Sponsoring Committee: Dr. Charlotte Rappe Zales, Moravian College
Dr. Sandra Fluck, Moravian College
Ms. Michele Good, Wilson Area School District

MATHEMATICS JOURNALS: A MEANS OF MATHEMATICS COMMUNICATION

Amy E. DalPezzo

Submitted in partial fulfillment

of the requirements for the degree of

Master of Education

Moravian College

Bethlehem, Pennsylvania

2010

Abstract

This qualitative research study documented the observed and reported experiences of eighth grade students who wrote in mathematics journals. The participants were 25 eighth grade pre-algebra students in an inclusion classroom. Throughout the study, students wrote in journals twice a week while focusing on three skill sets: solving problems multiple ways, explaining math thinking and reasoning, and connecting mathematics to real life.

The study proposes that mathematics journals have a positive effect on student learning. Journaling strengthens the aforementioned three skill sets in students. It can also lead to progress on assessments when students are tested on making connections and explaining math processes.

Acknowledgements

The completion of my master's program, culminating with this thesis, would have been unattainable had it not been for my students and the support of my professors, colleagues, and family.

I want to begin by thanking my students. Each one of you has achieved greatness in some way during the course of this study. Thank you for communicating about math in your own way. Each one of you is an individual, and this study reminded me of that fact. Without your originality, the results of this study would not be as profound.

I must also thank my professor, Dr. Charlotte Rappe Zales. Without your guidance and supervision, I could not have completed such a well-rounded thesis. I am appreciative of the countless hours you spent reading and editing my work. You are dedicated to Moravian's graduate program and the success of its students.

I would be remiss to not thank my fellow teacher action researchers: Dyann, Nishida, Amy, Ali, and Nicole. I could not have gotten through this without your support, humor, and snacks. Each week we embarked on a new adventure. I could not ask for better classmates.

Gratitude also goes out to my family. I want to thank my mom and dad for encouraging me to pursue a teaching career in math. It was you who forced me to take Calculus I during my freshman year of college. Little did I know how that mandate would affect the math teacher I have become. Also, when I

complained about being in a rigorous graduate program, you reminded me how I would reap the rewards of my hard work. As usual, you were right. I also need to thank my grandfather. You express to me how important my work is and continually find ways to cheer me on.

Lastly, I must recognize my boyfriend Austin. Your shoulder was the one I laughed, cried, complained, and fell asleep on during this entire graduate process. You have willingly and graciously helped me any way possible so as to alleviate my stress level. Thank you for being mister optimistic.

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Researcher Stance

Math and journals. What type of symbiotic relationship do these two words have? Absolutely none. They go together as well as oil and water. At least that is what I thought during my grade school years. As a self-proclaimed "math" person and number-cruncher, I left writing to the "English" crowd. They were the ones who were supposed to use the written word to express themselves, not me. Let me show my math calculations used to solve a problem. Let me use a chart or table to display my work. Simply put, let me do math without the explanations, justifications, and definitions because of the writing and journaling that goes along with it. Allow numbers to suffice.

This mentality permeated through to my teaching career, which began six years ago. Seeing as though my teaching reflects who I am as an individual, I excluded writing and journaling from my math curriculum. I did not want to be bothered with it as a student and therefore did not want to be bothered with it as a teacher. It was not until my third year of teaching, after attending a professional conference entitled *Writing About Mathematics: An Essential Skill in Developing Math Proficiency*, that the tides began to change. I realized that math communication and expression was an area of weakness for me as a teacher.

Highlighted throughout the professional conference was the National Council of Teachers of Mathematics (NCTM). After delving into NCTM philosophies, I came to understand that while I ultimately had the choice of

whether or not to include math communication in my classroom, I would be doing my students a disservice by excluding it any longer. My math program should have been allowing my students to "organize and consolidate their mathematical thinking through communication, communicate their mathematical thinking coherently and clearly to peers, teacher, and others, analyze and evaluate the mathematical thinking of others, and use the language of mathematics to express mathematical ideas precisely" (NCTM, 2000, p.60). Having students simply provide answers was not getting me anywhere near to achieving these aims. I had to find a way to adapt my teaching so that my students would become the problem-solvers of the future.

Around the same time I realized my shortcomings as a teacher, another factor came into play: No Child Left Behind legislation. Annual yearly progress (AYP) was now going to be gauged by using the Pennsylvania System of School Assessment (PSSA). On this yearly exam, students were asked to complete open-ended response items where they had to show work and provide explanations and justifications of what they did to complete the math problem. This seemed to me to be the state's way of testing students' mastery of the goals set forth by the NCTM. Exposing my students to these types of prompts now became mandatory, as my job could be in jeopardy if my students did not perform at sufficiently high levels. Finding a way to incorporate math communication into my classroom became key.

