protect the anonymity of the partcipants.

The teachers who participated in this research have all been in the teaching field for approximately the same amount of time and have worked in the same building for the last 10 years. Though their environment is quite similar their teaching styles, regarding emphasis on integrating literacy, have vast differences.

Implications and Conclusions

"How would you define mathematical literacy?" This question opened the doors for understanding how each of the participants viewed the impact of literacy skills within their classroom. Their definitions ranged from understanding vocabulary words, to grasping concepts off written paper, and even to understanding the language of mathematical terminology. The first

two examples show the restriction to written language. This is the standard "reading and writing" definition. The last example opens the possibilities to include all mathematical terminology, later expanded upon to include reading equations and examples to understand what is going on.

How one defines literacy determines how they choose to implement it in their class. This was demonstrated by the interviews, lessons plans, and observations I made. The teachers who incorporated literacy "when it happens naturally" limit their understanding of what literacy is to vocabulary, word problems, and reading the textbook. The teacher who expanded the definition admits that arguing and reasoning are key to understanding; to argue math you must be mathematically literate.

During the research I noted that one participant placed the job of teaching reading (in all contents, including math) on the English teacher. The same participant also limited mathematical literacy to mainly word problems and vocabulary. Reading a math textbook is different than reading an English class book. Tovani (2004) pointed out "math teachers read… differently than those who do not teach or read math" (p 27). The way that these teachers read allows them to understand the math behind the words. The strategies that math teachers use to decode mathematical writings allow them to understand the text. These are the strategies that should be taught to math students; these are also the strategies that English teachers cannot teach as effectively. Math teachers need to be able to teach their students how to read mathematically. This is not only something that should be done at the beginning of the year. Teachers should be reinforcing the skills throughout the year in order to model good mathematical thinking.

When discussing word problems multiple participants mentioned the issue of reliability on calculators. Students learned the steps for decoding word problems and changing them into diagram and equations. They also learned how to evaluate the equations. However, students

rarely checked their work at the end. Two participants agreed that the answer the calculator gave was the answer their students believed. This was because the students generally did not evaluate the validity of the answer. *Does the answer make sense mathematically? Did I answer the right question? Did I use the proper notation or unit?* These are the reasoning questions that students skip. Teaching students to justify or defend their answers would help them catch small mathematical errors, issues with initial decoding of the word problem, and even stray negative signs. Not only would students have the correct answer, they would also understand what that answer meant and where it came from.

It can be concluded that teaching literacy skills involves conscious awareness of what being literate means. Content area literacy is more than reading books, writing stories, and learning vocabulary. This literacy is the ability to understand a text, whether it is a textbook, word problem, worked out example, etc., and the ability to communicate that information out, through reasoning, justification, and clarifications (Matteson, 2006). Conscious and intentional teaching of literacy skills has been shown to aid in comprehension of the topic itself. Tovani (2004) stated that literacy instruction helps us to ask "*So what?"* This one question allows the reader to understand what is going on, why it is happening, and what that means. These connections build understanding, or comprehension. Gee (1989) reminds us that we need to use and critically examine text to gain understanding. There is more than just one literacy (Kucer, 2009), and literacy is more than just reading books (Larson & Marsh, 2005). Literacy skills are needed with every content with every text. Students need to be able to negotiate these texts in order to comprehend them. A student who struggles with math, who may be held back from future careers due to this, could be helped if they were taught not only the concepts but also how to understand and reason with these concepts.

Limitations

The literature and theoretical information provided a starting point for my research. After gaining insight from current mathematics teachers I have found that there are still unanswered questions. I wonder if the teachers who have a limited view of literacy will be able to truly integrate literacy in their classrooms. How could we change the curriculum of the mathematics classes to encourage the teaching of literacy skills in a mathematical setting. When will content area teachers finally agree that reading instruction is not limited to the English classroom and that all teachers are teachers of literacy?

This study was limited by the amount of data collected. If time permitted, interviewing more mathematics teachers in various schools and districts would have provided a more global view of literacy through the eyes of the mathematics teacher. I may have found more limited views of literacy instruction and even teachers who have found multiple ways of developing literacy skills effectively in their classroom.

The research I conducted supported the literature I have read. The understanding that mathematics teachers (and other content area teachers) have, that there is no reading in the class, presented itself in my research and various studies previously conducted. The general concept of "what is literacy" was completely different when referencing the theoretical findings verses the studies (researched and conducted). This discrepancy describes the most significant opportunity for content area teachers regarding the teaching of literacy in their classrooms.

