The Connection between Language and Writing in Mathematics

Rebeca A. Kolupski

The College at Brockport, rku1@gmail.com

Follow this and additional works at: http://digitalcommons.brockport.edu/ehd_theses

Part of the Education Commons

To learn more about our programs visit: http://www.brockport.edu/ehd/

Repository Citation

http://digitalcommons.brockport.edu/ehd_theses/440

This Thesis is brought to you for free and open access by the Education and Human Development at Digital Commons @Brockport. It has been accepted for inclusion in Education and Human Development Master’s Theses by an authorized administrator of Digital Commons @Brockport. For more information, please contact kmyers@brockport.edu.
The Connection between Language and Writing in Mathematics

By
Rebecca Kolupski
Summer 2014
A thesis proposal submitted to the Department of Education and Human Development of The College at Brockport, State University of New York in partial fulfillment of the requirements for the degree of Master of Science Education
# Table of Contents

**Abstract** .................................................................................................................. 7

**Chapter One: Introduction** ...................................................................................... 8

- Statement of the Problem ..................................................................................... 8
- Significance of the Problem ................................................................................. 10
- Purpose of the Study .............................................................................................. 12
- Study Approach .................................................................................................. 14
- Rationale ............................................................................................................... 15
- Chapter Summary ................................................................................................. 15

**Chapter Two: Literature Review** ........................................................................... 16

- Introduction .......................................................................................................... 16
- Making Meaning through Mathematical Language .............................................. 16
  - Social/Joint Meaning Making ........................................................................... 17
  - Communication .................................................................................................. 17
- Vygotsky – Language and Meaning Making .......................................................... 19
  - Language ............................................................................................................. 19
  - Zone of Proximal Development ....................................................................... 20
  - Scaffolding .......................................................................................................... 21
  - Writing .................................................................................................................. 24
- Mathematical Thinking with Language ................................................................. 25
- Mathematical Standards ....................................................................................... 27
- Real World Connections ....................................................................................... 28
Findings ......................................................................................................................... 53

Theme 1: Incorporate Literacy through Constructivist Theory ..................................... 53

  Starting with the End in Mind ................................................................................. 54
  Student Questioning Drives Instruction ................................................................. 63
  Use of Manipulative Materials to Enhance Learning .............................................. 70
  Using Group Work to Promote Learning ............................................................... 82
  Summary .................................................................................................................... 89

Theme 2: My Beliefs Directly Influence my Teaching Practices ..................................... 90

  Giving Students Opportunity to Explain Their Thinking ....................................... 91
  Unpacking Problems Allows for Greater Understanding of what to do ................. 96
  Showing Students Reading is a Part of Mathematics ........................................... 103

  Chapter Summary ..................................................................................................... 106

Chapter Five: Conclusions and Recommendations ................................................ 108

  Introduction ............................................................................................................. 108
  Conclusions ............................................................................................................. 109

    Written and Oral Language Aids in Mathematical Meaning Making ............... 109
    Teaching Practices Decided Upon by my Beliefs ................................................. 112

  Implications for Student Learning ......................................................................... 115

    Students are Directly Impacted by Teacher Practices ......................................... 115
    Literacy Should be used in Conjunction with Mathematics ............................... 116
    Teaching Practices Should Engage all Learners ................................................ 117

  Implications for My Teaching ................................................................................ 118
Abstract

Literacy is an important aspect to include with all mathematics because it allows for students to construct new knowledge in a meaningful way. I think that students will be much more successful when they can see the connection between the two, as all literacy elements are included within mathematics. Students must be able to read, write, speak, listen, and view to clearly communicate and interpret all mathematics. The purpose of this study was to explore whether my personal beliefs regarding mathematics and literacy matched my teaching practices within the classroom in both districts where I taught. I collected data using journal entries, lesson plans, and observations from my mentor. I found that in almost all cases, my teaching practices did match my beliefs of incorporating literacy within mathematics. The few places where a disconnect occurred, showed that even though my teaching practice did not match one of my beliefs, the change was made to make sure all students were constructing new knowledge. This self-study was important for my own practice, as it provided large insights into what I do to encourage all students to learn. This study was important for all students because it is seen that communication is a prime source in representing information to others. For teachers, determining whether the teaching practices used are most effective for students is a very important thing. If the teaching practices are not effective, then they need to be altered with the students in mind. Through my study, I saw that the decisions I make about teaching are done with all students in mind and the ways they learn.

Keywords: Mathematics, Literacy, Student Engagement, Language, Communication
Chapter One: Introduction

Statement of the Problem

I sat in class on an early Saturday morning listening to the professor explain the assignment in its entirety. The assignment was simple, open ended with only one requirement: find something you are passionate about that you don’t know much about and learn more about it. From that moment I knew I wanted to do something not many of my other peers would do because I wanted to set myself apart, research something that I had always wanted to but never really had the time or chance to do. After careful thought of exactly what I wanted to hone in on, I decided to produce a case study around the importance of incorporating literacy in mathematics within a school setting. This idea was something I was always so enthralled with, but was never given any concrete evidence within any of my undergraduate or graduate classes. Through that assignment, as well as after the assignment ended, my questions about the issue evolved to incorporate how my personal beliefs resonate through my teaching. It is one thing to strongly believe something and it is another thing to enact it through teaching.

While teaching, I see those students who have the mathematical strategies to answer the questions, but then they struggle with verbally expressing what they have done because they don’t know the point of what they are doing. I want students to be as successful as they can, but without the necessary understanding of the question, how can we expect them to be? New York State expects students to be able to write their thinking and to defend their reasoning using mathematics to know if they understand the material (engagny). If they have a hard time verbalizing their thinking, then they are going to have an even harder time writing it down. It is crucial for students to state their reasoning in a cohesive manner that shows
proficiency. Knowing how to answer the problem is only showing surface understanding. What needs to be achieved is to know why that is the answer and what it represents in the context of the problem. All of the students I have worked with seem to know the computational strategies, but have no idea what they represent; they simply go through the motions.

Communication has now been deemed one of the most important goals by New York State for all students to be proficient in within mathematics (engagny). This communication is in the form of creating, refining, and sharing of concrete topics and concepts to others and to one self.

Reading, writing, listening, speaking, and viewing are the five aspects of literacy. These are the ways that students take in new ideas and internalize them to then communicate to others. This process has to be done simultaneously for students to achieve the deep understanding that is required for them to be the most successful. Syverson tells us that the conventional view of literacy learning is as a set of skills for the apprehension or creation of text-based materials such as books, periodicals, signs, worksheets and forms (2008). This is a sequential view seen as linear and linear is not always what works most appropriately. What this means is that this type of learning cannot be done with each skill receiving the same time and depth for learning. Some are more difficult to understand and therefore take more time to process. Mathematics is the same way: students take different amounts of time to truly comprehend each topic. Teachers are now focused on incorporating all aspects of literacy within all content areas, which includes mathematics. Students need the ability to read, write, listen, speak and view all mathematics concepts with a deep understanding. Once this is achieved, it is known as mastery of the concept.
Within my current classroom, I am always trying to express the importance of why we are doing what we are doing and how it relates to the real world. My seventh graders just want to get it done without really having to think. I push them to want to know why they are doing something and how it will later affect them. I also push myself to take the time for those explanations to make sure my students will be successful. I constantly ask them to explain their thinking to the entire group so others can hear what their explanation sounds like. It also gives them the opportunity to compare it to what they had to say to see whether they had come up with something appropriate. Allowing for several students to share the same idea gives all students the realization that there is not one single concrete way to explain it. I want students to be successful and the greatest way to do that is to incorporate speech and writing simultaneously within the classroom.

Language, literacy and mathematical meaning making need to be brought to a conscious level so students know how and why they occur together. Through my explanations and the questions I ask my students, I want them to realize why I use language and literacy to construct mathematical meaning. This is so important to me because I believe it is the most appropriate way for all students to become successful and to be able to answer the “so what” questions. They need to know why they are learning these concepts and how it will benefit them to be successful in the real world.

Significance of the Problem

I believe that speech and writing need to go hand in hand with each other for all students to be successful. Students need to realize the connection between the two for them to conceptualize new learning in a deeper way. It is also important that the way I feel is truly
portrayed to my students, as it is a positive attribute to instill in them. Communication is how one portrays or gets an idea across to another person or people. Without communication we cannot know what someone else is thinking or understanding. Math communication is different for all students because they each understand things in a different way. Each student makes meaning of something in an individualized way, based on personal beliefs and experiences.

There needs to be a connection between talk, literacy, and mathematics so students can make mathematical meaning of all new learning. As new learning is taking place, they must also be able to communicate their thinking to concretely show they understand the processes and why these processes are done. In a case study done by Huang and Normandia about students’ perceptions on communicating mathematically, their research showed that “the use of language, both spoken and written, is crucially related to the learners’ construction of mathematical concepts and the subsequent development of mathematical thinking” (2009, pg. 3). Students construct new understandings as they go through the process of active listening. This type of active literacy has to do with physically going through the motions to gain the understanding through all language processes. A soccer player will be more successful learning how to shoot if they are physically practicing the motion. They will however be unsuccessful if they do not practice and simply listen to what their coach has to say. Mathematics is the same way; students are only going to develop the deep understanding by going through the process of actually doing the work and then making sure they are able to communicate exactly what they did. The job of the teacher is to scaffold and assist the students as they construct the meaning until they are able to do so successfully and independently.
Samaras (2011) explains that there are several different self-study methods and each one is used to discover something different as well as how the individual is going to construct the process. For my purposes I used the Living Educational Theory. This “examines the alignment and authenticity of one’s beliefs and practices and generates theories of the lived practices” (Samara, 2011, pg. 98). I wanted to make sure I was promoting exactly what I believe so my students are able to witness that and use it to be at the standard that New York State says they should be. Through this self-study I discovered that I am in fact incorporating all necessary materials and language, verbal and written, for all my students to be successful learners.

Each teacher has a very distinct belief system brought on by experiences, interactions with others, and individual learning through different sources. What we believe in directly affects how we teach others. If one strongly disagrees with homework, then homework will most likely not be given or given in moderation. If one strongly believes in a constructivist approach to learning, then that is the way the classroom environment will be conducted. Whatever the teacher’s specific belief or beliefs may be, they will directly affect all those who are impacted by it. I was also discovering whether my teaching practices matched up to my specific beliefs around connecting mathematical language of speech and writing. Through the data, it does show that everything indeed matched together.

**Purpose of the Study**

The main purpose of the study was to examine the connection between my beliefs and my current implementation of those beliefs within every class that I teach. I believe speech and writing are powerfully connected. In this study, speech is related to how a student verbalizes
understanding in the context of mathematical reasoning. It also goes a step further to see how students construct their meaning of mathematics through language and literacy. Several students know how to get the answer within their head, but it is impossible to know what is happening without that person explaining the process. In so many instances it seems that students simply cannot do that because they don’t have the words to express their thinking. In other cases they just don’t have the process of expressing their thoughts to others.

It is important for educators to realize how their beliefs are portrayed to the ones who will be most affected by them. In this instance, I strongly believe in the relationship among oral language, writing and mathematical meaning. I want this belief to be portrayed to my students in the most positive way so they desire to ask the tough questions until they get it. If we, as educators, start to figure out the relationships between beliefs and outcomes, then we can adapt our teaching practices to make our viewpoints truly stand out in a positive manner.

Through studying my own practice, I answered the question,

How do my beliefs about the connection of talk and writing in mathematics match up to my teaching practices in the classroom?

Consequently I also answered,

How do I portray my beliefs within the classroom to my students?

I designed this study around the premise of reflecting on my own teaching practice to get a better idea of how my actions represented my beliefs. It fits directly with my passion for incorporating all sorts of literacy within mathematics because of the current disconnect between the two. Students need to see how everything within school is related and builds upon each other. New York State refers to this idea as the staircase of complexity, as one thing leads
to the next (engagny). Before I could start my research I had to figure out where my beliefs had come from and what exactly molded them to what they had become today. This was important to know ahead of time because I needed to realize the history before I could look at the future.

**Study Approach**

This self-study was a qualitative inquiry. I chose that type of study because the research took place in the natural environment of my classroom. The specific data I collected were chosen to directly provide concrete evidence to answer the research question. A self-study was chosen to specifically focus on how my beliefs influenced the way I taught. I also examined whether the two are seen as connected through my teaching. This was important for me to discover because I am the one that my students rely on so I needed to make sure my actions are the best they could be.

My data were collected in three separate forms that connected in the analysis. I used a personal journal, lesson plans that I created, and observation notes from my mentor while I taught certain lessons. Having another person observe my teaching gave an unbiased reaction of exactly what another saw as I taught. This data were also collected between two separate school districts. District one had collection of all three data pieces, while district two does not include the observation notes from my mentor due to a scheduling conflict.

As I began collecting my data, there were some things I needed to answer specifically about myself that would help guide me. I needed to figure out exactly what my beliefs were and what caused them to form in such a unique way. Once I figured that out, I was able to discover how exactly I portrayed those beliefs to my students. I knew I had certain beliefs, but it
was time to ascertain the relationship with my teaching practices. This was an important piece to the study approach because my portrayal of teaching is directly related to the data.

**Rationale**

I chose to complete a self-study because I wanted to figure out exactly how I portrayed my beliefs in teaching. I feel so strongly about this particular subject area so I wanted to discover how I actually portrayed this to my students. As my students start to uncover the ideas I feel strongly about they will hopefully in return start to understand these ideas on a deeper level for themselves.

The three separate data collection pieces ensured my research question would be answered to the absolute best of my ability. Each piece brought its own unique data points that ultimately fit together to a larger picture. The language and ideas that I had been using since the start of the school year changed and adapted as my beliefs and ideas also continued to change. This was noted within the data collection and was seen as I changed teaching techniques to try new things.

**Chapter Summary**

It is critical for teachers to uncover the ways their beliefs match up to how they present new learning to their students. As I believe that speech and writing should be used simultaneously to give students the ability to deepen their understanding, I needed to detect how I did this. Through the concrete research and research studies that I had come across, as well as my own research design, I have distinctly shown how my beliefs match up to my teaching practices.
Chapter Two: Literature Review

Introduction

The literature review is based upon language in mathematics, with a focus on talk and writing. Two main parts encompass this whole: the ways students use language for mathematical meaning making and the way math standards have intertwined language within them.

The first section relates to making meaning as a joint process with the social aspect of language. Within this social aspect, communication plays a large role. This leads directly into how Lev Vygotsky viewed language as a tool to help scaffold students to create a wider zone of proximal development. Writing is used as another communication tool to enhance the ability to make meaning. This section wraps up with how mathematical language is used as its own separate language to create a deep understanding for all students.

The second section, mathematical standards, relates the similarities between the New York State standards and the National Council of Teachers of Mathematics standards to show the importance of real life applications of mathematics. As students relate new mathematical concepts to their own independent lives, they are making meaning by creating what makes sense to them. This section wraps up with explaining how a students’ environment can help construct these needed real world applications.

Making Meaning through Mathematical Language

Incorporating speech and writing together is an important tool for students to allow success on a deep level within mathematics. These two things need to happen simultaneously for the best results to occur. The two can be related and characterized as language. Language is
the basis for all communication; it is how one person allows another person to understand specific ideas. “Developing a voice in mathematics is one of the most important goals of the twenty first century” (Whitin & Whitin, 2001, p. 1).

Social/Joint Meaning Making

Communication

Communication is important to the development of mathematical understanding; just to “put students in groups and let them communicate as they solve problems” (Richards, 1991, p. 16) is not very helpful. In some cases students need to learn how to communicate with peers and with their own thoughts as they construct meaning. It is not in the students’ best interest to work together when the understanding of how to effectively communicate is not there. As teachers it is important to give all students the necessary skills and strategies for them to work through different concepts to create meaning in their own special way. We know that students negotiate meaning individually, with their peers and to others (Perry, 2001; Yackel, 1991). This communication needs to be done in the most cohesive way for students to get their ideas across. As students work towards this, they are able to produce meaning most effectively. When students do have the capability to work through different ideas with group members, Perry (2001) suggests that the students provide two different approaches to solving the intended problem. Coming up with two different approaches really solidifies this idea. “Across many studies, collaborative learning activities have been shown to be very beneficial to children’s learning and conceptual development in mathematics” (Simpson, Mercer, & Majors, 2010, p. 3). As students share their ideas with the rest of the group, others are able to explore
how different classmates approached the same problem. This type of strategy will in most cases extend each student’s repertoire of strategies that they can use (Perry, 2001).

The use of mathematical communication is now required by New York State with an increased focus in all areas of mathematics as a step by step process (engageny, 2013). The more students communicate, the more they learn what works and how to refine their ideas to make them the most appropriate for who they are communicating with. As we grow older we tend to speak differently depending on who our audience is, and this works the same way with mathematics communication. “Representations allow students to communicate mathematical approaches, arguments, and understanding to themselves and to others” (NCTM, 2013, n. p.).

“As students communicate their ideas, they learn to clarify, refine, and consolidate their thinking” (NCTM, 2013, n. p.). Teachers need to incorporate open ended questions where students are not just required to come up with the right answer, but use explicit reasoning and explanation (Kyriacou & Issitt, 2008). This idea was shown through the analysis of 15 different studies which incorporated talk in mathematics classrooms. When students construct verbal explanations of their answers, they were navigating towards the deep understanding they were searching for. With every new or different approach comes a negative side and communication is no different. “Because teachers and students each construct their own meanings for words and events on the context of the ongoing interaction, it is readily apparent why communication often breaks down, why teachers and students frequently talk past each other” (Cobb, 1988, p. 88). The teacher and student bring different experiences and understandings to the table. This is something the teacher needs to consider as he/she decides what examples to use or descriptions to make sure each student can understand. When the teacher is constantly
immersed in the content by teaching it to several classes, it needs to be remembered that the students are learning it for the first time and need it taught step by step. While communication of the new content is occurring by both the teacher and the student, they are working to create a bridge that they can relate to and understand. That bridge will be constructed differently by each student and the teacher.

**Vygotsky- Language and Meaning Making**

**Language**

Students clarify their thinking and construct meaning when they verbalize what they learn (Monroe, 1996). It is important to do this because as students put the explanation into their own words, they are doing it in a way that makes most sense to them. Each student has had his/her own experiences that are only relatable independently. Since no two people are the same, teachers cannot construct the meaning for them. Conversation as a form of communication “allows students to convey ideas, feelings, and experiences that can lead to the development of higher cognitive functions, including critical thinking, sound reasoning, and problem solving” (Albert, 2000, p. 109). We know that a conversation happens amongst people as a give and go process; one person listens as the other speaks and vice versa. The people within the conversation have to be somewhat knowledgeable in the topic to follow and reciprocate with their own ideas. If the person is not educated in the topic, the other participant is left to do more of the talking through concrete explanations. This idea would work best for students because they relatively understand the topics so when they speak to a classmate not so much explicit explanation needs to be done. But when they do talk to
someone else with limited understanding about the idea, they will be forced to explain in great
detail.

Lev Vygotsky explains that language is the most important tool for making meaning both
individually and socially (Vygotsky, 1962). Students use language to make meaning and work
through ideas to then understand the process. This type of learning is known as social
constructivist theory and is highly effective because it involves collaboration of peers through
social interactions (Powell & Kalina, 2009). Students use the tool of language to work through
different ideas. “Social constructivism is based on the social interactions a student uses in the
classroom along with a personal critical thinking process” (Powell & Kalina, 2009, p. 243).