As if the pressure from the state and realization of my own faults were not enough, a third dynamic came to my attention: my students' imperfections. Throughout my first few years of teaching, my students were able to complete basic math problems. I could give them a rule or algorithm, and for the most part, they could solve the problem. If given word problems, however, students struggled, producing nothing. They were incapable of forging an attack. Students also struggled when verbally asked to explain or support the steps they followed when solving a problem. To make matters worse, we as teachers were beginning to analyze data, namely from 4Sight Tests. These tests were being administered to students on a bi-monthly basis to act as a predictor of PSSA performance. Students received scores in six categories: numbers and operations, algebraic concepts, geometry, measurement, data analysis and probability, and open-ended response. As I sat through meeting after meeting, I consistently saw that the open-ended response category was the lowest performing category out of the six. This certainly corroborated what I saw in class. My students were faltering, and I needed to serve as an agent of change for them. My goal was to find a way to help them with their struggles.

Hence, this research project stemmed from three factors: the weaknesses I had as a teacher, the needs and demands of the state and national governments, and the difficulties of my students. They caused me to address the mathematics communication issues present in my classroom. In doing so, I took action,

teacher action research that is. These aforementioned factors led me to my research question “What are the observed and reported experiences when eighth grade students write in math journals?”

Literature Review

Introduction

For quite some time, there has been a push towards a more concepts based learning of mathematics rather than a skills based, algorithmic approach. Concepts based programs have taken the forefront so that students look at the larger picture and apply previous concepts to new learning, thereby making connections between the past and present. In order to demonstrate a higher level of understanding, though, students must learn how to effectively communicate their ideas. One way of fostering math communication is by including mathematics writing into the curriculum and classroom. A specific way of doing this is through student use of mathematics journals.

Mathematics Achievement

Skills based versus concepts based programs. Skills based programs do not address the needs of all students, leading to lower academic achievement. As students get older, their attitudes about mathematics become negative. "From fourth grade to eighth grade the percentage of students who claim to like mathematics declines 13 points from 69% to 56%" (Martinez & Martinez, 2003, p. 28). In addition to poor opinions about math, students in this age bracket begin to perform worse on achievement tests. The reason for this is because of the "explain-practice-memorize teaching methods" employed by teachers at the middle school level (Martinez & Martinez, 2003, p. 28). By simply teaching

algorithms, students have difficulty with complex problem solving and lack the general math knowledge even necessary to solve problems. With these skills based or teacher-directed programs, "students are thought of as a tabula rasa where learning is characterized as passive and receptive" (Walker, 1999, p. 4). Overall math achievement decreases, as "some estimates suggest that traditional explain-practice-memorize approaches to math instruction are successful for no more than 15% of students" (Martinez & Martinez, 2003, p. 29). Therefore, more concepts based skills need to be incorporated into the regular math classroom.

In order to explore the effect differing math programs have on student learning and achievement, Mastin (1996) conducted a study of two third-grade classrooms. The teacher in one room used a skills based arithmetic program focused on algorithms while the other used a concepts based program that focused on math application, problem solving, and language usage to express ideas. Findings showed that students in the concepts group outperformed the skills group in both computation and problem solving, with a more significant difference in problem solving. Students in the concepts based class also showed evidence of building knowledge upon prior skills. Unfortunately, the skills group demonstrated shallow understanding of material and routine problem solving strategies. Therefore, teaching for application and communication appears to have greater impact on student achievement.

Connections standards: Pre-k through grade 12. Students fare better in concepts based programs because of the connections that they make between math concepts they previously learned, math and other subjects, and math and their own lives. The National Council of Teachers of Mathematics (NCTM) has called upon math programs to evoke connections among students across all grade levels, both primary and secondary. As an international leader and developer of both standards and principles for school mathematics, the NCTM (2000) pushes for the interrelatedness of math ideas. There are three connections standards applicable to grades pre-kindergarten through 12.

The first standard states that students should "recognize and use connections among mathematical ideas" (National Council of Teachers of Mathematics [NCTM], 2000, p. 64). As students work on one concept, they should be reminded of a past one that relates. The new concept is then seen as an extension of the old. Younger students see multiplication as repeated addition while older students begin to notice that ratios, proportions, and percents are related.

The second standard on connections posed by the NCTM (2000) is that students "understand how mathematical ideas interconnect and build on one another to produce a coherent whole" (p. 65). They should be able to apply old information in a new setting. If they see math as a whole, they are less apt to view individual skills separately.

The third standard involves the integration of math outside the mathematics classroom. The students should "recognize and apply mathematics in contexts outside of mathematics" (NCTM, 2000, p. 65). Not only do students use math concepts in other classes such as science and social studies, but they also need it in their everyday live. Whether it is creating a graph to chart experimental results or calculating percent discount, students need math in all facets of life.

Connections standards for grades 6-8. In their middle school years, students begin to develop deeper connections with the mathematics material. This allows them to make connections that build mathematical understanding, which in turn, leads to overall math achievement. In grades 6-8, students focus on rational numbers, proportionality, and linear relationships, and make connections to these new topics using their prior knowledge (NCTM, 2000). They constantly question how the new material relates to what they have done before. This happens in the presence of enriching math activities.