References

Adams, A. (2010). Rehearsal or Reorganization: Two patterns of literacy strategy use in secondary mathematics classes. *The Montana Mathematics Enthusiast, 7(2&3)*, 371-390.

Baker, D., Street, B., & Tomlin, A. (2006). Navigating Schooled Numeracies: Explanations for low achievement in mathematics of UK children from low SES background. *Mathematical Thinking and Learning, 8(3),* 287-307.

Freebody, P., Luke, A. (1990) 'Literacy' Programs: Debates and Demands in Cultural Context. *Prospect*, *5(3)*, 7-16.

Gee, J. P. (1989). What is Literacy? *Literacy: A Critical Source Book*, *171(1)*, 525-544.

Hart, S., & Petrill, S. (2009). The ABCs of Math: A genetic analysis of mathematics and its links with reading ability and general cognitive ability. *Journal of Educational Philosophy, 101(2),* 388-402. doi: 10.1037/a0015115

Heath, S. (1982). What no bedtime story means: Narrative skills a home and school. *Language in Society*, *11*, 49-76.

Kester Phillips, D., Bardsley, M., Bach, T., & Gibb-Brown, K. (2009). "But I Teach Math!" The Journey of Middle School Mathematics Teachers and Literacy Coaches Learning to Integrate Literacy Strategies into the Math Instruction. *Education, 129(3),* 467-472.

Kucer, S. (2009). *Dimension of Literacy: A conceptual base for teaching reading and writing in school settings*. New York, NY:Routledge.

Lankshear, C., & Knobel, M. (2003). *New literacies: Changing knowledge and classroom learning*. Buckingham: Open University Press.

Lankshear, C., & Knobel, M. (2007). Researching New Literacies: Web 2.0 practices and insider perspectives. *E-Learning, 4(3)*, 224-240.

Larson, J. & Marsh, J. (2005). *Making Literacy Real: Theories and practices for learning and teaching.* Thousand Oaks, CA: Sage Publications Inc.

Matteson, S. (2006). Mathematical Literacy and Standardized Mathematical Assessment. *Reading Psychology, 27,* 205-233. doi: 10.1090/027027106006422491

Matthews, M., & Rainer, J. (2001). The Quandaries of Teachers and Teachers Educators in Integrating Literacy and Mathematics. *Language Arts, 78(4),* 357-364.

Miller, D. (1993). Making the Connection with Language. *The Arithmetic Teacher, 40(6)*, 311-316.

National Council for Teachers of Mathematics (NCTM). (2000). *Principals and Standards for School Mathematics*. Reston, VA: Author.

Phillips, D., Bardsley, M., Bach, T., & Gibb-Brown, K. (2009). "But I Teach Math!" The journey of middle school mathematics teachers and literacy coaches learning to integrate literacy strategies into the math instruction. *Education, 129(3),* 467-472. doi:1801926201

Rutherford-Becker, K., & Vanderwood, M. (2009). Evaluation of the Relationship Between Literacy and Mathematical Skills as Assessed by Curriculum-Based Measures. *The California School Psychologist, 14,* 23-34.

Siebert, D., & Draper, R. (2008). Why Content-Area Literacy Messages Do Not Speak to Mathematics Teachers: A Critical Content Analysis. *Literacy Research and Instruction, 47(4),* 229-245. doi:10.1080/1938807082300314

Thompson, D. (2007). Communication and Representation as Elements in Mathematical Literacy. *Reading and Writing Quarterly, 23*, 179-196. doi: 10.1080/10573560601158495

Thompson, D. & Chappell, M. (2007). Communication and Representation as Elements in Mathematical Literacy. *Reading & Writing Quarterly, 23*, 179-196. DOI:10.1080/10573560601158495

Tovani, C. (2004). Do I Really Have to Teach Reading? Content Comprehension Grades 6-12. Portland, ME: Stenhouse.

Wade, B., & Moore, M. (1998). An Early Start with Books: Literacy and mathematical evidence from a longitudinal study. *Educational Review, 50(2),* 135-145.

Appendix A

Interview Questions

1. Can you tell me about your teaching career?
2. What made you choose mathematics
3. What do you think is the main reason some of your students struggle to understand mathematics?
4. How would you define math literacy?
5. How do student know how to read textbooks? Do you spend any time teaching this?
6. Why do students struggle with word problems?
7. How do you teach new vocabulary words?
8. Are you required by administration or standards to teach literacy skills? (What ones?)
9. What ways do you integrate literacy into mathematics teaching?
10. What opportunities to practice reading, writing, and word study do you plan in to you lessons regularly?