**Zone of Proximal Development**

The zone of proximal development, or ZPD, is what a student can achieve with the help
of a more capable individual versus the zone of actual development; what a student can
achieve independently. The definition given by Albert is “it occurs when students are involved
with tasks or problems that go beyond their immediate individual capabilities in which teachers
(or adults) assist their performance, or in collaboration with more knowledgeable peers” (2000,
p. 109). It is important for teachers to understand each student’s ZPD to allow them to be
successful without getting frustrated. As teachers use the ZPD to assist students, they are using
a method where “students act first on what they can do on their own and then with assistance
from the teacher, they learn the new concepts based on what they were doing individually”
(Powell & Kalina, 2009, p. 244). Using mathematical language will allow the teacher and the
students to make meaning together as the teacher is aware of each student’s zone.
The way the student is supported through the ZPD is through social interaction as the more capable person helps the student with the understanding. Ngee-Kiong Lau, Singh, & Hawn say that the internalization may awaken social functions that come about through the social interaction and that these social interactions do not only occur with the teacher, but also with peers (2009). Peers have different experiences and a different way of thinking of new ideas that may match with what another student requires to reach the deep understanding. “From an educational perspective, there is learning potential, where students require their peers’ contributions to make progress in their learning” (Ngee-Kiong Lau et al., 2009, p.310).

An important piece to remember about the zone of proximal development is that it is what a student needs support with at a specific point in time (Zack & Graves, 2001). Each student has a different level of background knowledge which shows through as they learn new concepts. Students will often find one topic very difficult, but then another topic much easier to grasp. This means that their ZPD will change dependent on what they are learning. Wood et al. (1976) explained that as students are learning these new skills and concepts, they are combining them with the new material to accomplish more complex tasks. As the more capable person is working/helping the student succeed, different strategies and explanations are used to help support what the student requires. This idea of assistance is also known as scaffolding.

**Scaffolding**

When teachers use the ZPD for each student, they are aware of what the student can do independently and where they need assistance. The strategies and techniques they use are scaffolding the student to allow for success. As students verbalize their thinking aloud, the teacher can give them prompts and ideas to assist with this process. “Scaffolding is an assisted
learning process that supports the ZPD, or getting to the next level of understanding, of each student from assistance of teachers, peers, or other adults” (Powell & Kalina, 2009, p. 244). In mathematics, teachers use scaffolding as they present new ideas and gradually release more and more responsibility onto the students to create that deep understanding with independence.

Anghileri (2006) created three different levels of scaffolding to support learners throughout the entire process of learning new material. The first level occurs before the teacher interacts with the students. Environmental provisions are created, found, or enhanced based on each student’s individual needs for that particular lesson. With all teaching, this level is taken into consideration before the lesson is taught, but may need to change as students start working with the material. Grouping is another part of this level and is important because students need to be immersed around other students who are going to support and enhance their learning. A better way of thinking about this level is not yet including any of the mathematics; it’s all about the preparation and not the teaching.

Level two gets into making sure the student understands the new learning. “Explaining, reviewing, and restructuring involve direct interactions between teacher and students related specifically to the mathematics being considered” (Anghileri, 2006, p. 41). Explaining for students can be difficult because they know the process and procedures, but cannot verbalize their understanding. Scaffolding by the teacher is used here to support each student with prompting and guidance to get that explanation from the student. Reviewing is categorized by Anghileri in five types of interactions; “getting students to look, touch, and verbalize what they see and think, getting students to explain and justify, interpreting students’ actions and talk,
using prompting and probing questions, and lastly, parallel modeling” (2006, p. 41). These classifications force the student to develop his/her own thinking and independence instead of relying on teacher support. The scaffolding is still there brought about by the teacher, but lies more on the student. At this stage in scaffolding, new material should not be brought to the student, it is all about reflecting on what has already been presented. Interactions in this area may look like, “provision of meaningful contexts to abstract situations, simplifying the problem by constraining and limiting the degrees of freedom, rephrasing students’ talk, and lastly, negotiating meanings” (Anghileri, 2006, p. 44).

The highest level of scaffolding is known as level three; the last level of supporting students. This level “consists of teaching interactions that explicitly addresses developing conceptual thinking by creating opportunities to reveal understandings to pupils and teachers together” (Anghileri, 2006, p. 47). This understanding is done through verbalization or written explanations done by the student. The teacher supports the student to make connections between these new concepts with old concepts by determining what they have in common. Since math has so many overlapping concepts, it is important for students to make those connections. Mccosker & Diezmann support this higher level of scaffolding as they say it “can foster students’ creative and divergent thinking skills, enhance their independence, sense-making and self-confidence in mathematics” (2009, p. 32). When scaffolding is done correctly by questioning students’ actions and thinking without terminating their ideas, it can account for internalization of ideas created by the student.
**Writing**

“The promise of writing is that it offers an alternative to the visions of classroom communication that are strictly oral in nature” (Baxter, Woodward, & Olsen, 2005, p. 119). As students learn within the classroom, they normally verbalize their understanding to the teacher or to a peer within the class. Students need to write because it forces them to make meaning through written language as they write independently and as they share their writing with others. “Teachers can use writing to assess their students’ understanding, foster number sense, and extend mathematical conversations” (Whiten & Whiten, 1998, p. 161). New York State requires students to “model with mathematics” as they solve problems in their daily lives (engageny, 2013, n. p.). Writing is just one strategy to use as a representation to model what is trying to be explained. As students start to use this modeling technique, they will start to work through their ideas to come up with a precise and accurate description. “The assertion is made that writing – only one of many language tools– is a device for mediating cognitive development, moving the learner through the zone of proximal development to the zone of proximal practice” (Albert, 2000, p. 111).

It is just as important for students to write their thinking because of the strict emphasis on mathematical communication that has been emphasized by New York State standards (enganey, 2013). For those students who are timid to vocalize their thinking, they have the opportunity to express what they know through written communication. “Articulating one’s thought processes in writing demands a greater number of words to express understanding of concepts or ideas” (Albert, 2000, p. 112). This process still allows the teacher to know whether all students understand the concept through what they write instead of solely what they say. As
teachers work to incorporate speech and writing simultaneously, students are able to get their ideas out there between each other before putting it down on paper. If students can verbalize their thought processes, they will be much more successful when it comes time to write the explanations. “This social context of learning helps transform written speech because written language provides opportunities to use oral language out of social context” (Albert, 2000, p. 112).

**Mathematical Thinking with Language**

Language and mathematical concepts need to happen simultaneously as they work with each other to produce the same idea, but still include their differences. What this means is that mathematics has a certain language separate from everyday speech. Certain words, letters, and phrases represent something very specific in mathematical language. When this new language is taught to students, it needs to happen so that the new language matches directly with the new topic. When mathematical concepts are segregated from the language contexts in which they naturally occur, learning difficulties are likely to result (Ewing, 1996). A disconnection occurs when a student cannot relate the language with the learning. Baxter, Woodward, & Olsen (2005) also explain that as students converse with one another and themselves, they are working to make sense of the mathematics which in return increases their self-efficacy. Self-efficacy is the belief that one has for him/herself on the ability to achieve something. In this case it is the personal belief that a student possesses about being able to achieve the deep level of understanding.

Both spoken and written language need to be shared by the students and the teacher. As this is done, students are able to make deeper connections and relations between them. It is
not okay for students to have a surface understanding of simply how to get the answer. They need to have a deeper understanding of why they are doing what they are doing and what it all means. Knowing how to get the answer is not what teachers are hoping for. Students need to be able to explain why the strategy works and what it all represents. In a study by Raiker “on the use of language by both teachers and learners in mathematics lessons,” it was demonstrated that the “use of language, both spoken and written, is crucially related to the learners’ construction of mathematical concepts and subsequent development of mathematical thinking” (2002, p. 50). When students create knowledge they are also developing language. These two things are interrelated in a way that one cannot happen without the other. Huang & Normandia refer to them as “acting as a catalyst” (2009, p. 2). Each idea works together to produce an increased understanding in a quicker approach than one at a time.

“Students and the teacher give mathematical explanations to clarify aspects of their mathematical thinking that they think might not be readily apparent to others” (Yackel, 1991, p. 5). As a person elaborates on an idea or thought, they are giving more information to the recipient in an attempt to have them fully understand. That person is trying to help the other person accomplish the same understanding that the speaker has. Teachers often reword the same sentence or idea in multiple ways to get all students on the same level of understanding. Teachers will also give multiple real world examples in an effort to tap into each student’s personal experiences. Regardless of how it is done, it is done with one intention; to allow the same understanding by all students.

As students work to construct meaning through the various sources they are given, it is important to remember that the environment that this takes place in will affect the outcome.
Yackel & Cobb have found that teachers who work to establish “sociomathematical norms create a classroom climate that supports problem solving and inquiry” (1996, p. 461). In the regular classroom students explain their thinking aloud, but incorporating a sociomathematical norm would encourage “students to explain their solution using mathematical argumentation” (Yackel & Cobb, 1996, p. 458). This type of classroom climate pushes students to use evidence to justify their explanation with precise terminology. The student is required to think deeply about how to communicate the idea across to the intended audience.

**Mathematical Standards**

Mathematics is a difficult content area for most students because it has so many deep layers that encompass the whole. Students must be successful within each layer to become well rounded citizens in the real world. New York State created state standards which outline what a proficient student should have the capability to do (engagyny, 2013). Teachers use the standards to create lessons and activities to ensure all concepts, strategies, and ideas are internalized within each student to then perform individually. One thing that students need to have the ability to do is use language, both oral and written, to explain their thinking of mathematical concepts. Both of these things need to happen simultaneously for the most successful learning to occur. As these two ideas are woven together, students need to know that all mathematics is related to the real world in some shape or form. When they understand what they are doing has a purpose, they will become more successful.

Students must distinguish what is expected of them so they can fulfill those expectations and continue to grow them. Communication is how we explain to others what we want them to know. As students explain their mathematical thinking through communication
they need to know what their end goal is. The National Council of Teachers of Mathematics (2013) has identified learning to communicate mathematically as a major goal for students. Kilpatrick, Swafford, & Findell (2001) from the National Research Council have defined mathematical proficiency as having five distinct interrelated strands: “conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition” (2001, p. 5). Conceptual understanding is having a strong comprehension of mathematical concepts, relations, and operations. This is important for students to acquire because it is the basis of all mathematics. Procedural fluency is the ability to quickly and efficiently carry out mathematical procedures. Strategic competence is having the ability to formulate, represent, and solve mathematical problems. It is all about having the appropriate strategies to get the correct answer to a problem. Adaptive reasoning is having the ability within one’s mind for logical thought, reflection, explanation, and justification as to why an answer is correct. It also provides the basis for why a particular strategy was chosen to solve the problem. Students can build on their efficacy through productive disposition; figuring out that all mathematics is useful and has a point. Each one of the five areas are important alone as they are woven together to produce a whole. A student cannot be truly proficient in mathematics unless he/she has acquired the necessary deep understanding through each strand.

**Real World Connections**

It is important that all real world applications for every topic within mathematics be taught in a way that allows students to think on a deeper level. This can be achieved by relating each concept to a unique and personal experience. “An emphasis on mathematical connections
helps students recognize how ideas in different areas are related” (NCTM, 2013, n. p.). Active literacy is what researchers call the digging into the deeper processes of why the language, symbols and encoding of written language in mathematics is used (Monroe, 1996). It explains why such processes are used and what the benefits of each are. Each has been created to help students with the creation of deep understanding. Students need to encounter the natural connection to achieve literacy success in mathematics. Learners need to experience language not as a set of isolated skills, but as meaningful, purposeful, and inseparable from real life (Monroe, 1996). As they can relate each topic or concept to their own lives, they will make a unique and very specific connection that makes sense to them. Those personal and unique connections are how students start to comprehend each topic and concept. “The opportunity to experience mathematics in context is important, but students should connect mathematical concepts to their daily lives, as well as other situations in other content areas” (NCTM, 2013, n. p.).

However, it cannot be assumed that the students know concretely how to establish these connections independently. Real life connections need to be explained and described to students for them to be able to internalize them in their own way. We cannot assume as teachers that they understand where and when to use each topic or strategy in their own lives. Students achieve growth in active mathematical literacy through participation in meaningful mathematical activities (Monroe, 1996). As students start to move towards proficiency, New York State created a standard describing this proficient student; “mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify and complicated situation, realizing that these may need revision
later” (Engageny, 2013). The student is able to make more sense of the problem by relating it to the real world, but then can go back and change things once they receive more information from working through the problem.

Active literacy is “a process that enables learners to go much deeper than the coding and encoding of written symbols” (Boomer, 1985, p. 5). They must see this language as inseparable from real life; they combine together as one unit. For learners to actually achieve mathematical literacy, they must go beyond the basic computational skills that have served both to define and to limit mathematics (Monroe & McMain, 1994). These basic computational skills are what each student uses to simply solve the problem and come up with an answer. The basic way is no longer enough; they must acquire and use the content specific language with precision. To achieve this type of literacy, students need to be immersed in an environment in which they are required to solve several meaningful real life problems (Monroe, 1996).

Students need to see that the environment they live in is rich with mathematics instead of using it only in academics.

As real life applications are used, students can start to see how each concept directly affects their own unique lives. They will start to internalize these ideas and then concretely notice them in their day to day activities. As Monroe (1996) also explains, learners who are to achieve mathematical literacy must solve meaningful problems related to many real-world contexts. Only by doing so can they develop an understanding of their world that is enhanced by mathematics, instead of coming to believe that mathematics has nothing to do with the real world. As this is established, students will get that age old question answered of, “why am I doing this?”
When students learn to construct meaning through their computations, they need to use what they have done and created as they explain their thinking. New York State requires that the work done be tied directly into how the students explain their thinking (Engageny, 2013). “Representations should be treated as essential elements...in communicating mathematical approaches, arguments, and understandings to ones’ self and to others” (NCTM, 2013, n. p.). As this is done by all students, with the help of the teacher, they can construct the appropriate meaning.

It is not only how we teach students mathematics, but it is also where we teach them. The environment the student is learning in needs to be organized in such a way that has the student in mind. It needs to be comfortable and invites learning to occur. Each student has his/her own unique environments as each live separate day to day lives. Every environment each is in has some effect on his/her learning abilities. All natural learning environments reflect a commitment to the basic premise that the natural motivation of the student is of prime importance in structuring learning experiences (Monroe, 1996). Each classroom needs to allow the motivation of each student to thrive and be successful.

In a case study developed by Perry in the fall of 2001, she studied the nature of students’ communication as they engaged in specific mathematical tasks in different settings such as independent, small group, and whole class. She gathered her research from a designated fifth grade classroom using inductive analysis. This type of analysis is unique because once the data was collected she did not set them into concrete or conceived categories; instead the themes and patterns from within emerged outward to help avoid bias. Her major finding was that students most often engaged in negotiation of new topics
individually before they negotiated with other students. Each type of negotiation came in a different form; creating visuals, crossing out or erasing, and self time. Self time is the time a student uses to independently think about new ideas without necessarily writing anything down; it can be thought of as a time for reflection. Perry noted that students “created visuals as a part of doing mathematics rather than as external to the process” (2001, p. 74). Creating pictures of what is described in the problem is a way to organize ones’ thinking and helps the student make sense of the solution. These visuals were often times sloppy and messy which Perry says reveals “the spontaneous nature of this type of communication” (2001, p. 75). The visuals that were used to negotiate meaning individually were then shared to negotiate meaning with other students to portray their explanation.

When communication turned to involve peers, Perry (2001) noted that this was done with strictly oral language. Students used different strategies for different purposes and Perry (200) noticed that some used more than others. She later discovered that students had acquired a different number of strategies and were able to master different ones in different situations. What works for one student may be impossible for another to comprehend.

Once the meaning was made verbally, and in some cases with visual stimulation, the primary teacher had the students write their thinking independently about their new learning. As students wrote, Perry (2001) saw that they were describing what had been done whole class or in the small groups as students shared their thinking. In most cases the students did not strictly use words, but relied heavily on pictures and symbols. Perry (2001) believes these students may not have been ready or even equipped for this type of writing. “Children should
have multiple and frequent experiences with writing for different purposes, such as justifying, testing ideas, reflecting, explaining, and showing work” (Perry, 2001, p. 78).

**Chapter Summary**

From the literature presented, there are two major ideas that make up the larger picture of incorporating language, written and oral, within mathematics to produce proficient students. These two ideas need to happen simultaneously and in a way that works best for each individual student. There are several factors that go into using language as the prime strategy in mathematics. Both the student and teacher need to work together to create a common language that everyone understands. As students start to use content rich language, they can enhance their skills by relating it directly to their everyday lives. When students utilize each of these ideas through scaffolding from the teacher, they will have the deep understanding necessary to be “college and career ready” (engagyny, 2013, n. p.).
Chapter Three: Methods and Procedures

The main purpose of this study was to discover how my personal beliefs showed through my teaching practices. I believe that students need to connect literacy practices within mathematics to be able to construct a deep understanding through oral and written language.

Research Question:

Through the six week study, I was able to answer the following question:

How do my beliefs about the connection of talk and writing in mathematics match up to my teaching practices?

Context of the Study

The study overlapped between two separate school districts, but I taught seventh grade mathematics in both. This was due to my placement ending in district one and I was then hired right after in district two. In the first district, I was with the students from the first day of school establishing relationships and routines. In the second district, I started in the middle of the school year; the week before February break. This posed a challenge because the teacher had already established the way she wished her class to be taught. Students were used to the way she did things and I had to do my best to make an easy transition to establish my own unique way of teaching.

District one and two were located within the same county, but different towns. The population of the county was recorded in 2010 to be 14,519 people (city-data). In 2011 it was recorded that the median household income was $47,753. Within the population, 85.2% were estimated as white, 5.4% as Hispanic, 5.1% as Black, 2.4% as Asian, 0.2% as American Indian,
0.01% as Native Hawaiian and Other Pacific Islander, and 1.6% as being two or more combined races (city-data).

In district one for the 2011-2012 school year, 11,478 students made up grades kindergarten through grade 12. This was a steady decline from the 2009-2010 school year when the population was 12,210 students (NYSR, 2013). Students eligible for free lunch made up 29% of the district population with 11% who received reduced lunch prices.

Specific to the school where the study took place in district one, it was recorded in the 2011-2012 school year that 12% of the students within the entire school were classified as Black or African American, 10% as Hispanic or Latino, 2% as Asian or Native Hawaiian, 75% as White, and 1% as Multiracial (NYSR, 2013). The annual attendance rate for that school year was 96% with a suspension rate of 14%. 31% of the students were eligible for free lunch, while 14% of the students were eligible for reduced lunch.

In school district two, 3,635 students made up grades kindergarten through grade 12 for the 2011-2012 school year. That was also a steady decline, similar to the decline district one had from the 2009-2010 school year when the population was 3,818 students (NYSR, 2013). Students eligible for free lunch made up 11% of the district population with 4% who were eligible for reduced lunch prices.

Specific to the school where the study took place in district two, it was reported in the 2011-2012 school year that 8% of the students within the school were classified as Black or African American, 11% as Hispanic or Latino, 3% as Asian or Native Hawaiian, 76% as White, and 2% as Multiracial (NYSR, 2013). The annual attendance rate for that school year was 97% with a
suspension rate of 6%. 13% of the students were eligible for free lunch, while 7% of the students were eligible for reduced lunch.