At the middle school level, teachers have an active role in the connections process. They integrate multiple subjects into the mathematics curriculum (NCTM, 2000). Both science and social studies can be sources for new problems. Language arts might provide the framework necessary to write a mathematical argument. It is the job of educators to provide interdisciplinary units of study. In addition, teachers assist students in building their current math ideas so that connections can be made. This might include revisiting previous problems so that

they can be viewed in different ways. Overall, teachers help in forming mathematical connections at the middle school level so that students understand material more deeply, which leads to student achievement.

Connecting and contextualizing math instruction. In a study conducted by Kulm, Capraro, and Capraro (2007), results showed that making connections during math does help to raise overall academic achievement. These authors analyzed what would happen to sixth grade students after the year-long implementation of a math program entitled Connected Mathematics (CMP). This program focused on having students apply new math material to old math material and to students' lives. After analyzing the Texas Assessment of Academic Skills (TAAS) data, the authors noted a four point increase in overall math achievement since using the CMP program (Kulm, Capraro, & Capraro, 2007). The group of at-risk students also showed increases in math achievement. Consequently, forming connections with math concepts taught does lead to academic gain.

Contextualizing math instruction also allows students to make connections to their work, leading to math success. In his study, Bottge (1999) wanted to see how instruction using contextualized problems (CP) affected student performance on computation problems, word problems, contextualized problems, and transfer tasks as compared to instruction using word problems (MP). Student samples were taken from a remedial math and pre-algebra class. Results of the study showed that "statistically significant differences were found on the contextualized

problem test and on the transfer task for CP students in both the remedial and pre-algebra classes" (Bottge, 1999, p. 88). Basing problems on real world scenarios allowed students to see how math works on a daily basis. By connecting with the information, students instructed under the CP model were able to perform at higher levels in certain test areas.

Mathematics Communication

Concepts based math programs that make mathematical connections usually contain a communication piece. Since the goal of a concepts program is to have students thinking at higher levels and applying that knowledge, students must demonstrate their methodologies and thought processes used to solve a problem. The only way to do this is through sharing their ideas.

Communication standards: Pre-k through grade 12. The NCTM (2000) has endorsed mathematics communication across all grade levels, just as it did with mathematics connections. The NCTM promotes speaking, writing, reading, and listening as forms of communication in the math classroom. These forms of communication allow students to reflect on mathematical ideas, gain better mathematical understanding, and make public their new findings. In order for this to happen, teachers must provide worthwhile math tasks. "Procedural tasks for which students are expected to have well-developed algorithmic approaches are usually not good candidates for such discourse" (NCTM, 2000, p. 60). More concepts-based questions will lead to further inquiries. Out of the

necessity for mathematics communication, the NCTM has adopted four communication standards.

The first standard from the NCTM (2000) is that students should "organize and consolidate their mathematical thinking through communication" (p. 60). Acting out a situation, drawing, using manipulatives, explaining, diagramming, writing, and using math symbols all help students systematize and merge their thoughts. All of these factors force students to reflect and clarify what they learned.

The second communication standard says that instructional programs should enable students to "communicate their mathematical thinking coherently and clearly to peers, teachers, and others" (NCTM, 2000, p. 61). Sharing math ideas verbally within the classroom community is key. Students need to be allowed to test their thoughts to see if they make sense and are convincing. It is the job of the teacher to promote an inviting classroom where mathematics ideas are welcomed. Written communication should be held in as high of a regard as verbal communication. Over time, students' written responses should become increasingly complex, where they not only state mathematical properties they used, but also employ mathematics vocabulary.

The third communication standard from the NCTM (2000) calls for students to "analyze and evaluate the mathematical thinking and strategies of others" (p. 62). Seeing another way of solving a problem adds meaning to the

task at hand. Invented strategies have to be analyzed for correctness and math logic. Looking at someone else's work allows students to determine where their strengths and weaknesses lie.

The NCTM's (2000) fourth standard calls upon students to "use the language of mathematics to express mathematical ideas precisely" (p. 63). The goal for students is to be able to use formal math language to show their understanding. Some words, when used in a math setting, have a more precise meaning. If students are to use math jargon successfully, they need time to grapple with their math ideas and develop informal means of expressing themselves. This will later lead to a more formal description.

Communication standards for grades 6-8. While the NCTM supports four standards for mathematics communication across all grade levels, it recognizes that classroom interactions related to math will look different depending upon the age of the students. There are three distinctive features found in classrooms at the middle school level (NCTM, 2000). For one, the math concepts are more complex compared to elementary levels. This means teachers present more abstract ideas to students. Communicating is a good way to rid students of possible misconceptions they might have. Secondly, students in grades 6-8 are evaluated more stringently than their younger peers. Students at this level should be able to explain how they solved a problem while also analyzing, comparing, and contrasting its meaning. Lastly, social norms at the

middle level change. Students are very self-conscious and hesitate to share their math ideas for fear of being ridiculed. They simply want to fit in with the group. These three factors all influence how math is shared in a middle-level classroom.

In order for communication to be successful in grades 6-8, the teacher provides the framework (NCTM, 2000). To begin, math teachers need to foster mathematical ideas within the classroom. Mutual respect and trust need to be present. Students have to understand that making mistakes is acceptable and will lead to future understanding. In addition, teachers must select worthwhile activities. "Teachers should identify tasks that relate to important mathematical ideas, are accessible to multiple methods of solution, allow multiple representations, and afford students opportunities to interpret, justify, and conjecture" (NCTM, 2000, p. 271). If the right math situation is chosen, students will be engaged in the learning process which will lead to an increased willingness to communicate. Last but not least, teachers monitor student learning in order to guide classroom discussion. It is important that one student does not monopolize the dialogue in the classroom. Everyone needs a chance to speak. Even if a student answers with a misguided response, the teacher can capitalize on that moment and make it a learning experience for everyone. "There is not now, never has been, and it is hoped, never will be a genuine substitute for a teacher who knows how and what children need to learn and when they need to learn it" (Liedtke & Sales, 2001, p. 355).

Keys to strengthen math communication. Math discourse at the middle level can be challenging. In a section of her book, O'Connell (2005) shares various keys to strengthening mathematics communication within the classroom. Teacher modeling, questioning, and feedback are essential. Partner and group work along with class discussions also help in spreading math ideas. O'Connell encourages vocabulary acquisition too, because if students do not know the language of math, they cannot share their thoughts.

Out of all O'Connell's (2005) ways to support communication in the math classroom, the largest number revolves around writing. Teachers should include frequent and varied writing activities into their classrooms. These writing activities need to be integrated into the units of study and not stand alone as separate skills. Lastly, students require support while engaging in writing tasks.

Mathematics Writing

Writing proves beneficial to students. Writing has proven to be a useful means not only in math communication but also in math achievement. In a study conducted using beginning algebra students, Williams (2003) sought whether writing about problem-solving helped to improve problem-solving skills or not. The control group received regular and nonroutine problems to complete while the treatment group received regular and nonroutine problems to complete, along with reflections on the nonroutine problems. Findings showed that treatment group enjoyed the writing activities and thought the writing helped them to

become better problem solvers. Students in the treatment group also showed greater gains in problem-solving ability than the control group. Hence, including writing into this math classroom helped promote math communication while bolstering student achievement.

In a study conducted by Pugalee (2004), written descriptions of mathematics work also prevailed, but this time it was over verbal descriptions of math work. The analysis was done on 20 high school algebra students who alternated giving written and oral descriptions of their problem-solving strategies. It was found that students who wrote descriptions of their problem-solving process had more correct solutions than when they used the think-aloud method. Students using the written process also had higher frequency of metacognitive behaviors, such as orientation (reading questions and analyzing information presented) and execution (making goals and performing calculations). Mathematics writing proved to be more beneficial to students in helping with communication and overall math success.

An additional study by Card (1998) supports the fact that mathematics writing leads to math accomplishments. This research was conducted in a second grade classroom where students were given daily writing prompts to respond to. At both the beginning and completion of the study, students took the Card Mathematical Problem Solving Assessment for Second Grade (CMPSASG). Results from both test sessions were compared. “There was a drastic change in

scores from the beginning test to the ending test. Eleven of the twenty-one students' scores increased by over fifty percent from the beginning test to the ending test" (Card, 1998, p. 44). Therefore, daily writing prompts boosted student achievement in this classroom.

Strategies for incorporating writing. While mathematics writing helps students, it needs to be implemented in a way that is palatable to the students. Therefore, teachers can use several strategies to make writing successful in the classroom. One approach is to implement the mathematics writing tasks in a three-part process (Baxter, Woodward, Olson, & Robyns, 2002). The teachers in this study had students write about their attitudes and feelings towards math during the first stage. In the second stage, students moved to writing about familiar math ideas. Lastly, students wrote about more advanced math ideas. By phasing the writing, students were able to move to higher levels of math understanding, such as explaining and justifying their work. The writing conducted through this research was found to help students understand math better, to allow students to see math problems can be approached using different strategies, and to increase student self-esteem. The teachers conducting the study were able to identify areas of student weakness and misconception, which allowed for them to intervene early on. In summary, writing allowed for communication of mathematics ideas while at the same time pushing students to higher levels of accomplishment.