The seventh grade classroom in district one was located on the second floor of the building. A SmartBoard stood against the front wall with all the desks facing toward it. The desks were in three separate rows; the two outside rows comprised of three desks pushed side by side. There were four of these groups in each row. The center row was made up of two desks side by side with again four of these groups. Each student had an individualized desk with the seat attached.

The daily routine was the same for each class. The students came into the classroom, picked up a warm-up worksheet from the front table and took it to their assigned seats. Once their homework from the previous night was out on their desk to be checked, they started the warm up independently. Once the bell sounded, I shut the classroom door which indicated class had started. I gave brief announcements and circled throughout the students checking their homework while they continued on the warm up. I had a designated student collect the warm-up worksheet and I picked my favorite wrong answer to display to the class. From there, the entire class analyzed what was good about it and where the student was confused. This was an anonymous process because it was a learning experience for all of the students to reflect. I handed out the class notes and I worked with the students to answer some example questions. Class time was given for the students to either work in pairs or independently to work through more problems. Homework was given at the end of each class to further enhance independence on the subject.
I was required by New York State, as well as the district, to teach the students through what they created called Modules (engagny). For the seventh grade math curriculum there were seven separate modules with each focusing on a different general topic. The modules contained standards that were addressed within, why it was important for students to know this material, and how to teach each topic. Within each module there were set lesson plans that were strictly examples of each topic. There were examples to be done together as a class and then examples for students to work through either independently or in pairs. The intended purpose of each module was to get students “college and career ready”; that was the goal of New York State as well as the school wide improvement plan for the participating school (engageny).

These modules were very specific, but aligned directly with the Common Core Standards (New York State, 2013). I had to get through the material in an indicated amount of time with the students having achieved proficient understanding in each topic. I had some wiggle room in what I could exclude or what I could add to enhance the material, but for the most part I was told what to teach.

The daily routine was something I came up with on my own. I chose to run it that way because at each moment the students were expected to be working on mathematics. It was the same each day so the students knew what to anticipate and they knew what they should have been doing without me having to tell them each day. It took several weeks to get them in the routine, but once it had been established it worked well.

Things were a little different in district two because the routines and procedures were set in place by the former teacher. This seventh grade classroom was also located on the
second floor and the door led into the back of the classroom. The desks had the seat attached and they were in groups of two, side by side, in three rows. The front wall was lined with white boards and a projection device called an Elmo. An Elmo is a technology tool that projects whatever is put under it by a camera onto the screen to make it visually easier to see. The teacher desk was located in the far front corner of the classroom facing the students.

The walls of the classroom in both districts were covered with posters and words. There was a word wall on the back chalk board where new words the students were learning or continuously saw were posted. This was used for the students to have repeated exposure of the same important vocabulary. New words and posters of new learning were continuously added through each unit. Posters of mathematics concepts still to be learned were also shown as a way of foreshadowing, to get students acquainted with the idea.

The daily routine in district two was somewhat the same as in district one. As the students entered the classroom, they picked up papers to be used that class period in bins from the back table. They went to their assigned seats, took out their homework, copied the essential to know question for the day in their notebook, and got started on the warm-up. As students were working on the warm-up, I was either checking homework or pulling a small group of students to work on a different warm-up at the back table who needed extra support. After the warm-up, I went over the homework with the students and started the lesson. Throughout the lesson, students had the opportunity to work independently or in pairs to further enhance their new learning. I checked each students understanding of the lesson through a quick ticket out the door. That ticket out the door determined part of the lesson for the next day.
The schedule was a unique one in that I saw each class daily, but on every other day I saw two classes for an extended 20 minutes. The bell did not always designate the start or end of class because of this scheduling. Days were split between A and B days. Each day I taught periods one, three, six, and eight. Each period was 42 minutes in length with nine separate periods in the day. On A days, I saw periods one and six for the extended 20 minutes and on B days, I saw periods three and eight for the extended 20 minutes. On an A day, the regular period one went from 8:10 to 8:52, but I saw my period one math students until 9:12. The bell would ring at 8:52, but the students remained in their seats to continue learning until I dismissed them at 9:12. The extended periods were referred to as E20 which stood for extended twenty. This was the same process for each extended period every other day.

Modules were not the teaching tools used in this district; instead they followed directly along with the textbook. This textbook was titled *Math in Focus: Singapore Math* (Cavendish, 2013) and this was the first year that it was being used. I met with the two other seventh-grade math teachers twice a week to come up with warm-ups, extra worksheets, and exit tickets to use. We all taught the same thing on the same day, but used different language and examples that we saw fit. Because the students were required to take the State Test at the end of the year, I tried to incorporate pieces from the modules because of the language. New York State makes the state test and New York State created the modules so my belief was that the language used in both would be similar so it was important to get students familiar with it.

I continually adapted and changed the daily routine as well as my teaching practices to figure out what worked best for the students. Coming into the classroom midway through the
year posed a challenge because the students were not used to my classroom management techniques as well as teaching styles.

**My Positionality as the Researcher**

I am a 24 year old Caucasian female currently living in a Western New York city. Before starting my Master’s degree in Childhood Literacy, I gained a Bachelor’s of Science degree in Mathematics with a concentration in Childhood Inclusive Education. I have four initial teaching certifications in an attempt to make myself more marketable in the teaching world. These areas include Mathematics grades 7-12, Childhood grades 1-6, Students with Disabilities grades 1-6, and Early Childhood grades birth-2.

Previously, I worked with students in grades 3-5 as a math intervention specialist. This was a six week period right before the 2012 New York State math test was given to the students. Prior to my current position, that was the only other long term experience I had. Day to day substitute teaching in two other districts had also comprised my teaching experiences.

When I taught in district one it was a Title 1 middle school. This means that at least 40% of the schools’ students came from low-income families. I was a long term substitute with the students from the first day of school. I taught four separate math classes; one class was accelerated with 26 students and three other were regular classes with varying sizes between 16 and 28 students. The accelerated class moved at a faster rate and more material was covered from day to day than in the regular classes. The regular classes were all taught the same concepts based on the New York State standards. For this study, I decided to focus on my teaching in the smallest regular class. I chose this because it was the only available time that my mentor had free to observe me. My mentor was also a seventh grade math teacher, but taught
on a different team than me. That means she taught different students than I did, but we taught our students the same things. She was currently in her twenty-sixth year of teaching mathematics. She observed me twice through informal observations due to unforeseen scheduling conflicts.

Currently, I am working in district two. I teach four regular math classes because they do not offer an accelerated program in seventh grade. Each class is taught the same things, but the pacing is somewhat different based on student needs. My examples as well as class activities change based on what students can handle. Each class varies between 20 and 26 students. I have chosen to focus my data collection on the first class of the day because of their high maturity level. In this class I do not have to worry about behavioral issues so I can ask higher level questions and push their understanding to new levels.

As a teacher-researcher, my educational philosophies affect everything I do. I believe my role as a math teacher is to provide the necessary instruction and environment that is most conducive for learning. This instruction surrounds the idea of useful strategies and tools the students will be able to use independently to come up with an appropriate answer. It is also much more than simply finding the right answer; I need to make sure each student knows why he/she is doing the problem and why it is important. Real world applications are helpful for students to be able to put themselves into the context of the situation and gain understanding of where they would use different concepts. Students don’t just learn math to pass the state test, they learn math to be successful members of society.

My philosophy of teaching has drastically changed since the start of my education career. As I started college, I had very little teaching experience so I used what I had learned in
college classes; I adopted the best pieces that I thought would work best for me. Once I started gaining more experience as I was put into different classroom settings, my philosophies changed based on what I saw and did. Some ideas worked better than others so I used what worked and tweaked them to make it even better. As my education path is nearly finished I pretty much have a set philosophy, but know it will continue to change as time goes on.

My main personal goal is for all students to be able to learn in a community rich environment in which they feel safe, valued, and above all have fun while they are learning. Students learn abstract mathematical ideas that they will use to develop their minds. These new ideas will allow students to think outside the box when learning and connect new learning to things they have previously learned. They need to visualize and be able to interpret information in unique ways where this abstract thinking will be required. Students should not be expected to sit at their seats for the entire day and strictly listen to the teacher talk at them. This type of teaching and learning is of course ineffective and produces nothing worthwhile.

Knowing the needs of each learner is crucial in making sure the students are learning and understanding the material. This allows for them to make that internal connection necessary to put the information into their long term memory. If they do not have the knowledge from before, they are going to have a difficult time being successful in the future. Another important thing to know is each student’s zone of proximal development to get the student on an appropriate learning path. The zone of proximal development is what a student can achieve independently versus what a student can achieve with the help of a more capable person assisting (Albert, 2000).
The type of learning that I think works best is known as social constructivism created by Lev Vygotsky. This theory forwards the idea that the role of social interaction is a fundamental precursor to the development of cognition (Jaramillo, 1996). Students need the opportunity to discover the learning through meaningful activities and interactions with peers. The role of language in learning is an important piece for communication. Students need to know how to use language, written and verbal, to allow others the ability to comprehend what they are representing. As students solve problems in the real world, they are using the tool of language to help satisfy their need. Vygotsky believed that a child's potential should be measured not merely in terms of what a child already understands, but should include the child's capacity to profit from what others can help the child to understand (Spencer, 1988; Vygotsky, 1978).

I decided upon this research topic based on my personal experiences within a graduate class. During one of my courses we were required to do a project that the professor titled as “Go For It!” and that is just what she wanted us to do; pick a topic and just go with it. She told us that she wanted us to research and design a study about something we were always interested in, but never really had the chance to do anything with. My project incorporated children’s books within mathematics as a tool to enhance learning. The most important research I found was that this was a useful approach because for those students who loved math but didn’t necessarily like to read, they could combine math with books and vice versa (McHough & Kosiak, n.d.). Through my case study, I discovered that this process also involved all students and hit every type of learner; the visual, kinesthetic, and auditory. For this current study I picked a self-study to delve into my own teaching practices and figured out why I do the things I do.
Data Collection

Before data collection could take place, I needed to figure out what information to acquire based on my research question. I took my overall question and broke it into smaller questions. It was important to create these questions because I needed to take into account where and how my beliefs were formed. These are the sub-questions I came up with:

What are my beliefs about the role of speech and writing in mathematical learning?

What has informed my beliefs?

What are my teaching practices?

Why do I choose those teaching practices?

How do I plan my teaching actions?

Through these questions, I was able to come up with three data collection tools to obtain the most useful information.

I collected data through the use of journaling, lesson plans, and written observations from my mentor. This was all created based on the unique aspects of what I wanted to discover about my personal beliefs and teaching practices.

Journaling

I wrote in my journal three times a week after each indicated class that I used for the study. I reflected on how I portrayed the lesson and what type of language I used. I also indicated how I provided the students with real world examples. The main piece I wanted to show was how much time I gave the students to use oral language and how much time I gave them to turn that into written language.
The journal was set up so that each page contained two columns like a T-chart (shown in appendix A). The left side was strictly field notes of what I did during the class period; my teaching practices. It also encompassed how I used scaffolding with the students to use more oral and written language to explain their thinking. The right side of the page was for interpretations, questions, or wonderings at that time, and any explanations that needed to come about after writing the observation notes. This right side helped answer the questions of what were my teaching practices and why I chose them. The right side also showed if there were any gaps between my beliefs and teaching practices. Since my intended goal was to focus on my teaching practices and my beliefs, the journal entries guided me in that discovery.

This was the most challenging data collection in the respect of writing notes and reflections after I had taught each lesson. I was required to write as though I had observed the lesson as a bystander. I was not writing about why I had done something, but instead noticing the things I said and did.

Lesson Plans

Lesson plans were written before the class period. They were a plan of what I wanted to include based on the student objectives, outcomes, and State Standards. These plans were atypical from the usual lesson plan writing because my focus was on what I did as the teacher and how I encouraged my students and less on what the students were actually doing. It was important to have a plan before the class started so I could have a general idea of the flow of the class. There was no way I could anticipate everything beforehand that I was going to say or do because I did not know what my students were going to say and do. This was why lesson plans were created; to give some guidance for the class. For each lesson plan, I wrote when and
how I wanted my students to use language to explain their thinking. The lesson plan format is show in appendix B.

When the lesson ended, I would go back to the lesson plan and make notes of what things I stuck with and what things I had changed and why I changed them. I used the lesson plans and the notes I wrote afterwards to then reflect in my journal. This again helped me discover what teaching practices I used based on my beliefs. My beliefs also showed through during the lesson plan making because I chose to do something based on what I considered appropriate for my students.

Observations

Based on my mentor’s personal schedule with availability, she only observed me twice in district one due to unpredictable scheduling conflicts. I indicated to her what I wanted her to take note of with how I portrayed the importance of oral and written language to my students. She knew my personal beliefs because I had expressed them to her in numerous ways and we had discussed them during planning periods. She also indicated how much time and in what ways I gave the students time to think and come up with a suitable response for my indicated questions. All of the things she observed were written down to use as data. The format she used is shown in appendix C. District two did not have this piece of data because I could not find another teacher free during the class period to observe me.

Summary

The formal observation notes were designated to go hand in hand with my journal entries to see what fit together. It was important for me to bridge the gap of what I believed was happening and what was actually occurring. The data was a large portion of what the
outsider observed based on my personal beliefs. The lesson plans I collected went hand in hand with what I planned to happen and what actually happened.

**Data Analysis**

I coded all three data sources: journaling, lesson planes and observations to figure out what connected as I triangulated the data analysis. Something is more profound when it can be shown on many sources with each source showing the same idea. My intended goal was to see how my beliefs matched up with my teaching practices from all three areas. This goal was indeed achieved once analysis of the data took place.

To code my data I used the “constant comparison method” (Hubbard & Power, 1999, p. 120) to analyze each data tool. Hubbard and Power explained this coding as a way to understand data from the beginning as well as to show similarities found from similar studies (1999). It was important that my data match up with well-known researchers to show evidence and relevance that what I had discovered was concrete. Each piece that was put together and analyzed using the coding technique, proved to answer my research question in the most suitable way.

**Journaling**

I was hoping to see some patterns and overlaps based on how I conducted my teaching practices and how my students used what I taught them to explain their mathematical thinking. The right side of the journal entry gave me an insight of why I did what I did and was able to figure out that it did work. From the right side I was able to see what my exact teaching practices were. The language that I used was important to determine if I was using the best
teaching practices as well as allowing for the students to use language to demonstrate understanding.

As a way to keep myself organized and to observe patterns, I coded both the right and left side each journal entry. I used visual symbols as my coding technique where each symbol represented a different category (Hubbard & Power, 1999). As the data were continually collected and coded, it was apparent which categories were most apparent based on how many symbols arose.

**Lesson Plans**

The lesson plans were analyzed to show what I stuck with and what I strayed from. This helped answer the sub questions of how I chose my teaching actions. Based on the students’ in class performance and how they showed their understanding, I changed what I said and did even when it was not written in the lesson plans. The notes written after each lesson on the specific plan, indicated if my on the spot teaching matched what my intentions were based on the objectives, student outcomes, and State Standards.

Coding was done in each lesson plan to differentiate between things I stuck with and things I changed on the spot as I taught. I used colored markers to keep things organized. I started out with two set categories and found one other one as the research continued to develop. I hoped to discover why I changed things and in what ways those changes aligned with my teaching beliefs. These written lesson plans indicated how and in what capacity I used literacy to enhance the students’ understanding of the material.
Observations

This was a useful data point because it was an outsider’s perspective of what I was doing. My language was an important aspect and it became a true indication through observations that what I said matched my beliefs. Journaling was done after the lesson and planning was done before, while the observation was done during. I often forgot what I said or did, but my mentor was watching in real time taking notes of what was occurring. I looked at the observations and determined that indeed my language matched my beliefs. The coding of this data analysis piece was done again by categorizing the major themes that continued to arise. Those themes helped me discover that indeed my teaching practices aligned with my specific beliefs around literacy in mathematics.

Triangulation of Data

Throughout the entire data analysis, I used the method of constant comparison across all three data types as well as within each independently. Hubbard and Power described this data analysis as predicting and explaining a certain behavior that has been revealed through the data collection (1999). The behaviors and patterns that were shown were then categorized to build a common theory based on the study question. This common theory in fact was used to answer my research question. As each data source aligned directly with the intended question, it was evident of how my beliefs matched up with my teaching practices.

Procedures

The study took six weeks to complete with each week looking somewhat similar with the only variation being what day I decided to journal and when my mentor observed me because of the ten day rotation. The rotation in district one was a cycle of when each class met
with an indicated teacher. Two out of the ten days had shortened class periods so that each teacher could see all of his/her classes in that day. These fell on a Friday or day right before a school break. The other days in the rotation had a longer class period so a teacher would not teach all of his/her classes.

Three weeks took place in district one and three weeks took place in district two. The weeks were consecutive so the three weeks in district one were the last three where I was the teacher and in district two it was the first three weeks that I was the teacher.

My procedures for the week were as follows in both districts:

- Created lesson plans for the week
- Wrote journal entries based on what occurred in the class period
- Had mentor observe my teaching in district one only

**Criteria for Trustworthiness**

The duration of the research study was six weeks. There were a total of 18 lesson plans and journal entries with two observations from my mentor in district one. The three kinds of data that I used formed a triangulation to give the most accurate findings to answer my research question. Using three separate, but equal data types helped increase the credibility of my study as each showed an overlap with the others. The informal observations by my mentor helped with diversity of interpretation because it was an outsider’s perspective. I used all possible outside resources to show my teaching practices were authentic as they lined up with my personal beliefs.

Personal bias came into effect since this was a self-study and I was studying myself in all areas. Through the written portion of the data analysis, it was stated when something was a
personal thought and not a concrete finding from my data collection. I also had my research partner help with the interpretation of the data to again eliminate as much bias as possible.

**Limitations of the Study**

The major limitation that held true for this study was researcher bias. Since I was the one conducting the study about myself, I knew what I had intended, but that was not necessarily the way it was portrayed to the students. This is why the observations were a critical piece which eliminated as much bias as possible.

Another limitation of this study was the fact I was collecting data within two separate districts. In district one, I had gone through the pressures of starting a new school year as well as establishing myself with the students from day one. In district two, I had come in as the new teacher when the students had already adapted to the other teacher. District two posed a problem because I had to establish routines and boundaries at the same time as teaching the students. My data reflected the fact that I had to discover what the students could and could not do. Once I had that established, I was able to use the best teaching practices that fit their individual needs.

**Chapter Summary**

Discovering if there was a concrete relationship between my beliefs around the connection between language and mathematical learning with my teaching practices was informative and instructive. As I used each of my three data points to analyze this study, I was able to understand more clearly where my beliefs came from and how I used them to help my students come to a deep understanding of mathematics.
Chapter 4: Interpretation of Data

Introduction

This self-study was completed for several personal reasons based on experiences and the desire to learn more. It was important to reflect on the educator I have become to determine whether my beliefs matched up with my teaching practices. With the new Common Core learning standards adopted by New York State, it was also important to see whether the teaching ideas I utilized were aligned with those standards. As the sole provider for allowing meaningful learning experiences for my mathematical students, it was crucial to determine whether my teaching practices were the most appropriate for supporting my students in the creation of new knowledge.

This study took place between two different school districts, both in seventh grade classrooms where I taught mathematics. Within each district, a single class was chosen to focus on in regard to collection of the data. Since I taught the same things in each class, the data that were collected portrayed the same teaching practices and beliefs. This also holds true across both districts.

Research Question

This was a qualitative, self-study in which I used three separate tools to collect the data and learn more about myself. The research question answered through analysis of this data was:

How do my beliefs about the connection of talk and writing in mathematics match up to my teaching practices in the classroom?
Findings

This chapter represents the specific findings which show my teaching practices in fact align with my personal beliefs about the importance of literacy within mathematics. Two very specific themes resulted from the analysis of the data. The first theme that was identified through the data analysis, was the different teaching practices I used aligned with a constructivist theory belief. These specific teaching practices also showed how I incorporated literacy within each mathematics classroom in the two districts. The second theme is characterized as the fact that my beliefs specifically influenced the way I taught. Within each of these themes, there were smaller categories that concretely integrated the different areas of literacy; writing, speaking, viewing, listening, and reading. Each theme will be explained with specific evidence from the data to represent findings. In some cases, there was some disconnect between my beliefs and teaching practices that will also be explained in the following sections.

Theme 1: Incorporate Literacy through Constructivist Theory

Through my constructivist theory belief, I used specific elements in my teaching practices to incorporate literacy within mathematics. The triangulation of data in district one, as well as the two data pieces in district two, were concrete evidence that this took place. In a constructivist classroom, the teacher helps the students acquire knowledge through problem solving and reflection. It is a critical component that all students gain this capability to be successful lifelong learners. The following sections describe specific practices within a constructivist classroom: the whole to the parts, student questioning drives instruction, manipulative materials, group work, and interaction of knowledge. Each element of my
practices is described and followed with evidence from the data. This evidence illustrates how
the data either connected or disconnected from my research question of my beliefs matching
my teaching practices.

**Starting with the End in Mind**

It is easier to begin with the end and work toward the start; know where you need to
go. When you take a trip, the destination is known before the path of travel has been
considered. This goes the same way with my teaching practices because I believe it is important
for my students to know where they are headed. This idea forces students to attempt to make
meaning as they read through different resources.

The specific teaching practice explained in this section is how I used different resources
to have the end in mind for each new chapter. I adapted this idea for the students to start with
what they should be able to do by the end and work from there. It was a critical component in
my classroom because I wanted the students to have an understanding of what they should
expect to see in the upcoming weeks.

The theory, whole to part, is linked to a constructivist theory in two ways. First, it
provides useful resources for all students to acquire and use to assist with the process of
obtaining new information. Secondly, it provides students with the opportunity to reflect on
their experiences to construct new knowledge. This theory is all about the idea that the
“learning process of knowledge is also the construction process of knowledge; students are the
main body of learning activity and they construct knowledge on their own initiatives; teachers
are the helpers and the drivers for students constructing knowledge” (Jia, 2010, p. 197). This
specific teaching practice represents this theory because I gave students the opportunity to construct knowledge through the resources, activities, and environment I established.

This theory connects with the end in mind during the reflection process. As the students start to reflect on their experiences, thoughts, and wonderings, they realize when they have reached the end. The different resources the students use also help them in determining how their new constructed knowledge matches the end. The end in this case is what New York State says students should know at the end of each topic or chapter related to the standards.

In district one where the modules were used, an overview was included for each topic that would be covered. Most modules had three topics, topic A, topic B and topic C being the smallest. The following is an excerpt from module 2 topic A used on Monday, November 18, 2013 that I used to get my students ready for the new material. The entire overview for the module can be seen in Appendix D (engageny). I gave them a copy and instructed them to read through it and strive to make sense of what they should be able to do at the end.

In Topic A, students return to the number line to model the addition and subtraction of integers (7.NS.A.1). They use the number line and the Integer Game to demonstrate that an integer added to its opposite equals zero, representing the additive inverse (7.NS.A.1a, 7.NS.A.1b). Their findings are formalized as students develop rules for adding and subtracting integers, and they recognize that subtracting a number is the same as adding its opposite (7.NS.A.1c). Real-life situations are represented by the sums and differences of signed numbers. Students extend integer rules to include the rational numbers
and use properties of operations to perform rational number calculations without the use of a calculator (7.NS.A.1d).

This was a useful way to provide the information to the students because once they understood what the overview was describing, they knew they had mastered the material. The following journal entry shows this example as well as the scaffolding used to support the students.

Journal Entry Reflection of Lesson: Topic A Overview
Date: Monday, November 18, 2013

<table>
<thead>
<tr>
<th>Field Notes</th>
<th>Interpretations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Warm-Up</td>
<td>• Brief assessment used to determine what the students were proficient in before the start of the new unit.</td>
</tr>
<tr>
<td>• No homework from previous night to go over or check</td>
<td>• At first I chose to not give any instructions or explanations of the overview. I simply told students to read through it. Some students underlined, made notes, or simply read through it without doing anything else with it. I chose this because I did not want them to have any expectations as they read. I wanted them to have a clear mind. No ideas clouded their judgment as they read which allowed for them to make different individual connections with the material.</td>
</tr>
<tr>
<td>• Interpretation of topic A from the module (print out)</td>
<td>• Students reread the overview again with instructions: highlight, circle, or underline words or ideas that sounded familiar or they knew specific information about.</td>
</tr>
<tr>
<td>• Rereading of overview</td>
<td>• This was done to get them making</td>
</tr>
</tbody>
</table>
• Group discussion of interpretations of overview

• Students explained specific aspects of the overview and the connections they made with it. As students listened to other students explain their thinking, they realized connections that they in fact overlooked initially. We also discussed the whole point of reading the overview which was to determine what they all will be able to accomplish at the end of the chapter.

This journal entry specifically shows my teaching practice of starting with the end and finishing with the parts. Since I believe literacy to be a crucial piece of mathematics, this example shows writing, reading, listening, and speaking. Starting this lesson without any instructions left the students open to interpret the overview in any way they desired. This also shows how I used scaffolding as I went back after the initial read to work more with the written material. If I had given them the reading and said nothing and did nothing, then it would have been meaningless as students wouldn’t have known what to do with all that information. Going back to it with something to do allowed for a better and worthwhile experience. I gave the students certain things to look for to focus on the interpretation.

As students worked through the module they were able to go back to the overview. This allowed for realization of which pieces they knew that they didn’t know...
from the start. Most of the students highlighted or starred the areas they felt
comfortable with or had gained new knowledge with. This gave them a visual of how
much they learned.

District two did not use modules, but instead focused concretely with the day to
day layout designed by the textbook *Math in Focus* (Cavendish, 2013). At the end of
each chapter, a bulleted description of *Key Concepts* as well as a concept map titled
*Chapter Wrap Up* was included. Each of these was used to give the students the
opportunity to determine what they would be learning and what they should eventually
be able to understand. The terminology within these two separate sections was difficult
because students had in most cases not seen the terms before. As they read through
them, background knowledge was used to try to problem solve in determining if they
knew what the words were relating to. The following is a short excerpt of the *Key
Concepts* used on Monday, February 24, 2014 for the end of the statistics chapter, the
entire chart can be seen in Appendix E (Cavendish, 2013, p.236).
If you take a look at the fourth bullet as it explains how to find the interquartile range, the students already knew where the quartiles were on a stem and leaf plot. They would then use that previous information to realize that was something that could be easily found. Students constructed meaning as they read through the Key Concepts, and viewed the Concept Map. The Concept Map (Cavendish, 2013, p.235) also used on Monday, February 24, 2014 is shown below for the same unit as the Key Concepts.
Chapter Wrap Up

Concept Map

Random Sampling

Population
takes data from

draws conclusions about

Random samples

generates

are used for

Inference

makes use of

are used in

Measures of Center

Measures of Variation

estimate

Spread of data

Simple random sampling

Stratified random sampling

Systematic random sampling

Stem-and-leaf plots

Range

Quartiles

Mean absolute deviation

Least value

Lower quartile

Median

Upper quartile

Greatest value

5-point summary

Box plots

Interquartile range

Consist of

Form

Used in

Illustrate
The following is the journal entry written after the students used both the *Concept Map* as well as the *Key Concepts* to assist in determining known ideas.

**Journal Entry Reflection of Lesson: Topic A Overview**  
**Date: Monday, February 24, 2014**

<table>
<thead>
<tr>
<th>Field Notes</th>
<th>Interpretations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Hand out of chapter wrap-up (Concept Map)</td>
<td>• Students had to interpret the map and connect it with ideas or experiences that they were familiar with. This less reading allowed for students to interpret it in new ways. Some students drew arrows off the circles to write in their own connections to show it went with that main idea. This map also helped students to read and interpret a visual aid as they had to follow the arrows and determine that it all fit together to create the larger concept of the unit.</td>
</tr>
<tr>
<td>• Key concepts worksheet</td>
<td>• Students worked in pairs after the initial read to talk through ideas and connections.</td>
</tr>
<tr>
<td></td>
<td>• This had more reading attached to it in the form more of a list than paragraphs. Giving the key concepts after the concept map allowed for a preview of the concepts. This was a more precise list of what the students should be able to do by the end of the chapter. In some instances it gave the process to find the correct answer. Some students did show frustration because they did not understand the language used in each concept. When that happened I told them to go back to the concept map and see if any of the language matched and where they thought that concept might overlap on the map. Having them use</td>
</tr>
</tbody>
</table>
Again, these are two separate, but equal resources that I used to start with the end and work toward the pieces that create the whole. When I was teaching these students in district two, I wanted them to discover on their own just how much material they already knew. I believe this allowed for an increase in motivation because the students went into the new chapter knowing what they needed to know to be successful. This journal entry also shows how I used literacy as I used it the same way in district one. Giving them the opportunity to connect both the concept map with the key concepts represented scaffolding as I gave them more material that would help support the learning.

It is evident that in both districts that I used different resources as part of my teaching practices as a way to make sure the students knew when they had reached mastery of the topic; knowing what the end was. This was an important component because as literacy is important within mathematics, the students were forced to read different material and break it down into its parts. It was not expected that they were going to know what each sentence or representation described, but be able to later on relate it to what they were working on. The intention was for students to problem solve using different reading strategies to gain a sense of what was going to be provided next. Reading allows students to comprehend what is presented to them, but reading is not just being able to understand written words, it encompasses being able to comprehend tables, graphs, maps, and diagrams. All of this reading was primarily done at the
beginning of each chapter for students to have a sense of what the end of the chapter would look like. This is a helpful teaching practice because it helps the students anticipate what to expect and helps with the reflection process to construct new knowledge.

**Student Questioning Drives Instruction**

The types of questions that students ask determine what they are attending to. If they are confused about something, they formulate a question to communicate the uncertainty. Talk, as a form of literacy, let me know where a disconnect occurred and how I could assist the student to get back on track. As students start to understand new material, they ask fewer questions because their own knowledge can answer their wonderings. The way students talk, not just about confusion, but also about what they understand, informs where instruction needs to go.

The specific teaching practice for this section is that I used the students’ questions to drive my day to day and on the spot instruction. When a question was asked, I needed to determine how to best answer it. Did I have time to answer it on the spot? Was it relevant to the topic or would it be addressed later? How could I best answer it to make sure all the students understood the response? These were the types of questions I asked myself each time a student asked a specific question regarding the content of material. In some instances I was able to problem solve on the spot, while other times it required a more thorough and prepared response.

As Lunenburg explains, “teachable moments are moments when the students' interest, knowledge, and enthusiasm intersect and transcend a particular lesson” (2011, p. 6). Different
questions can turn into teachable moments when they can further enhance material and require students to think at a higher level. This type of questioning also shows the high interest level of students as they desire to deepen their knowledge. This was used throughout both districts when I saw I could enhance material and understanding through what the students were showing me, through the questions they asked.

Through the formulated questions of the students, they were using talk to express themselves. Mercer (1995) argues that “learning in a classroom setting is based on students having to explain and justify their decisions to each other and describes exploratory talk as exhibiting these features” (p. 19). Exploratory talk is how students express their thoughts and wonderings vocally to peers, adults, or themselves. It can also be argued that students use exploratory talk as they derive their unknown thoughts or confusions into questions. They first need to explore what they do know to figure out what they don’t know.

The questions that students asked were also helpful for my own sake because it gave me a window into each student’s zone of proximal development. It allowed me to better judge how I could best assist each student so they could gain a better understanding. As I listened to what students had to say, it really directed my teaching practices to make sure students were benefitting from them.

In district one on Thursday, November 21, 2013, I had written a lesson plan based on subtracting integers using a specific process known as the additive inverse. I had not accounted for possible changes in the lesson plan because I believed the students in the class would catch on to the new concept as quickly as they had done previously. As the lesson went on, students asked more and more clarifying questions. This told me that I needed to change my previous
plan because students had reached their frustrational level. It would have been one thing if a couple of students were still confused, but it was the entire class so something needed to be done immediately. The ways in which students formulated their questions informed me that the instruction needed to change. In some cases students had a difficult time even formulating a question because they weren’t certain how to express what they needed. As seen in the following data excerpts, I had certain things I wanted to cover within the lesson that are shown in the lesson plan write up. Once the students started asking questions, I had to alter my plan and work toward scaffolding the students to understand the material. The entire lesson plan can be found in appendix F. The journal entry below describes how and why the change occurred. The entire journal entry can be found in appendix G.

**Brief Description of Lesson:**

**Date: Thursday, November 21, 2013**

- Warm-up (my favorite no)
- Check in/review previous night’s homework on adding integers
  - Students come to the board to write down answers
  - Answer questions on difficult problems
- Take notes on new strategy of subtracting negative integers (additive inverse)
- Guided practice of specific problems
  - Students verbalize the process for each guided practice example
- Independent practice worksheet
  - Start working on it independently using class notes and then work with neighbor to check process and answers.
  - Check for understanding through observation monitoring
- Use additive inverse to subtract negative fractions and decimals
- Exit ticket: 4 additive inverse problems
Journal Entry Reflection of Lesson: Subtracting Integers
Date: Thursday, November 21, 2013

<table>
<thead>
<tr>
<th>Field Notes</th>
<th>Interpretations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Independent work time to practice the additive inverse. As I walked around and looked and what students were accomplishing, it was evident a majority of them had not grasped the concept as I had thought. Students also continuously told me that they did not understand what to do. “This doesn’t make any sense at all and all my answers are wrong and I don’t know why. I don’t get any of this, why are we even doing this if I just keep getting them wrong?” I gave students time to work with their neighbor to see if they could work through it together. Students still struggled so I made the decision to continue modeling and release some responsibility as I used scaffolding whole group. It was not going to make sense for the students to start subtracting negative decimals and fractions if they couldn’t even subtract the whole numbers. During the regroup, I used real life examples to help interpret the strategy and what it exactly was helping accomplish.</td>
<td></td>
</tr>
<tr>
<td>• It was not going to be in the students’ best interest to continue moving forward with the lesson when they were clearly at their frustrational level. Through the change, the students were able to slowly internalize the idea and realize why it was helpful to use.</td>
<td></td>
</tr>
<tr>
<td>• I felt confident after the lesson that the students would be successful on their homework. That too needed to be modified since we had not gotten to decimals and fractions.</td>
<td></td>
</tr>
</tbody>
</table>

The previous lesson plan and journal entry show how the lesson needed to be altered based on student questioning. The students represented their zone of proximal development by their questions which led me to change the teaching practice I was using to best assist them. There was not enough within the questions students asked, as documented within the journal entry for it to be considered as a teachable moment because it was directed toward specific content and not content that would enhance the material. After the warm-up and review of the
homework, students took notes on the new material, the additive inverse. Taking notes is not the usual constructivist approach, but I wanted to be certain that the students had a strong resource as they worked through different problems. As the notes were taken, I made sure that I was using specific content language. The language I used was an important factor because that was the language they needed to comprehend through the entire chapter and after. As students started to work independently, the questions they asked were evidence that they had hit their frustrational level and new learning was no longer going to occur. Right then and there I decided that the confusion needed to be addressed on the spot. I made that decision because the rest of the lesson became useless since students were not comprehending the process. The change in the lesson caused a decrease in students’ exploration of the topic and an increase on specific instruction through modeling and gradual release of responsibility.

This illustrates the theme through the fact that I used my teaching practice of student driven questioning to modify my teaching which then assisted in the pathway of learning for the students. If I would have continued the lesson, then the students would not have had an appropriate experience that they could use to construct knowledge.

In district two, we had started a new chapter on finding probability. This was something students had previous background knowledge in, but not enough to be proficient in the subject. The lesson for the day on Tuesday, March 4, 2014 was determining mutually exclusive events; two events that cannot occur at the same time. I had the students work in groups to come up with different examples of an event. I walked around to different groups to listen to what they were coming up with. Some of them had a great start while others couldn’t quite grasp the content. I had only two groups out of 12 who really struggled. They each asked for assistance
and this gave me some great insight. Their questioning and appeals exposed what they needed which was coming up with examples that were independent of each other. Because only two groups were struggling, it was not in every student’s best interest to take more time to go over the idea because the majority understood. I did however know that I needed to work with the four students to get them back on the same page with the rest of the class. As I got the other students working independently, I pulled the four students to the back table to work as a small group. These students all had the same confusion on the same topic. Before these students could move forward they needed to really internalize the idea. The following is the specific lesson plan created and the italicized areas show everything these students would not have been able to accomplish without understanding the term *mutually exclusive*.

**Lesson Plan: Mutually Exclusive Events**  
**Date:** Tuesday, March 4, 2014

**Student Objectives:** Students will be able to:
- Define the term mutually exclusive.
- Give examples that demonstrate mutually exclusive events and represent them using a Venn diagram.

**Student Outcomes:** Students will:
- Work with a partner to come up with their own real life example of a mutually exclusive event.
- Represent their mutually exclusive with a Venn diagram and share with another group.

**State Standards:**
- 7.SP.B Draw informal comparative inferences about two populations.

**Brief Description of Lesson:**
- Warm-up (finding probabilities of given events)
- Review of homework from previous night
- Notes/Mini Lesson (mutually exclusive)
  - Students take notes of the definition of a mutually exclusive event and give example taken directly from the text book
Orally describe different events that would be mutually exclusive
- Rolling a 2 and 3 at the same time with a standard die
- Flipping a coin and having it land on heads and tails
- Through talk as well as visuals

- Put students in groups to come up with their own example of a mutually exclusive event and represent it using a Venn Diagram (circles would not overlap)

- Groups of two join together to make a group of four to share their example

Notes/Mini Lesson (not mutually exclusive)
- Students take notes of the definition (the opposite of mutually exclusive)
- Orally describe different events that would not be mutually exclusive
  - An odd number and a number divisible by 5 in the set 1-20
  - Months of the year having the letter a in it

- Put students in groups to come up with their own example of an event that is not mutually exclusive and represent it using a Venn diagram (the circles would overlap)

- Groups of two join together to make a group of four to share their example

- Independent practice (worksheet)

This example shows how student questioning drove my instruction. As students used talk, they portrayed their lack of understanding of the material. Almost half of the lesson would not have been feasible for the four students since it wouldn’t have made sense. Every student in the class needed the proper opportunities and experiences to be able to construct new knowledge. The four struggling students were not receiving those opportunities until I intervened. I made the decision to pull the four students into a smaller group because it was evident the other students were comprehending the term “mutually exclusive” so a whole group lesson was unnecessary.

As I worked with the four students, I had to come up with a plan on the spot, since I had not prejudged this scenario. It was my intention to provide as many relatable real life examples of this concept to ensure each student could make an individual and meaningful connection. Having known the students for some time, it was effortless in coming up with the different
situations. Once the four students showed understanding through verbalization of their own examples, they were able to rejoin the class and were successful with the remainder of the lesson.