In her article, Burns (2004) mentions other methods teachers can use to ensure the success of math writing. Teachers must establish the purpose of writing. Students should know they are writing because it helps them understand the math material, and it allows the teacher to assess how they are progressing. In addition, teachers should identify themselves as the audience. Students have to understand that this writing will help the teacher use the best methodologies to teach everyone. Discussing ideas before writing, including prompts, and posting useful mathematics vocabulary all help students to begin the writing process. It lessens their frustration level, allowing them to write freely. Lastly, students should share their writing in pairs or small groups. They will feel less intimidated in this type of setting, rather than in front of the whole class

More advice on mathematics writing is provided by Brandenburg (2002). She suggests starting off small. The work for the teacher associated with writing tasks can be tremendous. Teachers should make adjustments accordingly and do what is best for them. Because students will most likely resist writing during math class, teachers must be firm and consistent. If students are made aware of the expectations, they will usually adhere to the policies. Another way to get students to take writing seriously is to make it count. Brandenburg (2002) proposes using semester portfolios where students take topics that were covered, explain them in words, and demonstrate them mathematically. By and large, the

previously mentioned techniques aid in the successful implementation of math writing.

Types of writing. Typically when asked to write in math, students produce varied writing samples. These samples fall under four different categories: non-personal and non-reflective, non-personal and reflective, personal and non-reflective, and personal and reflective (Powell, 1997). If the goal of writing in mathematics is to connect math to the students and increase their achievement, then the category that best supports math thinking is personal and reflective. When it is personal to students, they affix their own meaning to it. When it is reflective, students become better metacognitive learners. Therefore, personal and reflective writing pieces should be incorporated as often as possible.

Mathematics Journals

Students are attaining higher levels of achievement through concepts based math programs that promote math connections. Integral to these programs has been the use of mathematics communication techniques, in particular, mathematics writing tasks. A popular way of engaging students in the writing process is through the implementation of mathematics journals.

Uses of journals. Math journals have numerous uses in the classroom (Burns & Silbey, 2001). One way of utilizing them is for problem solving. Students show how they arrive at their answers by writing it in their journals. Secondly, journals are helpful with process prompts. Students analyze what they

already know, what they are unsure about, and what they would like to know more about. In addition, journals aid with language experience where students write down what they say aloud. Lastly, journal writing promotes math discussions as students describe what they have written.

Advantages to students. Different studies have been conducted on the topic of mathematics journals, all of which have found advantages for the students. For one, journaling allows students not only to understand math procedures, but also understand larger concepts (Clarke, Waywood, & Stephens, 1993; Jurdak & Zein, 1998). This happens as students move through different stages of math writing. They start with vague responses at the beginning, but end with connecting new information to what they already knew. Secondly, journaling helps students in their overall math achievement (Jurdak & Zein, 1998). Journaling promotes the mathematics communication that students need in order to help them succeed. In addition, math journals increase student motivation and willingness to learn. During one study, students felt journal writing was a positive endeavor that was effective in helping them communicate with their teachers (Di Pillo, Sovchik, & Moss, 1997). These students wanted to continue using journals. In another study, journal writing was deemed purposeful and reasonable by the students, increasing their motivation to write about their math processes (Clarke, Waywood, & Stephens, 1993). A fourth advantage to students is in the area of retention. Students in the Di Pillo, Sovchik, and Moss

(1997) study thought that journaling helped them to remember mathematics information for longer periods of time than simply for a test. Goldsby and Cozza (2002) write about two more advantages to students in their article. By using journals, student see why and how steps were performed in solving a math problem. Each student does not use the same strategies to solve every problem, so students get exposed to differing methods. Journaling also allows students to make the class personal, enabling them to connect to their learning. When students connect to their learning, they care about the tasks at hand.

Advantages to teachers. While journals are beneficial to student learning, they also aid the teacher. For one, student responses help to direct new learning (Di Pillo, Sovchik, & Moss, 1997). Based on what students write, teachers adjust their lessons accordingly. Concepts might have to be taught again, or the writing could show students are ready to move to the next topic. In this same article, it was mentioned that journals reveal student feelings and attitudes about math. If teachers know a student's stance on math, it can help in gauging a student's understanding. Lastly, journaling shows evidence of student thinking (Di Pillo, Sovchik, & Moss, 1997; Goldsby & Cozza, 2002). Student responses help teachers in assessing student understanding at a procedural and conceptual level. They can see who builds knowledge upon prior skills and who only applies algorithms. This shows which students need further instruction.

Summary

Some of the best math practices include the use of concepts based math programs. Integral to these programs is mathematics communication. Mathematics writing, in particular math journals, has been found to be one of the best ways to encourage math communication within the classroom. Journals have many uses and are not only beneficial to students, but also teachers.

Research Design and Methodology

Introduction

Throughout the past few years of my teaching career, I noticed a common weakness among all my math students: mathematics communication. My students struggled when asked to explain how they solved a problem or justify why their answer was correct. They simply did not know how to find the proper words to explain what they did. This weakness had relevance because of the fact that if students could not explain what they did mathematically, then they were not coming to a full understanding of the content. Therefore, my research question is: What are the observed and reported experiences when eighth-grade students write in mathematics journals? As a result, I used writing prompts two times a week. In order to gauge what effect the journals had on my class, I examined observations, written work, and surveys and interviews.