As students asked any sort of mathematic related questions within the lesson, it gave me a sound idea into their thinking and understanding. This was a crucial component to my teaching because I needed to make sure that the students were gaining understanding through the practices I demonstrated. When the students’ understanding was limited or nonexistent, I needed to do something to alter my practices with each student in mind. I was able to use their questioning to drive my “in the moment” instruction since I was able to determine what they needed. Their questions let me into their minds to get a glimpse of what they comprehended. These examples show how I specifically altered my instruction in regards to my teaching practices dependent on student questioning.

**Use of Manipulative Materials to Enhance Learning**

Manipulatives are hands on materials that students can use to construct meaning through visualization and interpretation. “Constructivist theories of learning postulate that students build increasingly complex knowledge through active engagement with concrete materials such as manipulatives” (Holmes, 2013, p. 1). This type of learning attends to the kinesthetic learner as touching objects is a way for him/her to understand new ideas. It also assists the visual learner as he/she can see the situations unfold in front of him/her. It is often times the case that students can better comprehend an idea when they can see the idea set before their eyes instead of it simply being described using verbal language.
The most important reason I used manipulatives with the students is that self-talk is required to interpret and construct individual meaning. The language that students use to engage in self-talk is language that only they understand because they are coming up with it on their own. No one is telling them a certain way to think or even how to use the manipulatives. They use them in a unique way as a tool to assist in learning mathematics. “Vygotsky (1987) hypothesized that the phenomenon of private speech, or self-talk, reflects children’s potential for self-direction to plan, guide, and monitor their goal-directed activity” (Ostad & Sorenson, 2007, p. 2). Self-talk encourages students to organize their thinking and plan out steps to complete the process. It also allows them to think deeply on a certain topic to interpret their understandings.

Another important factor of students using self-talk is that it has been seen to enhance self-regulation (Oliver, Markland, & Hardy, 2010). Self-regulation is how students monitor their own understanding and what they do when they start to sense a disconnect with the topic. Something needs to be done when they start to get confused; sitting there staring at the paper is not going to work. Students must decide what to do to gain some further help when their frustration reaches a maximum point. It is in the discretion of the students to take action to express their confusion. As students use self-talk, they are working through their confusions as well as their ideas to figure out if they can bridge the gap or should ask for assistance from someone else.

Through a case study done at Vanderbilt University in the spring of 2013, it was determined that “student achievement in grades PK-12 can be improved through the use of mathematics manipulatives” (Holmes, 2013, p. 1). This was done through a systematic review
of the research literature focusing specifically on different interventions that incorporated the use of manipulative materials. This shows evidence that hands on materials can aid in the increased achievement of student knowledge in mathematics.

In district one on Tuesday, November 19, 2013, I taped number lines on top of each student’s desk when we started the integer unit. The unit had to do with positive and negative integers using the four operations. This gave a quick resource for all students to use regardless of level or ability. This is what the number line looked like:

![Number Line]

Students used self-talk as they used the number line to determine where to start and what direction to move to arrive at the correct answer; the first step in successful mathematical discourse. Students needed to independently talk through their different ideas. Once they were able to start gaining new knowledge, through use of the manipulative as well as using self-talk, they were on their way to explaining their mathematical thinking aloud which is the basis of mathematical discourse.

I think that the number line was an important resource for this unit since it was a tool that students used independently. Students needed the specific modeling and scaffolding to use it in an appropriate way. Since this unit had to do with positive and negative numbers, students had to know which direction to move on the number line. The following is the journal entry I wrote after introducing the number line. The journal entry displays how students first brainstormed why a number line would be used. They then were given time to use the number
line and then reflect on its use. It also shows how I used a relatively simple manipulative to get
students thinking on a different level of a more complicated topic.

Journal Entry Reflection of Lesson: Using the Number Line
Date: Tuesday, November 19, 2013

<table>
<thead>
<tr>
<th>Field Notes</th>
<th>Interpretations</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Discussion of the use of a number line. Why is it useful?</td>
<td></td>
</tr>
<tr>
<td>- Students brainstormed ideas about the use of a number line. Since they all had background knowledge, they were able to verbalize a lot of information.</td>
<td></td>
</tr>
<tr>
<td>- Started with addition of positive numbers and moved to subtraction of positive numbers.</td>
<td></td>
</tr>
<tr>
<td>- This was known material, but I did this for students to re-familiarize themselves with directionality. I thought aloud so students could understand the process.</td>
<td></td>
</tr>
<tr>
<td>- Addition of negative and positive numbers and subtraction of negative and positive numbers.</td>
<td></td>
</tr>
<tr>
<td>- These were all very easy problems that students would have been successful solving without the number line, but they needed to become familiar with what way to move and where to start.</td>
<td></td>
</tr>
<tr>
<td>- Ending group discussion.</td>
<td></td>
</tr>
<tr>
<td>- Students had to verbalize the new information they gained from the first brainstorming session. Required to listen and speak.</td>
<td></td>
</tr>
</tbody>
</table>

Scaffolding was used during this lesson each time I introduced the number line with an operation at their independent learning level. This also allowed the students to engage in self-talk. It was my goal to show the students how to use the number line, not solve complex problems. If I had simply stuck the number line on the desk and not shown how to explicitly use it, most students would have eventually disregarded its presence. The higher level students would have most likely been able to figure it out, but it was beneficial for all students to know
how to use it. Giving the students time to work through some problems after I modeled, was an indicator of just how much more scaffolding was required. As I demonstrated, I used self-talk to model to the students what should be going on in their minds. As I verbalized questions and wonderings that I had, it allowed students to realize that it is okay to talk through ideas in their minds. It also showed that as you engage in talk silently, you can answer your own questions and wonderings. Once the students had more opportunities to work with the number line, their confidence level increased.

I also used a deck of cards with this specific group in district one on Friday, November 22, 2013 because I thought it was a good way to assist them in the learning process. These cards were used as a manipulative item as well as a communication tool. The black cards represented negative numbers and the red cards represented positive numbers. I instructed the students to put themselves in order from least to greatest in the front of the room. Students were unable to speak as their primary mode to communicate with their peers. Hand gestures, showing the card to others, and facial expressions were some of the ways the students could communicate. This really let students discover how representing information was vital in getting someone to understand what they were saying. This was not only a useful mathematics lesson, but also a lesson in life.

Using the deck of cards as a tool to assist in the construction of new knowledge matches to the constructivist theory as students were able to reflect on the experience to create new knowledge. When experiences were fun and meaningful, it was evident that students were able to reflect on a deeper level because they gained more information. This also matches my teaching practices as I used the deck of cards as a specific manipulative material. Incorporating
the different communication requirements represented how oral language was a vital component in comprehension. Students were again using self-talk as they determined where they should place themselves to form an accurate number line. They had to also visualize what a number line looked like in order to independently justify their placement using the numbers to the left and right of them. Since they were unable to speak aloud to converse with their peers, they had to use all of their previous learned information independently.

In district two on Thursday, March 6, 2014, I gave the students time to work on an activity to determine how many different three digit numbers they could make using four different single digit number cards. Students were put in pairs and given the directions and nothing else. I wanted to see the different strategies they would come up with to figure out the answer. Putting the students in groups to use the manipulatives pushed away from the self-talk to dialogue to express their ideas to their partner. Also being able to move the number cards around to concretely form different numbers allowed the students to conceptualize the process. It then gave them the opportunity to use that strategy when the same type of question was brought to them again. Within the lesson plan, I had only allotted for about 7 minutes for this activity, but quickly changed my plan as I observed student groups working. Students came up with some great techniques and ideas that were enhanced through working with the manipulatives. Using the hands on number cards turned into a meaningful process for all students. This was because it encouraged students to think in a different way. In my journal entry for this day I wrote about this realization and change to the plan. The entire journal entry can be seen in appendix H.
Date: Thursday, March 6, 2014

“After the timer buzzed, indicating the end of the activity, I noticed that several students were going above and beyond what was expected of them. They were using specific language that told me they had come up with formulas and rules based on the information. This allowed them to not have to write down each possible outcome. The groups also made sure this process would work with numbers of larger digits. I decided to give them another five minutes to work on this activity and then have them share out so they could see how the other groups approached the idea similarly and differently.”

This was a specific example of a teachable moment based on students’ use of manipulatives. My teaching beliefs and practices show specifically through this example. I believe that students construct knowledge through oral language. This oral language was enhanced through the use of number cards as a manipulative. The language was understood through the use of a visual aid to assist with communication. This example was taking self-talk further to include other students’ ideas and different levels of understanding. It was a way for students to use talk to determine what they comprehended versus what their partner had comprehended from the topic and activity. I think this was such a successful activity because it incorporated specific elements that met the needs of each type of learner. The kinesthetic learner was able to manipulate the number cards and form different numbers. The visual learner was able to see the numbers take shape and the auditory learner gained more information through hearing what their partner had to say. The use of the number cards as a
concrete learning tool encouraged all students to push their thinking in the best way they learn.

In another example in district two on Wednesday, March 5, 2014 on the same subject of probability, students had to roll a standard die to determine relative frequency of different numbers on the die using experimental probability. This was an example to show the term relative frequency in real life. Relative frequency is “the ratio of the observed frequency to the total number of observations in a chance process” (Cavendish, 2013, p. 267). Each number had the same chance of appearing, but students were calculating just how frequently each number appeared based on a certain number of rolls. Because an experiment was taking place, the probability of the different numbers occurring was known as experimental probability. The students each had a die, but were able to talk to their peers sitting around them to discover similar numbers appearing the same number of times. Using the die allowed the students to construct meaning through self-talk first and then by conversing with their peers. This was done by students reflecting on the experience as well as the mathematical process. As each number appeared after the role, they recorded the number. From there they had to determine how many times they rolled the die (adding each observed frequency together to determine a total amount) to find the relative frequency as a percent, decimal, or fraction in simplest form.

Something as simple as a standard die can be used as a beneficial learning tool that encourages all students to construct knowledge in a new way. This new way puts more of the pressure on the student to gain new knowledge through reflection on
different processes. From the start of the activity, the students used self-talk along with the die to construct new knowledge on the term *relative frequency*. As the students moved to discuss the activity with the people sitting around them, their self-talk turned into oral language where they were able to work through ideas and wonderings. I believe this to be one reason of why it was such a successful lesson because each student was given the time to determine what they knew and then to gain more information with the help of a partner.

Through each of these examples including manipulatives, students were engaging in mathematical discourse. Through the self-talk, they were problem solving to understand the concept internally. As they started to work through their ideas, they were ready to share with the entire group by representing their thinking through oral explanation and in some cases through the guidance of visuals. Manipulatives encouraged the students to discover important mathematical concepts through specific manipulation of the materials. The whole idea of using some sort of language, either self-talk or oral language, forced the students to internalize the process which then allowed for further reflection.

All of the previous examples explicitly comply with the essential idea from Holmes (2013) in the respect of students building complex knowledge through their active engagement with different materials. When students are active participants, as in a constructivist classroom, they construct new knowledge in a specific way that only makes sense to them. It is also the case that with hands on manipulatives, which students can maneuver in unique ways, they are learning in a whole new way than in
typical classrooms that do not use manipulatives. Through this teaching strategy, students of all learning types were able to comprehend the new material in a fun and interesting way.

It is, however, the case that manipulatives were not always used in the way I had intended. I encouraged the students to use the manipulatives in a certain way to get them started, but expressed that manipulatives could be used differently. I did this because I didn’t want to persuade the students to use them in a way that didn’t make sense to them. Some students who needed assistance getting started quickly adapted to the way I showed them because they didn’t know what else to do. As one of my teaching beliefs, I believe that the most suitable way for students to learn is through experiencing and then reflecting on what they have just experienced. “When something new is experienced the learner recollects prior knowledge and tries to make a connection into the existing cognitive or metacognitive network of ideas” (Hinnett, n. d., p. 2). The way some of the students used the manipulatives was not allowing for the greatest possible reflection because they used them the way I suggested. They hadn’t come up with it on their own and continued to alter it until it assisted their understanding.

The teaching practice demonstrated in the following example still shows my belief of the power of manipulatives, but the practice had to be altered. Since I value the experiences that students take part in, I had to change the previous plan as the lesson became not what I intended it to be. As the process of using the tools became the problem, it then hindered students’ ability to truly understand the material. I knew that the material was not the problem because it was something the students had enough background knowledge in to be successful. I
came to the conclusion that the issue had to be the manipulatives because students weren’t using them as a way to enhance the material and reach a deeper understanding. When this occurs, an on the spot decision needs to be made to achieve what I had intended from planning the lesson. Knowing how many students were struggling or having issues was an indicator of what I needed to do and how.

An example of this was when the students in district one used different colored cubes to represent negative and positive fractions on Monday, December 2, 2013. My intended goal was for students to discover a way to easily add and subtract fractions in a way that made sense to them. Students struggled a great deal so I gave them a push about how a positive and a negative number can cancel each other out to make zero when they are opposites. I did an example of this with the whole group and let them work again in their pairs. Every student did it the way I showed them, but that wasn’t my goal. I wanted them to come up with unique ways to then be able to share those ideas with the rest of the class. Since they were all doing it the same way, there was nothing to share. Students would not have gained any further understanding from listening to their classmates share ideas since they used the manipulatives the same way. If I had decided to let students talk through the process they used, most of the students would have not listened to their classmates speak and it would have become meaningless.

As I reflected on this lesson, I thought about the possible reasons the students had trouble using the manipulatives and I came up with two different possibilities; not understanding how to add or subtract negative numbers or not understanding how to use the manipulatives to represent each problem. This is something that I was not able to answer.
because I thought of it after the fact and did not ask more questions of the students. I thought it was most likely a small portion of each possibility. Adding and subtracting negative numbers was still something students struggled with, so of course incorporating fractions made it even more difficult. If students still didn’t have the strong understanding with whole numbers, then it wasn’t a surprise that they would struggle with the fractions. This was also the first time students had used the cubes and it was perhaps the fact that the many color options were overwhelming. I do think that it was a small factor of each possibility explained that caused the confusion of the lesson.

The theory that manipulatives support students’ learning through active engagement is clearly evident by the examples shared in this section. My teaching practice of ensuring that all types of learners were included during the planning and implementation of lessons is clearly shown. Kinesthetic and visual learners can really use their best learning strategies to create a strong understanding. Each type of learner uses self-talk to work through ideas to construct new knowledge of how the manipulatives support the topic. It was my intended goal to include literacy in all aspects of my teaching because of how important it is. Literacy was incorporated here by students interpreting the materials through reading and speaking. Listening to what other students had to say was an important factor for all students. With students using the manipulatives in different ways, it was helpful for students to experience how their peers used the tools to support their learning. It was important for all students to realize this because it represented that there was not a single way for the manipulatives to be used to support learning. Since they are used as a tool, each student used it in a way to support his/her needs.
Writing was not an intricate detail, but it was still done in respect to numbers and problem solving. Each teaching practice I used, or adapted, is evidence of the theory in place.

**Using Group Work to Promote Learning**

As students work together to formulate meaning, they each bring something different to assist their peers in understanding. They problem solve as a team by asking questions, verbalizing their wonderings, and trying different things to gain a solution. Keeler and Steinhorst argue that “students learn better and retain more if they engage in learning activities that require them to think and process information rather than passively listen to lectures” (1995, n.p.). In my teaching in both districts I tried to incorporate group work to allow for this collaboration, but sometimes it was not always a suitable option. I believe that students use a great deal of talk as a form of literacy to help construct meaning of new material. They are given the opportunity to talk through their ideas to gain a sound and concrete understanding in group situations. “Proponents of collaborative learning claim that the active exchange of ideas within small groups not only increases interest among the participants but also promotes critical thinking” (Gokhale, 1995, n. p.). This is however not always the case. Students need to be active participants in this process or it becomes meaningless. Even though I believe in the idea of group work to promote new learning, it was not always the best strategy to use.

When collaboration and talk are combined together, they are more powerful than when separated. What I mean by this is students may collaborate together by showing diagrams or representations, but when they don’t explicitly talk about their ideas little is accomplished. The same goes with just talking, when students only talk at each other, little to nothing is accomplished. This is because students don’t consider the ideas of others when they are being
Ample amount of learning can be achieved by all students when these two entities are mixed together. Successful collaboration is the key in promoting new learning (Gokhale, 1995).

As students use collaboration, there are often outside factors that need to be accounted for, for success to occur. Some of these factors can be addressed beforehand, like flexible grouping, and some need to be addressed during the lesson, like student engagement. Regardless of circumstances, it is the case that I attempted everything to promote successful collaboration with talk amongst all students.

In district one the students completed a group project since the class was small in size and students were able to work diligently in small groups. We had been working on direct and inverse functions by taking a look at graphs, charts, and comparing them to real life situations. On Tuesday December 10, 2013 I put the class in four different groups with four students in each group. There were four requirements for the project so that allowed each student to take ownership of one of them so each student was working equally. I gave them a large piece of poster paper that was divided equally into four sections. They were also given an envelope with different numbers that were associated with the table they would need to create. The amounts were in the form of a ratio, fraction, decimal, or whole number. On the poster the sections were as follows: graph, table, explanation of how it was justified as inverse or direct, and a real life situation. This group project was completed over two class periods. At the end of the second day, each group presented their project to the class. The presentation was very informal, but it was important for the students to realize that they needed to be able to explain their thought process for others to understand.
The teaching practice incorporated with the project was that students were forming a concrete understanding of the material in a real world setting with my assistance. I was there to assist and encourage the collaboration process within student groups. It is one thing for students to do the work correctly, but what really matters is that they know why it all makes sense. Incorporating the material into a real life situation promoted this idea of “Why am I learning this and why is it important?” I needed to make sure students understood why the project was being completed so it became meaningful. I continuously walked around to the different groups asking open ended and clarifying questions to get a sense of their understanding as a group. If it seemed that one student had a stronger understanding than the others, I would have that student explain his/her thinking clearly to the other students. I made sure the explanations were clear by providing assistance if it was required through questioning or further interpretation. Having the students achieve the same understanding was important because they needed to explain it in a way that other groups were able to understand.

All forms of literacy were incorporated in the previous project. Talk was incorporated in both the students working together in groups as well as having to explain their thinking as they presented. As the information was put on the posters it incorporated written language in the forms of visualization and explanation through words. The visualization was through the graph and the table and in some cases through pictures students drew to enhance their real life example. The description of how the situation was determined to be inverse or direct had to be well thought about before it was written down on the poster. Students worked through exactly what to write to explain how they developed an answer. Reading was done when students read back what they wrote to make sure it all made sense. When each group presented, the rest of
the students sat and listened carefully to what each student had to say. Since no two groups had the same information, it was important to hear how each group handled the work load and the steps they used to accomplish the task. Different groups used different techniques and that was exactly what I was hoping for, for students to hear and discover there wasn’t one specific way to complete the project.

This example of students working together shows that all forms of literacy can be incorporated in a project that benefits all students regardless of ability or learning preference. Since students did have different strengths and needs, flexible grouping allowed all students to feel successful as they brought different and unique elements to the table. Since students most likely had the same initial understanding before the material was taught, they were more likely to be able to talk through ideas as a way of problem solving so all group members understood in the same way.

In district two, I was able to use group work more often than in district one because the students in district two were able to really discuss ideas in a way that each group member was constructing new knowledge. The day before every test, students worked in groups to answer different questions from the chapter review section in their textbook to prepare for the test. What students were discovering through this station activity was which concepts and ideas they still struggled with and should focus on that night at home. The following is a short excerpt from the textbook that I took questions from to incorporate with this group work on Friday, March 7, 2014. The questions that were not incorporated with the stations became questions for homework. The entire chapter review can be seen in appendix I (Cavendish, 2013, p.237-239).
Chapter Review/Test

Concepts and Skills

Find the range, the three quartiles, and the interquartile range.

1. 2, 4, 1, 7, 3, 3, 9, 10, 1, 0, 6, 8, 5, 5, 9

2. 34, 66, 90, 25, 46, 81, 40, 67, 95, 104, 36, 49

3. 1.23, 1.45, 1.09, 1.78, 1.55, 1.67, 1.37, 1.05, 1.23, 1.11

4. 162.5, 248.6, 130.7, 344.9, 322.0, 234.2, 150.8, 304.7, 326.4

Use the information below to answer the following.

Tara tossed two number dice 24 times. She found the sum of the values for each throw and displayed the sums in a dot plot.

5. Find the range of the data.

6. Find the 3 quartiles of the data.

7. Find the interquartile range.

For the most part, students should have been able to answer the questions independently since it was the day before the test. The grouping allowed students to ask clarifying questions in case there was one thing that still caused some confusion. Talk was the primary source of literacy in this stations activity as students worked collaboratively to either answer the question or make sure they had achieved the correct answer. Some of the questions did require more of a written explanation and those were the questions that were labeled Math Journal as seen in appendix I with questions 14 and 15. Students also had to listen to what their group members had to say and then interpret that verbal language to determine if they understood what was being communicated. This entire process of working together demonstrated the importance of literacy as it encompassed talk, listening, and writing.
As students worked through each question, it was my job to ensure students were understanding the literacy elements I incorporated. This was done as I assisted different groups in interpreting the information. The assistance I gave was dependent on what students needed, but in most cases it was helping them define a certain vocabulary term or knowing where to start to problem solve. I also needed to make sure that students were communicating effectively with the other students in their groups. Communication was such an important aspect because the students needed to work together to problem solve any confusions. I helped students differentiate between different communication strategies by working with each group separately and modeling what appropriate communication looked like. I would problem solve with different group members over confusion that most students were having. I went into each group with preconceived notions of what the students may understand or may not understand. When it was determined that students had some confusion, I altered my preplanned ideas to meet the needs of the students I was working with. I also used questioning to get students thinking on a deeper level. All of these different ideas are representations of how my teaching practices incorporated literacy within mathematics.

For the most part there was never a large issue in district two with working in groups, but the occasion still arose that I had to change my teaching practices. There were always outside factors that caused students to misbehave or show that they couldn’t handle the unstructured qualities of group work. These factors included, but were not limited to, time of day, personal issues, days leading up to a school break, or difficulty of task. In one instance in district two, students were put into groups that I had created and were asked to work together to complete a worksheet that came after the notes they had just taken from a mini lesson. Now
this was on Friday, February 14, 2014 and students had worked hard all week and it was apparent that they needed the weekend to de-stress from school. They had started off strong and started to taper off by talking about plans for the weekend. I redirected different groups several times and nothing seemed to get through to them. I knew the material was at their instructional level because it was somewhat new and they had done well with answering questions during the mini lesson. I made the decision to stop the group work and told the students they needed to work independently on the remainder of the worksheet. That was not a practice I felt comfortable with after the students just learned brand new material, but students were not gaining any more knowledge through the ineffective group work. To salvage some productiveness, I knew I had to alter my practices for that moment in time. This change worked tremendously well and I was able to check in with different students to answer any clarifying questions they would have asked their group members. Sometimes my practices needed to change, but they changed with the students in mind; to make sure they were learning as much as they could. This same idea also happened again in district two on Wednesday, March 26, 2014 as the groupings needed to be changed based on student performance. These were the only two times that I had to change the lesson plan in respect to the students working in groups.

This informed me a lot about myself as an educator that I was willing to change my teaching practices to benefit the students in the greatest ways. It was unrealistic to keep the students in groups if they were not completing the task and using it the way it was intended. In both districts I had a discussion with the students about why I changed the teaching practice and they all understood. It was apparent by their responses that they knew the appropriate
way to work in groups, but for some reason on those two days it was not the case. When group work was done correctly, it really encompassed the importance of literacy primarily through talk and communication.

Promoting new learning needs to be done with students in mind and needs to incorporate strong collaboration. Group work allows for this to be done as long as grouping is flexible, students are actively engaged, and ideas are shared freely. When these things do not happen, learning is not meaningful for the students. As I decided how to incorporate group work into different lessons, it was my intention that each one would be successful and result in students learning in a new way. Since I could not control every factor within the classroom related to each student, I tried to adapt any situation that presented itself into a positive one that promoted learning. The ideas presented by Keeler and Steinhorst (1995) as well as Gokhdale (1995) suggests the positive consequences as students engage in successful group work. I strongly believe that group work is only successful when each student contributes and is engaged in the entire process. As one example shows, that was not the case so I made the decision that resulted in students still learning, but in a different way than I had intended. In any case, I made sure that all students were gaining new knowledge.

Summary

Each of the previous subsections describe a particular element within a constructivist classroom. Each element has specific data points that describe how my teaching practices aligned with my beliefs about literacy within mathematics. It was the case that my beliefs did not always match directly, but that was important data that needed to be analyzed. As it was looked at, I found that my beliefs never changed but sometimes the practices I used did change,
dependent on student needs. My belief that all students learn in the most appropriate way in different situations is what drove my instruction. If learning became meaningless, then the experience needed to change for students to be able to reflect on something meaningful. Construction of new knowledge comes when students are immersed in productive and meaningful material. I made sure the students were always engaged in meaningful experiences even if it meant that my teaching practice had to stray from my personal beliefs. This showed me that I can still incorporate meaningful literacy opportunities with all different types of teaching practices.

Theme 2: My Beliefs Directly Influence My Teaching Practices

My beliefs directly influenced the way I taught in district one and district two. Before the study took place, I constructed different beliefs from different sources. These beliefs continued to change and develop as I worked with different students within both districts, because they had different needs. What the students required to become successful directly influenced some of my beliefs, which consequently influenced my teaching practices.

The role of speech, as part of oral language, combined with mathematical learning is a crucial combination, in my personal opinion. Students have a greater chance of understanding the material more deeply when they can explain it in detail verbally. As they explain aloud, they are working through their ideas and problem solving to come up with an appropriate description so the participant(s) can comprehend. Students also need to listen to what other students have to say so they can share in the problem solving together (Beswick & Muir, n. d.). Speech and writing do not always have to happen simultaneously, but when they do, understanding is more stable. Students need the opportunity to work through different ideas
with classmates. As a new concept is being taught, students have different levels of understanding which allows students to work through different ideas as a give and take situation. Mousley (1999) explains that teachers use the demonstrations of students to gauge their understanding such as the ability to verbalize ideas, answer specific questions using their own language and relay new information to other students. The following subsections explain some of my beliefs and how I incorporate literacy within different teaching practices to help all learners grow.

Mader (n. d.) makes the argument that some students have difficulty writing their thoughts because of specific elements such as, inability to properly explain ideas, confusion of specific vocabulary, lack of planning out what to write, and the inability to infer a cause and effect situation. Since this can be the case, it is appropriate for students to have specific strategies to use to get around different confusions they may have. When students start to think about a verbal explanation, there are a number of things they need to think about: words that portray what is being explained, a coherent series of sequential ideas, and the realization of if what was thought was actually produced through words. When students express a dislike for writing written justification to a problem, it may seem they do not understand, but in reality their verbalization expresses they do indeed comprehend (Beswick & Muir, n. d.). That is why it is important for students to be given several different opportunities to express their understanding.

**Giving Students the Opportunity to Explain their Thinking**

When students have several opportunities to explain their thinking, both verbally and written, they are constructing meaning in a way that makes sense to them as individuals. These
opportunities are often times part of a gradual release of responsibly from teacher to student. The teacher starts out by modeling and scaffolding support for the students. Once students start to increase understanding, the teacher pulls back and allows students to construct new knowledge through meaningful experiences (Ensar, 2014). Students often times connect learning to personal experiences or previously learned material. When they explain their thinking, they are using literacy in the forms of speaking and writing. What I wanted most for the students was the ability to construct meaning that they could relay to someone else with ease and confidence. This individualized thought process gives students the ability to create the pathway in making decisions. This teaching practice incorporates students as the sole provider of communication. Students use their old and new understanding to portray wonderings, ideas, confusion, and eventually proficiency.

The idea of assessment is used for students to explain their thinking to show they have a strong conceptual understanding of the material. In district one on Monday, December 9, 2013 when my mentor was able to observe me, she noted the different times students were able to explain their thinking. This particular lesson had students turning written words into an expression with numbers combined with variables. A specific example included in the lesson plan is the expression first written in words: 14 is subtracted from 400x; that turned into an expression would be 400x – 14. The entire lesson plan can be seen in appendix J. My mentor’s written observation is an indicator of when and how much time elapsed for students to give that verbal representation. The following is her written explanation that describes this in full. I have only included the parts pertinent to this section.
Date: Monday, December 9, 2013

- Students review pages in the text: all students are following along
- Teacher asks a question specific to a problem having to do with subtraction
  - The problem is 14 subtracted from 400
- The teacher points out the problem from the book and asks students what that would look like as an algebraic expression (vocabulary used) (wait time of 60 seconds)
- Five students raise their hand immediately and the other remaining students look perplexed, the teacher seems to sense this and tells the students to share their thinking with the person next to them (90 seconds)
- The teacher brings the students back together and calls on a student that did not initially have her hand raised when the question was first asked.
- The student verbally explains her thought process (20 seconds)
- The teacher asks who thought of it that same way and students raise their hands (10 seconds)
- The teacher asks if anyone came about the answer differently and a couple students raise their hands. A student is called on and verbalizes his explanation (45 seconds)
  - No other students have a different way so the teacher continues with the notes.
- 3.6 worksheet: students work on the first two problems in groups to share their thinking and understanding. One group writes down their expression and then talks about each component to make sure each part represents the words shown.
- Two groups verbally explain their thinking as they share aloud. (2 minutes apiece) Different students talk if one gets stuck on a part. One group comes to the board and writes their expression to explain it easier.

This observation really informed me a lot about my practices of giving students different opportunities to explain their thinking not only to me, but also their classmates. As they explain their thoughts first to their classmates, they are restructuring explanations so that they make sense when it comes time to share aloud. It shows the gradual release of responsibility as students start to construct their own knowledge by working through various problems. Giving
time for verbal explanations in a whole group setting also shows my teaching practice that students learn from each other and can connect to personal experiences. I believe that students make deeper connections from not only working explicitly with meaningful material, but also through peer discussion. This excerpt from my mentor specifically shows the connection between my teaching belief and teaching practice.

In district two on Thursday, February 27, 2014, the students were learning about measures of variation, the way data vary in a set, and how to interpret interquartile range, the difference between the third and first quartiles in a data set. These were two different lessons but went hand in hand as they were used with the same data that could be interpreted to find specific elements of a data set. I gave students several different opportunities to not only construct meaning through verbal explanation, but also through written language. I thought it was important to incorporate verbal problem solving first, before the written portion because the verbal language allowed them to work through wonderings and confusions first. If students were not given explicit time to think about the process of both oral and written language, I believe it would not have been as meaningful. The combination of both types of language incorporate both my belief about the two and the lesson example shows the practice portrayed by the belief. The belief in this case was students having multiple and meaningful experiences to explain their thinking verbally and to others for feedback.

Sometimes when time was not in my favor, the amount of time students were able to explain their thinking had to be shortened to get through all of the material. In district two, I was required by the district to follow the pathway of the textbook which had divided chapters and sections into specific days. These days built upon each other so the material had to be
covered or else the students would be lost. One specific lesson on Wednesday, March 5, 2014 incorporated different types of random sampling methods. This section incorporated primarily reading with very little mathematical problems manipulating numbers. Since I had to get through the three different sampling types I was not able to incorporate all of the verbal explanations that I had intended. This was a lesson that at first required verbal explanation, but then moved into written explanation. The students had to differentiate between the three sampling options to determine which would be most appropriate and why. As it was not my authority to determine what was to be taught each day, I had to use my discretion regarding what pieces must be incorporated and what pieces I could take out. Students still had the opportunity to share with others, but there was not enough time as I had hoped to have an in depth conversation.

The sections of the textbook that incorporated the types of sampling were thick and lengthy which was quite different from what students were used to. The book had me covering all three types of samples in a single day, when in reality, it would have been more beneficial to take a single day for each type. The time constraint caused a disconnect with my teaching practice of giving ample amount of time for verbal language with peers. Even though the constraint was there, I did not waste any time within the lesson. If the chance was given for students to think aloud about the subject, I made sure to give it to them.

I tried my best to incorporate as much talk as possible with the material that was provided, but it greatly lacked the time it deserved. In the previous example, so much emphasis was put on reading that there wasn’t enough time to include much of anything else. I had the students reading directly from the textbook aloud and then as a whole class we would briefly
discuss each random sampling method to come up with our own examples. I had to cut back the time for students to give verbal examples which showed their thinking. This was due to the requirement of getting through all the material in the allotted time. I believe I did the best I could with what I had to work with.

One way to determine just how much students understand is by giving them the necessary time to verbally explain their thinking. Some students require more time than others as they take longer to organize their thoughts. This goes the same for explaining through written form. It’s not just about getting all the information out there for someone to interpret, but by providing a sequential and detailed explanation that is easily understood. The opportunities presented by me to the students, demonstrate the importance of communication to relay information. It is clearly evident through the different examples that communication can be successfully achieved through all combined aspects of literacy.

**Unpacking Problems Allows for Greater Understanding of What to do**

In most instances, a problem that students need to answer has so many parts and pieces to it which require them to really delve into the problem. If they don’t understand what the problem is asking them to find, then it is going to be very difficult to figure out where to start or even what to do. My belief is that students need to know exactly what the question is providing them with to be successful. In most cases, problems provide a lot of information, some relevant and some irrelevant. Students need the ability to know what is given to them and what they still need to figure out. The greatest “challenge is to identify statements in the problem that express relationships between quantities, to understand those relationships, and
to choose an appropriate operation or operations to show those relationships” (Charles, n.y., p. 5).

The teaching practice that follows this belief is providing explicit explanation and individualized time for students to specifically figure out how to be successful in problem solving. When students are first attempting to understand new material, it is the teacher’s job to make sure they are on the right process of gaining what needs to be gained. Checking in with students as they explain their thought processes helps determine what they are attending to and where the confusion still is. Through these next examples I show how I did just that to encourage all students to gain the new knowledge through the mathematic literacy activities.

The following is an example of a classwork problem from Friday, February 28, 2014 that students had to answer in the unit on probability. They were given information and then were required to figure out which statements were true based on the initial information given (Cavendish, 2013, p.192).
Solve.

The finishing times of 40 people in a 100-meter freestyle swimming event were collected. The quartiles for the data are shown:

\[ Q_1 = 62.05 \text{ seconds}, \ Q_2 = 69.16 \text{ seconds}, \text{ and } Q_3 = 71.43 \text{ seconds}. \]

List the letters of all the following statements that are correct.

- **a)** 50% of the swimmers managed to complete the 100-meter event in between 69.16 and 71.43 seconds.
- **b)** 75% of the swimmers took longer than 62.05 seconds to complete the event.
- **c)** Swimmers with times greater than the upper quartile are fast swimmers.
- **d)** Swimmers with times between the first and the second quartiles are faster
- **e)** The interquartile range shows that the time differences of the middle 50% of the swimmers is not more than 9.38 seconds.

- **f)** 50% of the swimmers completed the 100-meter event between 62.05 and 71.43 seconds.
- **g)** 25% of the swimmers took 71.43 or more seconds to complete the event.
- **h)** 10 swimmers completed the event in less than 62.05 seconds.
- **i)** The number of swimmers with times between the first and the second quartiles is more than the number of swimmers with times between the second and the third quartiles.

This information was confusing just from initially looking at it, but the students were required to determine which statements were in fact true. Without knowing the initial information, students would not be successful with answering the question. I put students in groups because
talk was required to answer this question as students talked through their questioning and wonderings from reading the problem. Reading was also a large piece because they had to know how to interpret the language being used in each statement. There were a lot of pieces incorporated in this problem, but it was a great indicator of which students had understood the mathematics through the literacy piece quicker than others. Not all problems were like the one shown above, but enough were like this that the students needed to know how to handle them.

As students were in their groups, I needed to make sure they were specifically unpacking the problem in the most appropriate way. I didn’t want to just give them the answer when they got stuck, but instead help scaffold their thinking with specific questioning. This was done to help the students gain the understanding through their background knowledge. Some students required more scaffolding than others, but that is only because students had different levels of understanding. Each student gains new knowledge in a different manner as well as a different amount of time. Rushing them would only cause confusion and frustration which would allow for zero gaining of new knowledge. I made sure to never rush any students as they attempted to verbalize their thinking to me. I provided several opportunities around the same topic to help promote learning in different ways.

This example also shows my belief in the importance of giving students a substantial number of opportunities to work through their ideas with new material. It also shows when solidification of the concept has been reached by the students which then ensures proficiency has been met. Students can show confusion solving one question and then are successful in the next. They can use their success to go back to their confusion as an attempt to problem solve and reflect. That is exactly what students did with the preceding example; they took the nine
statements and determined their accuracy from the given information. If students did not understand the given information then they would not have been able to differentiate between the true and false statements. Allowing students to work together to talk through ideas shows the teaching practice set in place that matches my belief.

In district one on Monday, December 9, 2013, students were still required to be able to unpack problems as this is a strategy that is very helpful. Since this idea revolved around reading and interpreting, it was crucial that the students had a strong understanding of the content vocabulary. It was also important that they knew how to interpret graphs, charts, tables, and diagrams. In the following problem taken from module 3 (engageny), students had to unpack the problems to figure out everything they needed to do to come up with an answer.

Lesson 2 Warm-Up

Jack got the expression $7x + 1$, and then wrote his answer as $1 + 7x$. Is his answer an equivalent expression? How do you know?

Jill also got the expression $7x + 1$, then wrote her answer as $1x + 7$. Is her answer an equivalent expression? How do you know?

The first thing the students needed to do was understand the problem; they needed to be able to answer the question of “What am I supposed to do?” The next step was figuring out what the word equivalent meant; in this case it was asking if the two expressions written were the same even though they were written differently. By simply looking at it, students needed to be able to figure out the different properties that were associated with expressions and numbers to determine if they were in fact equivalent. The example showed the commutative property of addition, meaning that it does not matter in which order the terms are added together. They
could have also plugged in any value for the variable x to see whether they arrived at the same answer for each expression. There were two separate ways to come to the answer, but without knowing the word equivalent, students would have struggled. The next question pushed their thinking a bit further as the variable x was not in the same place in both expressions. In this case they needed to know the rules of variables. They could, however, plug in that same value for x to determine that they were not equivalent. Students had to really understand what the problem was asking because it had multiple layers to it, it required them to do some things before they could explain their answer.