Setting

The location for this study was an eighth-grade, middle school Pre-Algebra classroom. The school is situated in eastern Pennsylvania and is comprised of approximately 500 sixth-, seventh-, and eighth-graders. While the school is not diverse in race, it is socioeconomically diverse. Students feed into the middle school from three elementary schools. Two of those schools cater to the lower socioeconomic group, while the other houses the higher socioeconomic group.

The classroom itself is about 850 square feet. There is a window and cabinetry along the far wall. White and black boards cover the front wall of the classroom. The wall parallel to the front wall contains a television, a cabinet, and a bulletin board. The fourth wall contains windows at the top that look into the hallway. The desks are trapezoidal shaped tables and are arranged in rows. There is one isolation desk in the back of the room. There are 34 seats in the classroom.

Participants

There were 25 students, 12 boys and 13 girls, who participated in this study. They were all eighth-graders between the ages of 13 and 14. The racial breakdown in the class was as follows: 18 white students, four African American students, two Hispanic students, and one Asian student. Three of the students have an Individualized Education Program (IEP) for this class.

Research Procedure

Approval and consent. Before implementing the study, approval needed to be given from multiple sources. First, I submitted a proposal to the Human Subjects Internal Review Board (HSIRB) at Moravian College. The HSIRB permitted me to proceed with my study (see Appendix A). During the first week of school, a consent letter was given to the principal, explaining how I would conduct the study and keep information confidential (see Appendix B). Now that the principal signed the letter endorsing my study, I was free to send a similar consent form home with my students (see Appendix C). The parents had to sign

the form, indicating if their child had permission to be a participant in my study. Once this preparatory worked was complete, I was free to begin journaling with students.

Journaling framework. Once the study began, journaling became part of the routine in my classroom. Students came into class on Tuesdays and Thursdays and immediately began journaling. They were instructed to write the date, copy the prompt, and complete their answers. As students used this time to work individually, I checked students' homework, helped absent students, and offered assistance with journal completion as necessary. After students had their solitary time to write and respond, we held discussions on what they wrote. Students usually discussed their writing in partners or small groups in order to gain confidence with their work. Discussions ended with sharing journal entries with the whole class. Therefore, journal writing was made part of the curriculum and not an addendum. The curricular units that were addressed while the study took place were as follows: Measurement, Algebraic Reasoning, and Integers and Exponents.

Measurement unit. During the first unit, students studied measurement. We examined both the metric and customary systems of measurement. Areas of focus for both systems were: determining the correct unit of measure, comparing measurements, and converting between measurements. To coincide with the topic of study, students responded to related journal prompts. Some of these included:

- Why is converting units in metric easy?
- How far might a stone's throw away be in customary units?
- How is converting metric and customary units similar and different?

Algebraic reasoning unit. The second unit of study revolved around basic algebraic concepts. Students worked on solving one- and two-step equations using all four main operations. Students then applied their knowledge of solving equations to solving simple inequalities. Other topics of interest included the distributive property, combining like terms, and graphing ordered pairs and functions. Students responded to a variety of journal prompts including:

- Write a real-world situation related to you for: $x + 10$.
- Explain why $8x + 8y + 8$ is already simplified.
- If n is odd, will the answer to $2n + 1$ always be odd? Explain.

Integers and exponents unit. After practicing basic algebra skills, students applied that information to the next unit of integers and exponents. A large area of focus in this unit was to learn the basic rules for adding, subtracting, multiplying, and dividing integers. Students then applied those rules with solving equations, solving inequalities, and graphing functions. To complete this chapter, students studied exponent rules along with scientific notation. Journals were ever-present as they had been in previous units. Some sample questions from this unit were:

- Give a real life situation that involves negative numbers.
- How are 3×2, 3^2, and 2^3 the same and different?
- Write 0.5 using a base and exponent. Explain why you are correct.

Data Sources

Observations. During each class period, I recorded notes that were housed in my field log. I wrote these notes in a composition book during class and then transcribed and typed those notes after class. All observations that I made were typed and numbered in one column. Reflections, on the other hand, were typed in an adjacent column so as to keep my feelings and opinions separate from my objective observations. I completed observations on both journal and non-journal days. I recorded times when I saw students using sound math explanations, achieving deeper levels of understanding, and making connections between math and real-world situations. I also documented both positive and negative behaviors of students.

Written work. Over the course of the study, I collected student work. A large part of this process included gathering and commenting on student journal entries on a rotating basis. Students were assessed with quizzes, which I collected and analyzed. These quizzes contained items where they had to explain some math thinking or relate math to their real lives. I also gathered all unit tests that were administered during the data collection period. These tests contained open-ended response items where students had to explain their math thinking along

with showing their math work. Upon occasion, classwork from the students was also saved.