The practice demonstrated is how students use their success from question to question through the encouragement and assistance of my questions and check-ins. As students thought about the first question, those thoughts were used to answer the next question. If they became stuck on answering the first question, then it would likely be the case that they would be unsuccessful answering the second. As students worked on this warm-up, I made sure to check in with the students who I thought would have some difficulty. I did this because if students had a good understanding of the first part, then they would be more likely to understand the second part. To make sure all students understood these questions, I went over them as a whole group showing them the process while incorporating a small discussion. This was done to ensure that all the students in the class understood the process as much as they understood the answer. This examples shows students unpacking the problem in two ways: first by knowing what the question was specifically asking and two, by the students being required to give a detailed response to back up their thinking. I was able to see if these things happened by
checking in with students and listening to their responses. Since the question asked “How do you know?”, students needed to clearly state their response in an organized summary.

In another example from district one, students had to complete a worksheet with word problems dealing with integers in the real world. Basically these were word problems that were related to things in real life. The following is an example of one of the questions that students had to unpack to figure out the correct answer completed on Wednesday, December 4, 2013. The entire worksheet is in appendix K.

2.) A hike starts at an elevation 30 meters below sea level and ends at a point 9500 meters higher than the starting point. How high would you be at the end of the hike?

Again, students needed to be able to unpack the problem by first differentiating the information given. The vocabulary is very specific so it was crucial for them to know that “below sea level” meant that the number was negative since sea level has a value of 0. As the problem continued, the students had to determine what to do with the two numbers given; add them or subtract them. Students who drew a representation of what the problem was describing tended to be more successful in determining the proper method to answer the problem.

This teaching practice of showing how written language dictates how the math is done, shows my belief of literacy in mathematics. Written words are more difficult to decipher than simply numbers with operations. Different words represent different things when related to mathematics. Students must be able to differentiate between strings of words to determine how to start answering the question. As students worked on the worksheet I wanted to make sure they all understood the relationship between words and mathematical symbols. If the
relationship was not comprehended, then the order or writing would not have been correct. For students who were really struggling, I had them write what they thought the words said as symbols and then go back and try to rewrite their symbols into words. This was done to see if they came up with an accurate answer. For students who grasped the concept quickly, I had them create their own written description and then switch with a partner to solve. These practices allowed for all learners to thrive and showed the strong emphasis of reading in mathematics. Reading is so important because students need to comprehend the problem to be able to answer it correctly. As they are creating new knowledge, they are reading different material and interpreting it to further their understandings.

Not all questions require that much analysis to determine where to start or the appropriate path to follow. In most cases word problems do require that much thought and students needed the ability to know how to sift through the information. In each district I used questions, like the previous examples, to relate the process of unpacking problems to mathematics.

**Showing Students Reading is a Part of Mathematics**

Reading is a part of mathematics just as much as numbers are. Students are not only reading directions or problems, but also charts, graphs, tables, etc. It was usually the case that directions and problems had many steps to them so if students were not reading the entire thing they would miss specific pieces. Also, if they were unable to comprehend the language used, they were unable to answer the question. I did all I could to imbed this idea in my teaching practices to relate it to all my students. They needed to also see how powerful reading was in mathematics.
I believe that students who have strong reading skills are more successful in understanding mathematical problems. This is because they have appropriate and helpful strategies that they use in both a reading and mathematics setting. Koesling (2009) believes students should read something at least twice before trying to solve because it encourages students to truly think about the logical path of the text. When students have a difficult time reading, they will then have a difficult time in understanding how to solve different problems. Reading is being able to take written words from a page and turn them into something understandable (Freitag, n. y.). The teaching practice I used to match this belief about reading was demonstrating this to the students as many times as possible. When modeling different problems, I would pull out the important information by underlining, circling, or writing it down off to the side. “Research has shown that modeling is an effective instructional strategy in that it allows students to observe the teachers thought process (Coffey, n. d.). This type of modeling represents the importance of reading to the students. Students then use the modeling to be successful independently.

In district two I gave a test on Tuesday, February 11, 2014 that came directly from their Math in Focus textbook (Cavendish, 2013). Since this was premade, the directions and questions were set in place by the makers of the text. It was my intended goal to have the students have a strong realization that directions tell you exactly what needs to be done. In the following problem, students had to answer three different questions using one set of directions (Cavendish, 2013, p. 48). The directions clearly stated what needed to be done for each question.
Since the directions state to “tell whether each table, graph, or equation represents a direct proportion, an inverse proportion, or neither,” (Cavendish, 2013, p. 48) it was not suitable for the students to use responses such as “yes” or “no”. Those responses do not clearly describe what was being represented in the three questions shown. It may have made sense to the student if he/she had been asking internally if each one was a direct proportion, but that was not what the directions said. After the test was given, I picked different students’ work to show the class and had them figure out why the student lost points. I kept each student paper anonymous because this was a learning experience. The more students were immersed in these
kinds of examples, the more they understood the meaning and were able to use them independently.

Since I believe reading is an important aspect of understanding, having not read the directions in the previous example resulted in incorrect answers. I noticed that in most cases, students wanted to simply get it over with and be done. That notion was an important realization because I was able to show how speed does not always produce accuracy. This teaching practice of relaying all this information to the students through examples and explicit instruction allowed for them to internalize what needed to be done to be successful.

**Chapter Summary**

The first theme that I discovered, incorporating literacy within a constructivist environment, represented how I used specific constructivist elements with the different areas of literacy: viewing, listening, speaking, reading, and writing. This was helpful to discover because it shows how I used two very different subjects and intertwined them in my teaching practices. In some instances there was a disconnect between my personal beliefs and which teaching practice I used. In those instances, my beliefs did not change, but I used different teaching practices to ensure student learning. This analysis of the data demonstrated just how my teaching practices matched up to my beliefs about literacy within mathematics. The previous sections represented this through the specific practices of the whole to the parts, student questioning driving instruction, using manipulative materials, group work, and starting with the end in mind. Each of these elements of a constructivist approach specifically matched up with a different one of my beliefs.
The second theme showed how my beliefs directly influence my teaching practices, which demonstrates how I teach with the students in mind. I discovered through the analysis of the data that I altered specific teaching practices to make sure the students were gaining as much knowledge as possible within my classroom. This theme again helps answer the research question, because the way I think about literacy and mathematics is portrayed through my teaching practices. All students require different things to be successful and I made sure that the students in both districts had the opportunities to work through new material in such a way that encouraged their learning.
Chapter 5: Conclusions and Recommendations

Introduction
The purpose of this study was to determine how and if my teaching practices fit my beliefs as I attempted to relate literacy and mathematics together. I chose to conduct a self-study because I wanted to discover how and if my teaching practices directly matched my personal beliefs. I feel so strongly about this particular topic, that it was critical to determine whether my outward actions are portrayed by what I believe on the inside. My specific research question was:

How do my beliefs about the connection of talk and writing in mathematics match up to my teaching practices?

This chapter will discuss the overall findings constructed through the data analysis done in Chapter 4. I found that talk helps students to understand new material. Subsequently, this type of talk, oral or self, encourages students to make concrete meaning that can be transposed to written interpretation. As students use both written and oral language to construct meaning in meaningful experiences, they will construct new knowledge in a successful way. My analysis shows the connection between my beliefs and practices. Why this is important will be explained in depth in the following sections. Implications for students as well as teachers will also be discussed. It is important to use this information in the future because it clearly describes how it is meaningful and worthwhile for students. All educators have the same goal; for students to gain as much knowledge as possible through meaningful experiences.
Conclusions

Written and Oral Language Aids in Mathematical Meaning Making

Language is often times most difficult to comprehend in mathematics because of the many layers that exist; words and symbols mean different things in different contexts. Students need to understand what is put in front of them in order to be successful in what is asked of them. It is most times the case that if students can verbalize their thinking they will be more successful in writing their thinking when it is required. It is not sufficient for students to simply get the answer correct; they must understand what the answer represents in the context of the question. In each example in chapter 4 that had to do with students working through meaning orally, students were much more successful when it came time to put those thoughts into written language. This was because they solidified the written language through first working through ideas orally. “Mathematics is not only calculation; the aim of teaching should also be the development of understanding and mathematical thinking” (Pehkonen, Näveri, & Laine, 2013, p. 12). This is something that shows strongly through my teaching practices because I believe in it so deeply. It was clearly evident through specific data excerpts which demonstrated the numerous ways I used different teaching practices to support student learning. The largest key finding was that the students engaged in meaningful experiences to reflect and construct new knowledge. I used modeling and scaffolding within the students’ zone of proximal development to ensure each student had the necessary opportunities to be successful.

The first thing is always for students to take the time to use self-talk to figure out what needs to be done and to construct meaning of new material. When students use self-talk they are only relying on their personal thoughts, experiences, and ideas for support. Vygotsky (1987)
hypothesized that the idea of self-talk reflected students’ potential for a deep understanding to assist in planning, guiding, and monitoring different activities and mathematical ideas. Students are sometimes unaware that this self-talk is even occurring; most will just think of it as internally thinking about what to do, but in reality they are really talking to themselves. Self-talk is often times most successful with hands on manipulatives or when visuals are involved in the process. This gives the students an extra push in constructing understanding of new concepts. That was something that became increasingly evident as I analyzed and interpreted all the data. Chapter 4 went into more depth describing how objects can assist the kinesthetic and visual learner to construct meaning. Kinesthetic learners learn best when they can touch, feel, and manipulate objects to construct meaning. The visual learner benefits from seeing the concept or idea take place. The objects used to portray this, also known as manipulatives, are woven directly with self-talk for students to gain an individualized understanding.

Through my findings, I clearly determined students used self-talk in numerous situations to help promote a deep understanding. I tended to also use self-talk as I demonstrated the way I thought about different concepts to my students. This type of modeling represents an appropriate pathway of thinking through ideas and wonderings. Students then were able to take my modeling and manipulate the tools in a way that was most appropriate for them. Students used self-talk individually when manipulatives were involved and also as they constructed meaning through talking and listening about new ideas with peers. As students then worked with their peers, the self-talk turned into oral language to communicate different ideas. As Vygotsky (1987) believed, language is used as a tool to organize information through
words and symbols. Once the students have organized their thoughts, using self-talk, those thoughts can then be clearly presented to others orally.

When students worked together, it involved a more precise type of language as students needed to work through their wonderings, confusions, or ideas with peers. These peers may have the same questions or wonderings and will then be able to talk through them together to come to a solution. In other cases some students may have a stronger conceptual ability and have already mastered the new material. In that case, that student uses language to help others come to the same understanding. This student has to be cautious of what language and terminology to use to communicate clearly to those who are not on the same level of understanding. Each student brings different understandings or ways of thinking about the same idea that can help those still struggling. As students work through ideas together, they are constructing meaning in such a way that is meaningful and worthwhile. Students will use visuals to help construct meaning or write key ideas to help in the process. “Connections occur when learners make connections between mathematical concepts, apply mathematics to other contexts outside of the classroom, and understand how different ideas in mathematics interrelate” (Kosko & Norton, 2012, p. 340). These connections are what solidify new learning.

It was my intended goal to give each group of students the opportunity to create meaningful connections through different resources and flexible settings. My findings demonstrated that students were most successful in making connections when it was relatable to real life. Since that was the case, I used different resources that related the mathematics to real world situations. The opportunities in which students were able to construct meaning together, helped solidify the main points. When group work was at its best, students engaged
in meaningful discussions to work through different ideas, confusions and wonderings. Each data excerpt was a reflection of how students dove into the mathematics to construct meaningful experiences with the help of my teaching practices.

Students can use other students for assistance as they turn their verbal understandings into written descriptions. Again, they are using assistance from each other to make sure their written language matches their oral language. They have to truly understand the material to be able to write it or else their written language is disorganized and rambles on. To prevent this type of disorganization, students must organize their writing so the reader can understand it easily and precisely. Freitag describes the importance of writing as “the student writes, information from the process is immediately and visibly available, which allows the learner to review the reasoning for correctness” (n.y., p. 18). This entire process makes it possible for students to achieve success in written language independently. Writing has become a tool to promote understanding because it has the potential for helping students to learn (McIntosh, 1991).

**Teaching Practices Decided upon by my Beliefs**

The different teaching practices that I used were determined based on my beliefs of the most suitable way to assist students in the learning process. Since I believe in a constructivist approach, my role was to encourage students through providing necessary materials and opportunities to discover new ideas. The new ideas were then reflected upon by the students to determine what they had discovered. Powell & Kalina (2009) explain that a constructivist approach is successful because it involves the construction of knowledge through social
interaction between peers. As students work together they create meaning in unique ways through the thoughts and ideas of others.

Literacy can be incorporated with mathematics through the use of group work. Group work allows students to problem solve as a team to allow the same level of understanding by each person. This is the time that students ask clarifying questions or talk through their wonderings with others. Group work must be implemented in a successful way or it becomes a meaningless process. Richards (1991) explains that you cannot put students in group and expect them to problem solve and communicate unless they have those skills. Once those skills have been established, group work becomes a very successful strategy to use. Speech is the most crucial piece of group work because students are required to communicate effectively and listen thoroughly. They must construct their language in a way that all others can relate to and understand. When appropriate language is used, it provides conceptual development of mathematics through collaboration (Simpson, Mercer, & Majors, 2010). These strategies may be used to relate the concept to real life, give an example, or use a visual cue. Since each group member is an individual, their experiences and understandings are unique which can specifically encourage other students to reach the same level of comprehension.

The findings from chapter 4 show evidence of how my belief of students working collaboratively to gain more knowledge matches my teaching practice of students working in groups. The NCTM (2013) explains that this type of communication assists with consolidation of an idea. It was evident that students engaged in meaningful discussions of specific material which allowed for internalization. It was the case that group work was not always the most
suitable option when it became meaningless to the students. Even though the data show that I strayed from a particular teaching strategy, I still held true to my beliefs.

My specific belief that literacy should be included in all areas of mathematics was shown to be valid as in each area it was discovered I used it in the classroom each day. Students are required to read and view different kinds of demanding information that has different layers. It is vital that they be able to write their understanding in a cohesive manner for others to read and understand. Before this written language can occur, students have to verbalize their thinking as a progressive process that shows understanding. “Communication allows students to convey ideas, feelings, and experiences that can lead to the development of higher cognitive functions, including critical thinking, sound reasoning, and problem solving” (Albert, 2000, p. 109). This communication is what students use to put their ideas into words on paper. Listening is a large part of comprehension, especially when new material is presented. Students need the ability to take in all this new information, whether it be from a teacher, peer, or activity, and construct individual meaning with it. Within each district, this idea of literacy surrounding the students was used and was successful in encouraging students to create new knowledge.

All aspects of literacy were incorporated together in my teaching practices because I thought it was helpful for students to gain a deep understanding of mathematics. The most important realization that students made was the large emphasis that reading has on comprehending mathematical information. Reading is required when looking at words, graphs, tables, visuals, or charts. Reading was incorporated in numerous lessons since it was an important tool to construct new knowledge. When the language is not taught specifically with the material, then students have a difficult time in constructing any meaning (Ewing, 1996).
Vocabulary cannot be taught in isolation as the students have little knowledge or experiences to match it with. As this idea of vocabulary was something I knew, I used the language from the start so students could familiarize themselves with it. It was not the case that I would explicitly describe to the students which form of literacy was being provided to enhance learning. I intertwined them together for students to become familiar with them as catalysts to the learning process.

A teacher’s specific beliefs are what they believe in and are usually dependent upon the teaching practices that they choose to use. Teacher beliefs need to be set aside so a teaching practice that is most suitable for all learners is used. It was shown through my data that the majority of my personal beliefs about literacy in mathematics matches directly with my teaching practices. All content areas should be seen to overlap by students so they understand each is a unique part that fits together as a whole. Mathematics should not only be done in math and reading should not only be done in English class. This is the message that needs to be portrayed to all students by all teachers.

**Implications for Student Learning**

**Students are Directly Impacted by Teacher Practices**

Even though this was a self-study, students were still the main component in both my teaching practices as well as my beliefs. Students are the main reason why teachers teach. The ideas that were described in the earlier chapters, explain just how students are impacted by the ways they are taught. Incorporating the most important pieces into their learning experiences will make sure they grow to be well rounded members within society. This includes the very powerful idea of students communicating through group work. Simpson, Mercer, & Majors
(2010) conducted many studies which showed collaborative learning, with talk as the main source of discussing ideas, was shown to have an increase in conceptual development for students. I believe students need to realize the connection between communication of mathematics with literacy and know that their teacher is there to do what needs to be done to make him/her successful as a student. The communication in this instance is the language students use to portray their ideas and thoughts to others. When they are describing something orally, students will draw upon other areas of literacy to help support their description.

As I decided how I was going to encourage students to grow in mathematics through my teaching practices I was considering my beliefs along with the students. It was important for me to try to discover new practices because I wanted to give my students several ways to interpret new information. Meaningful experiences are what students reflect upon to construct new knowledge. As I wanted students to internalize new ideas and concepts I made sure it occurred through my specific teaching practices.

**Literacy should be used in Conjunction with Mathematics**

Literacy and mathematics should be connected in all ways possible for students to realize that they go hand in hand together. Reading and writing are just as important in mathematics as they are in English. If it is truly thought about, reading is more demanding in mathematics because students have so much to read; directions, numbers, symbols, graphs, charts, tables, etc. Albert (2000) tells us that writing helps students move through the zone of proximal development to the zone of actual development. The students start with the assistance of a more capable person and eventually need the assistance from no one. Within the zone of proximal development, students require scaffolding to assist in the learning process.
(Powell & Kalina, 2009). It is crucial that they be presented with as many meaningful
experiences with reading and writing to conceptualize the process.

Literacy was incorporated into each teaching practice I implemented. Some teaching
practices used more literacy elements than others, but it was always the case that at least one
was being used. I tried to incorporate all of them within each lesson, but that was not always
suitable to student learning. Yes, I believe that literacy needs to be used, but I do not believe
that it should be forced in and result in students not learning.

**Teaching Practices Should Engage all Learners**

Students look up to their teachers for meaningful ways to discover new learning. If a
teacher does not feel passionate about a specific topic or teaching practice, than that is going
to show through to the students. The teaching strategies I used, such as group work, check-ins,
questioning, and fun activities, are ones that work with students and can be tweaked and
altered if needed. The main concept of incorporating literacy is the most important because it
was proven to work. A case study led by Raiker in 2009 resulted in demonstrating that “the use
of language, both written and spoken, is crucially related to the learners’ construction of
mathematical concepts and subsequent development of mathematical thinking” (p. 2). The
language is what students manipulate and work through to make sense of the mathematics.

All students comprehend information in unique ways. When students are engaged
within the lesson, learning occurs without forced effort. That is why I tried to encourage
students to see mathematics in a new and fun way to get them excited about learning. This was
done through different teaching practices such as group work, incorporating manipulatives, and
problem solving. Group work is a huge teaching practice that promotes engagement because
students sometimes are more willing to work with peers because they can talk about their wonderings and confusions. I discovered that group work indeed was a strong teaching practice that encouraged learning to all students.

Implications for My Teaching

Teachers look for ways to make learning meaningful for all their students regardless of ability. I learned a tremendous amount about myself as an educator that I will take with me to further enhance my teaching. I do believe that all students can learn when they are given the opportunity to do so. Through the data analysis it was evident that my teaching practices do indeed match my beliefs when it is appropriate for learning to occur. It was also evident that I am willing to change my practices to stick with the belief that all learners can learn. I think that is the most important thing that I learned about myself and that I will continue to use as I educate students.

Considering the things I learned about myself shows that I take pride and appreciation in my students and their ability to construct knowledge through meaningful experiences. This all matters because I wanted to make sure that my beliefs are portrayed to my students so they can see the importance and usefulness of the practices I used.

Providing Meaningful Experiences

For my further teaching practices, I will continue to develop my beliefs, as well as my teaching practices, to provide meaningful experiences for all students. What students are required to learn will continue to evolve as it is not the same things taught ten years ago. Right now, “developing a voice in mathematics is one of the most important goals of the twenty first century” (Whiten & Whiten, 2001, p. 1). Who knows what the emphasis will be on next.
Because of that fact, my teaching practices will most likely need to be altered to align with the new material to be taught. Since most of the practices discussed promote student involvement, they will only need to be slightly altered dependent on specific students. As teachers we know that no two classes are the same with student needs and learning styles. Students’ involvement can range from planning lessons with them in mind to implementing practices where all students can be successful. Albert (2000) tells us that when students use communication freely with peers, they are developing higher cognitive functions. I want to make sure I am continually including the most appropriate practices that include active engagement to portray literacy in mathematics.

**Recommendations for Future Research**

There are still some things I am wondering as I look back upon all of the research and the key findings I found. One of the largest pieces I wonder if it would be possible to determine how students relate to different teaching practices. Some students may like certain ones over others because they find them more meaningful or useful. I wonder this because students all have their own uniqueness so it would be interesting to discover what the majority of students may take to more. Along the same lines, it would be interesting to determine the successfulness of only a single teaching being continually used than multiple ones at a time.

It was intriguing to discover I felt comfortable to change my teaching practice on the spot dependent on students’ needs. This is intriguing because I wonder if students picked up on it or even made the connection. Since I had never specifically told students what I believe in or why I chose different teaching tools, it would be interesting to see what they attended to. I think it was clear that the students knew I would do what needed to be done to ensure they
were learning the appropriate information. For future research, I think it would be helpful if it was somehow determined what exactly students understood about a teacher’s practices. Do they think all teachers need to teach the same way? Do they know teachers have flexibility surrounding their practices?

Lastly, I think it would be helpful to also take a look at what would happen if beliefs did not match up to teaching practices. If a teacher believes in one thing, but demonstrates opposite beliefs through the teaching practices, how would this affect students? I think this would be interesting to pursue because it is usually the case that students feed off the actions of the teacher. If the teacher was not portraying excitement because of personal feelings, would that be something students picked up on?

Final Thoughts

As I look back at the entire process of creating and answering my research question, I have truly learned a lot about myself; more than I thought I knew. For the most part each new discovery was one that I was proud of. The most significant discovery was the fact that I felt comfortable to stray from my typical teaching practices to most benefit the students. My beliefs never changed, but I knew the current implementation was not succeeding, so a change was needed. It was not going to be meaningful for the students to be completing an activity or group work that was not encouraging them to learn.

I am thankful to have had this opportunity in determining whether my teaching practices matched my belief of incorporating literacy in mathematics. It has always been my goal to encourage students to construct knowledge through reflection on meaningful activities and experiences. As I incorporated literacy elements, the activities became more meaningful
because language and literacy tools helped with constructing meaning. It was sometimes a struggle to determine which teaching practices to use because I was required to use specific resources as well as teach in a certain amount of time. Given the constraints I had to deal with, I still believe I gained enough data to portray that my teaching practices clearly demonstrated my belief about incorporating literacy with mathematics to support student learning.
**Reference List**


Appendix A: Lesson Plan Format

Lesson Title:          Lesson #: 

Date Lesson Will Be Taught:

Student Objectives: Students will be able to...
   •
   •

Student Outcomes: Students will...
   •
   •

State Standards:

   1.
   2.

Brief Description of Lesson: (how language will be used)
### Appendix B: Journal Entry Form

<table>
<thead>
<tr>
<th>Date:</th>
<th>Lesson #:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Field Notes</th>
<th>Interpretations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

129
Appendix C: Observation Form

Date:

Notes about the Lesson:
Appendix D (engagny)

Date: Monday, November 18, 2013

Grade 7 • Module 2 Rational Numbers

OVERVIEW

In Grade 6, students formed a conceptual understanding of integers through the use of the number line, absolute value, and opposites and extended their understanding to include the ordering and comparing of rational numbers (6.NS.C.5, 6.NS.C.6, 6.NS.C.7). This module uses the Integer Game: a card game that creates a conceptual understanding of integer operations and serves as a powerful mental model students can rely on during the module. Students build on their understanding of rational numbers to add, subtract, multiply, and divide signed numbers. Previous work in computing the sums, differences, products, and quotients of fractions serves as a significant foundation as well.

In Topic A, students return to the number line to model the addition and subtraction of integers (7.NS.A.1). They use the number line and the Integer Game to demonstrate that an integer added to its opposite equals zero, representing the additive inverse (7.NS.A.1a, 7.NS.A.1b). Their findings are formalized as students develop rules for adding and subtracting integers, and they recognize that subtracting a number is the same as adding its opposite (7.NS.A.1c). Real-life situations are represented by the sums and differences of signed numbers. Students extend integer rules to include the rational numbers and use properties of operations to perform rational number calculations without the use of a calculator (7.NS.A.1d).

Students develop the rules for multiplying and dividing signed numbers in Topic B. They use the properties of operations and their previous understanding of multiplication as repeated addition to represent the multiplication of a negative number as repeated subtraction (7.NS.A.2a). Students make analogies to the Integer Game to understand that the product of two negative numbers is a positive number. From earlier grades, they recognize division as the inverse process of multiplication. Thus, signed number rules for division are consistent with those for multiplication, provided a divisor is not zero (7.NS.A.2b). Students represent the division of two integers as a fraction, extending product and quotient rules to all rational numbers. They realize that any rational number in fractional form can be represented as a decimal that either terminates in 0s or repeats (7.NS.A.2d). Students recognize that the context of a situation often determines the most appropriate form of a rational number, and they use long division, place value, and equivalent fractions to fluently convert between these fraction and decimal forms. Topic B concludes with students multiplying and dividing rational numbers using the properties of operations (7.NS.A.2c).

In Topic C, students problem-solve with rational numbers and draw upon their work from Grade 6 with expressions and equations (6.EE.A.2, 6.EE.A.3, 6.EE.A.4, 6.EE.B.5, 6.EE.B.6, 6.EE.B.7). They perform operations with rational numbers (7.NS.A.3), incorporating them into algebraic expressions and equations. They represent and evaluate expressions in multiple
forms, demonstrating how quantities are related (7.EE.A.2). The Integer Game is revisited as students discover “if-then” statements, relating changes in player’s hands (who have the same card-value totals) to changes in both sides of a number sentence. Students translate word problems into algebraic equations and become proficient at solving equations of the form $px+q=r$ and $(x+q)=r$, where $p$, $q$, and $r$, are specific rational numbers (7.EE.B.4a). As they become fluent in generating algebraic solutions, students identify the operations, inverse operations, and order of steps, comparing these to an arithmetic solution. Use of algebra to represent contextual problems continues in Module 3.

This module is comprised of 23 lessons; 7 days are reserved for administering the Mid- and End-of-Module Assessments, returning the assessments, and remediating or providing further applications of the concepts. The Mid-Module Assessment follows Topic B, and the End-of-Module Assessment follows Topic C.
## Appendix E

### Key Concepts

- Measures of variation are statistics that measure the spread of data.

- The range is a measure of variation. It is the difference between the greatest and the least data values.

- Quartiles are measures of variation that divide data into four equal parts. There are three quartiles: first quartile (or the lower quartile), second quartile (or the median), and third quartile (or the upper quartile).

- The interquartile range is the difference between the third and the first quartiles.

- The mean absolute deviation is the average distance of the data values from the mean.

- Data sets can be represented by stem-and-leaf diagrams.

- A sample is a set of data taken from a population. Random sampling is a process of collecting data from a population in such a way that:
  - every member of the population has an equal chance of being selected, and
  - the selection of members is independent of each other.

- Three types of random sampling methods are:
  - simple random sampling,
  - stratified random sampling, and
  - systematic random sampling.

- A simple random sampling method is carried out without any pre-planned order.

- A stratified random sampling method requires the population to be divided into nonoverlapping groups from which members are randomly selected.

- A systematic random sampling method is carried out by selecting the first member randomly, and subsequent members are selected at regular intervals.

- An inference in statistics is based on multiple random samples. The objectives of inference are:
  - drawing conclusions about a population,
  - estimating a population characteristic, such as a population mean, and
  - drawing comparative conclusions about two populations.
Appendix F

Date: Thursday, November 21, 2013
Lesson Plan: Subtracting Integers

Student Objectives: Students will be able to:
- Subtract integers using the additive inverse.
- Understand that the additive inverse has two distinct steps. Step 1: Change the subtraction sign to an addition sign. Step 2: Change the second number to its inverse or opposite.

Student Outcomes: Students will:
- Know how to use the additive inverse process and use it when they see subtraction of negative numbers.
- Verbally explain the process of how they arrived at the correct answer.

State Standards:
- 7.NS.A.1c Understand subtraction of rational numbers as adding the additive inverse, p – q = p + (-q).

Brief Description of Lesson:
- Warm-up (my favorite no)
- Check in/review previous night’s homework on adding integers
  - Students come to the board to write down answers
  - Answer questions on difficult problems
- Take notes on new strategy of subtracting negative integers (additive inverse)
- Guided practice of specific problems
  - Students verbalize the process for each guided practice example
- Independent practice worksheet
  - Start working on it independently using class notes and then work with neighbor to check process and answers.
  - Check for understanding through observation monitoring
- Use additive inverse to subtract negative fractions and decimals
- Exit ticket: 4 additive inverse problems
Appendix G

Date: Thursday, November 21, 2013  
Journal Entry reflection of Lesson Plan: Subtracting Integers

<table>
<thead>
<tr>
<th>Field Notes</th>
<th>Interpretations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• My Favorite No</td>
<td>• The “aha” moment of understanding why they had gotten it incorrect.</td>
</tr>
<tr>
<td>• Review of homework assignment. After the students wrote the answers on the board, I put a star next to the ones I agreed with and then we discussed the ones I did not agree with. Students who understood where the mistake was, were very eager to make the correction.</td>
<td>• Noticing great things about what the student did well.</td>
</tr>
<tr>
<td>• Taking notes on the new concept. Decided that the steps would assist the students with understanding the process. Since the term had two words, the process had two steps. Students seemed to grasp the concept as they answered the questions I posed during the mini lesson.</td>
<td>• Should I have had the student who put the wrong answer on the board try and figure out where the mistake was?</td>
</tr>
<tr>
<td>• Independent work time to practice the additive inverse. As I walked around and looked and what students were accomplishing, it was evident a majority of them had not grasped the concept as I had thought. Students also continuously told me that they did not understand what to do. I gave students time to work with their neighbor to see if they could work through it together. Students still struggled so I made the decision to continue modeling and release some responsibility as I used scaffolding</td>
<td>• Through the modeling I was showing the students what the process should look like. Through my assessment I had predicted they understood the strategy.</td>
</tr>
<tr>
<td>• It was not going to be in the students’ best interest to continue moving forward with the lesson when they were clearly at their frustrational level. Through the change, the students were able to slowly internalize the idea and realize why it was helpful to use.</td>
<td>• It was not going to be in the students’ best interest to continue moving forward with the lesson when they were clearly at their frustrational level. Through the change, the students were able to slowly internalize the idea and realize why it was helpful to use.</td>
</tr>
<tr>
<td>• I felt confident after the lesson that the students would be successful on their homework. That too needed to be modified since we had not gotten to decimals and fractions.</td>
<td>• I felt confident after the lesson that the students would be successful on their homework. That too needed to be modified since we had not gotten to decimals and fractions.</td>
</tr>
</tbody>
</table>
whole group. It was not going to make sense for the students to start subtracting negative decimals and fractions if they couldn’t even subtract the whole numbers. During the regroup, I used real life examples to help interpret the strategy and what it exactly was helping accomplish.
Appendix H

Journal Entry reflection of Lesson Plan
Date: Thursday, March 6, 2014

<table>
<thead>
<tr>
<th>Field Notes</th>
<th>Interpretations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Warm-up and review of homework.</td>
<td>• Students did not ask many questions to clarify homework questions, but instead asked if there answer was correct in a different form. For example, a decimal, fraction, or percent.</td>
</tr>
<tr>
<td>• Put students in pairs, handed out the materials for the activity, and set the timer on the board. Directions were included in the kit and no other verbal directions were given by me.</td>
<td>• After the timer buzzed, indicating the end of the activity, I noticed that several students were going above and beyond what was expected of them. They were using specific language that told me they had come up with formulas and rules based on the information. This allowed them to not have to write down each possible outcome. The groups also made sure this process would work with numbers of larger digits. I decided to give them another five minutes to work on this activity and then have them share out so they could see how the other groups approached the idea similarly and differently.”</td>
</tr>
<tr>
<td>• Students took notes in their journal about this topic in the form of definitions, charts, and example problems.</td>
<td>• Students used questioning to clarify their thinking and to make sure they understood the new material. When a student expresses the concept in their own words, it lets them know that they in fact have made a connection.</td>
</tr>
<tr>
<td>• Independent practice.</td>
<td>• This allowed the students to work through problems on their own so they could determine whether they had a strong conceptualization of this type of probability.</td>
</tr>
</tbody>
</table>
Appendix I (Cavendish, 2013, p. 237-239)

Date: Friday, March 7, 2014

Chapter Review/Test

Concepts and Skills

Find the range, the three quartiles, and the interquartile range.

1. 2, 4, 1, 7, 3, 3, 9, 10, 1, 0, 6, 8, 5, 5, 9

2. 34, 66, 90, 25, 46, 81, 40, 67, 95, 104, 36, 49

3. 1.23, 1.45, 1.09, 1.78, 1.55, 1.67, 1.37, 1.05, 1.23, 1.11

4. 162.5, 248.6, 130.7, 344.9, 322.0, 234.2, 150.8, 304.7, 326.4

Use the information below to answer the following.

Tara tossed two number dice 24 times. She found the sum of the values for each throw and displayed the sums in a dot plot.

5. Find the range of the data.

6. Find the 3 quartiles of the data.

7. Find the interquartile range.

Solve. Show your work.
The map shows the maximum temperature, in degrees Fahrenheit, recorded in 20 cities across the United States in a certain year. Display the data in a stem-and-leaf plot.

The table shows the weights of Labrador dogs, in pounds.

<table>
<thead>
<tr>
<th></th>
<th>72</th>
<th>73</th>
<th>79</th>
<th>68</th>
<th>101</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>88</td>
<td>78</td>
<td>71</td>
<td>85</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>93</td>
<td>77</td>
<td>98</td>
<td>95</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>81</td>
<td>56</td>
<td>51</td>
<td>62</td>
<td>70</td>
</tr>
</tbody>
</table>

- a) Draw a stem-and-leaf plot for the data.
- b) How many Labrador dogs are there?
- c) What is the range?
- d) What is the mode of the data?
- e) What is the median weight?

Find the mean absolute deviation.

10 57, 60, 31, 30, 26, 46, 52, 40, 35, 60

11 1.46, 2.03, 3.12, 2.55, 4.25, 1.80, 4.08, 2.87

Refer to the box plot to answer the following.

The box plot summarizes the heights of bean sprouts, in centimeters.

12 Find the lower quartile, the median, and the upper quartile.

13 Calculate the range and the interquartile range.

14 **Math Journal** Interpret what the range means in this context.
15 **Math Journal** Interpret what the interquartile range means.

**Use the box plot to answer the following.**

The box plot below summarizes the scores obtained by the contestants in a game.

![Box Plot Diagram]

16 What are the greatest and the least scores?

17 Find the first, second, and third quartiles.

18 If there are 160 contestants, how many scored 4 or more points?
Problem Solving

Use the statistics given in the table to answer questions 19 to 21.

In a population of 200 students taking a science test, the following statistics for the test scores were compiled.

<table>
<thead>
<tr>
<th>Mean</th>
<th>Median</th>
<th>Mode</th>
<th>Lower Quartile</th>
<th>Upper Quartile</th>
<th>Highest Score</th>
<th>Lowest Score</th>
<th>MAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>68.5</td>
<td>67.4</td>
<td>67</td>
<td>38</td>
<td>76</td>
<td>96</td>
<td>26</td>
<td>25</td>
</tr>
</tbody>
</table>

19 Math Journal By comparing the mean, the median, and the mode, what can you infer about the distribution of the test scores?

20 Math Journal By analyzing the statistics in the table, what can you infer about the variation of the scores?

21 Estimate the number of students who scored 76 or less.

Use the data in the table to answer questions 22 to 27.

The table summarizes the monthly sales figures, in thousands of dollars, for the women’s and men’s clothing departments at a store. For instance, sales in the women’s department in January were $10,000.

<table>
<thead>
<tr>
<th></th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women ($1,000)</td>
<td>10</td>
<td>15</td>
<td>8</td>
<td>12</td>
<td>28</td>
<td>34</td>
<td>36</td>
<td>18</td>
<td>14</td>
<td>16</td>
<td>27</td>
<td>40</td>
</tr>
<tr>
<td>Men ($1,000)</td>
<td>8</td>
<td>10</td>
<td>11</td>
<td>15</td>
<td>20</td>
<td>30</td>
<td>24</td>
<td>14</td>
<td>10</td>
<td>9</td>
<td>17</td>
<td>28</td>
</tr>
</tbody>
</table>

22 Calculate the 5-point summary for each of the two departments.

23 Using the same scale, draw 2 box plots, one for each departments.

24 Math Journal By comparing the two box plots, describe the sales performance of the two departments.

25 Calculate the mean sales figure for each of the two departments.
   Give your answers to the nearest dollar when you can.

26 Calculate the mean absolute deviation for each of the two departments.
   Give your answers to the nearest dollar.

27 Math Journal By comparing the means and the mean absolute deviations of the two clothing departments, what can you infer about their variability in sales?
Appendix J

Date: Monday, December 9, 2013
Lesson Plan: 3.6 Writing Algebraic Expressions

Student Objectives: Students will be able to:
- Translate verbal descriptions into algebraic expressions

Student Outcomes: Students will:
- Understand what words translate into operational symbols
- Know what order to put the numbers in based on the words given (primarily for subtraction)

State Standards:
- 7.EE.A.2 Understand that writing an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related

Brief Description of Lesson:
- Review with practice of 3.5 factoring expressions
- New material: practice 3.6
  - Review pages in the text (aligned with common core standards)
    - Students verbalize the different written expressions into algebraic expressions demonstrating what words told them that was the specific way to set it up
  - Practice 3.6 with partners
    - First two problems as examples performed by students and verbally explained
Appendix K

Date: Wednesday, December 4, 2013
Name______________________________________ Math Classwork
Integers in the Real World

1. Mrs. Bautista has a bank balance of -42 dollars at the start of the month. After she deposits 6 dollars, what is the new balance?

2. A hike starts at an elevation 30 meters below sea level and ends at a point 9500 meters higher than the starting point. How high would you be at the end of the hike?

3. At sunrise, the outside temperature was one degree below zero. By lunch time, the temperature rose by 17 degrees and then fell by 4 degrees by night. What was the temperature at the end of the day?

4. A submarine hovers at 240 meters below sea level. If it descends 160 meters and then ascends 390 meters, what is its new position?