Surveys and interviews. To complete the triangulated method of collecting data, I surveyed and interviewed my students to determine how they felt about the study. At the onset of the study, students took a pre-survey (see Appendix D) so I could establish a baseline on how students felt about mathematics communication. Around the halfway point of the study, I interviewed students (see Appendix E) as a way of member checking to see how students were progressing with their journals. At the conclusion of the study, I administered a post-survey (see Appendix F) to see if students thought math journals to be beneficial.

Trustworthiness Statement

My research study was designed with assurances that guaranteed the trustworthiness, credibility, and validity of my research findings. In order to ensure these three factors were upheld, I conducted a review of professional literature, received Human Subjects Internal Review Board (HSIRB) approval, distributed both principal and parent consent forms, collected triangulated data in a field log, dialogued using a teacher inquiry support group, and admitted my own biases.

I first began ensuring the process validity of my study by using appropriate methods for studying my research question (Hendricks, 2006). The

best way to do this was to review professional literature pertaining to math journals. The importance of my literature review was twofold. For one, it allowed me to learn what was already known about math journals. Becoming as knowledgeable as I possibly could, helped me design the best study possible. Second, I read about the successes of others using math journals, which helped identify future practices that I could incorporate during my research study. Following those who came before me substantiated the fact that my study was worthwhile to pursue.

After planning my study based on the findings of professional literature, I obtained approval from the HSIRB at Moravian College. This committee reviews research plans to ensure the safety of research participants.

Simply having HSIRB approval was not enough. I consulted my assistant principal as well. We met to discuss how I would conduct my research, and I shared the specifics of my math journal study. Once she fully understood what would be taking place in my classroom, I received her authorization via principal consent form.

Just because the HSIRB and assistant principal consented to my study, did not mean all students could be participants. According to Hendricks (2006), "if the study includes individuals younger than 18 years of age, a requirement is to obtain their parents' permission to use data obtained on them in the study" (p.111). Therefore, I conducted a class meeting with my students during the first

week of September. In the meeting, I explained the contents of the parent consent form. I made sure to point out that participation in my study was completely optional. Opting out would not hurt their grade in any way. If a situation should arise where a student would like to be removed from the study, he/she had the ability to. I also shared that during the study, students' names would be kept confidential by using pseudonyms. Research materials would be kept in a locked cabinet that only I had access to. Each student took the consent form home and returned it to school once signed.

Now that I had approval to begin my research, I ensured the outcome validity of my study by triangulating my data sources. If I was to have a successful resolution to the problems in my classroom surrounding mathematics communication, I had to collect data from surveys, student work, and observations (Hendricks, 2006).

Surveying and interviewing my students certified the democratic validity of my research. They made my students feel like they had a stake in my entire research process (Hendricks, 2006). I surveyed the students twice and interviewed them once.

In addition to surveys, student work proved the democratic validity of my study. The work I gathered included journal entries, classwork, quizzes, and tests. Reviewing and commenting on student journals was also a focus during the study.

Students needed to be provided with feedback so as to improve upon their future journal entries.

Ultimately, catalytic validity was addressed because of my third source of triangulation, observations. What I saw on a day-to-day basis helped change my views and practices (Hendricks, 2006). During class sessions, I took notes in a composition book. I then utilized the prep time following the class to formally type up those observations. Included in with but separated from my objective observations were my observer comments. These comments were where I speculated about meanings and recorded mental connections I made (Bogden & Biklen, 1998).

All surveys, student work, and observations were kept in a field log. Therefore, "the log is the data" (Ely, Anzul, Friedman, Garner, & Steinmetz, 1991, p. 70). The field log served as a chronological history of my study. I coded the data housed in the field log, which helped me lift themes from my study.

In order to gain additional insights and viewpoints into my study, I met weekly with my teacher inquiry support group. Dialogic validity was upheld because of the data that I shared with my peers. These groups help to "challenge each other's assumptions, propose alternative interpretations, offer suggestions about research methodology, respond to drafts, and often lend personal as well as professional support" (MacLean & Mohr, 1999, p. 21). As outsiders, my group helped me to see changes that might need to occur during my study.

The last factor addressed in order to ensure my trustworthiness was bias (Hendricks, 2006). One factor that I could not let negatively affect my study was the fact that I taught some of these students two years ago when I was a sixth grade teacher. I had to clear my head of their past actions and academic abilities to allow them to begin with a clean slate. Another bias I felt necessary to point out was my personal dislike for writing. This mentality could not permeate through to my study or else my students might begin to feel the same way. Addressing these biases allowed me to be objective and open to all outcomes of my study.

Summary

By carrying out my study, I sought to find out the effect mathematics journals had on my classroom. My research question was answered by implementing math journals for approximately a 16-week period. Writing prompts were given two times a week, with discussions being held on those days. In order to establish trustworthiness, I collected data through observation, written work, and surveys.

My Story

New Times Two

I stood outside my door excited with a smile on my face, yet nervous with butterflies in my stomach. What could have caused all this emotion? It was the first day of school and not just any first day. It was my first year as the eighth grade pre-algebra and algebra I teacher. It was also my first time implementing math journals into my curriculum. How was I to juggle both at the same time? Would I be able to fulfill my duties as teacher and action researcher without it becoming overwhelming? I thought back to the conversation with my principal earlier that summer as he enlisted me for this teaching position. Why did I not just say no? Walking into another year of teaching sixth grade, the sixth one to be exact, would have been so much easier. There would only have been one unknown, math journals, versus two unknowns, math journals and eighth grade.

Teacher: "Hi Jamie. How was your summer?" [Phew! One student I have already taught and know is a hard worker.]

Jamie: [looking up with a little smile] "Hi. It was good." [Jamie continues into the classroom.]

Teacher: "Good morning Tracy. How are you doing?" [What do you know? Another familiar face from two years prior. Tracy is another sweet girl, who also strives to do her best.]

Tracy: "Good." [Tracy walks into class.]

Kyle: "Hello Ms. DalPezzo." [said with a smile on his face]

Teacher: "Hi. Good to see you!" [I was pretty sure his name was Kyle. I had not taught him previously, but must have had some interactions with him. I was thankful that he appeared chipper and happy to be here.]

Teacher: "Welcome Katie." [Another recognizable face. One who struggled in the past for me. A student who I know did not feel supported by me in sixth grade. How will I handle her differently this year so that she feels I care about her success?]

Katie: "Hey Ms. DalPezzo." [At least she provided a response. Hopefully she is receptive to a new beginning.]

Teacher: "Hi, how are you doing?" [Bryan. I taught his brother my first year. I have heard Bryan can be a handful, so he might give me some of the same problems his brother did. I will try and be hopeful.]

Bryan: "Hey."

So as both familiar and unfamiliar students filed into room 224, I came to a realization. Maybe the unknown was not as great as I initially thought. Perhaps it was not new times two but new times one and a half.

Opening Ceremonies

After finalizing schedules, reviewing classroom rules and procedures, and getting to know one another, I was ready to introduce the journals to my students. As I passed out parental consent forms, I explained to my students that I was

currently going to school at Moravian College so that I could become a better teacher. In order to graduate, I needed to complete a large paper, roughly around 100 pages. For this paper called a thesis, I would be studying their class. We would be writing in math journals on Tuesdays and Thursdays each week. Following our writing sessions, we would be having discussions about our math work. They could expect me to record in my own journal the things they said or wrote, collect their journals, quizzes, and tests, and encourage them to try their best even if they struggled with a journal prompt. The goal was for them to become better math students, and we needed to work as a team to accomplish this goal. I would be learning from them in addition to them learning from me. Freire (2009) solidified the notion of reciprocal teaching for me as he wrote, "the teacher is no longer merely the-one-who-teaches, but one who is himself taught in dialogue with the students, who in turn while being taught also teach" (p. 80).

As I passed out the future math journals, which were simply composition books, I asked students if they had any questions for me about the study. I saw mostly blank stares. They did not show nearly as much emotion as I had explaining the project to them. I tried to tell myself that it was early in the study and that student expressions could change over the next few months.

From there, I instructed students to respond to their first prompt, "write five words related to measurement." Most students began writing immediately. I wanted to ease them into journal writing by tapping into their prior knowledge. If

I made the first questions too difficult, students would become averse to writing. After I saw most students finish, I instructed them to meet as a small group and compile a list of 10 words.

This first group sharing did not go as well as anticipated. I thought communicating a few words with some fellow classmates was not too daunting. Many groups just passed their paper around, however, and had each student in the group add two or three new words to the list. There was no oral communication occurring within the groups. I dismissed this as a result of being in a new class with new students, hoping that in a few more days, students would become more comfortable sharing with one another. Despite the lack of speaking, students were able to compile a multitude of words that I displayed using the website Wordle.net (see Figure 1).

Figure 1: Wordle entry.

Students seemed to enjoy guessing why some words were bigger than others in the Wordle display. They finally caught on that the bigger the word, the more times it was repeated. The large words were those most popular amongst all groups. This led us into a discussion about how the larger words came from the metric system and why those units were repeated more frequently than those units used in the United States. One student thought it was because they were studying metric units in science class, which I thought was an astute observation. We also discussed which entries were the same, but represented a different way. All in all, the first journal entries produced sound written communication but did not

initially lead to stimulating conversation amongst students. With a little help from technology and me, however, student oral communication skyrocketed.

A Day of Real-World Connections

Incorporated throughout the course of my study was the technique of making real-world connections with the mathematics concepts we were learning. By making connections to their lives and the world around them, students see the benefit to learning math. It helps to alleviate the question, "When will I ever use this?" On this particular day of journal writing, students responded to the prompt "write a real-world example related to you for x + 10." As they arrived and took out their journals, I could hear conversation amongst the students concerning the prompt.

James: "I don't get it."

John: "What does she mean?"

Katie: "I really don't understand this."

Teacher: [needing to mediate as confusion was running rampant] "Ladies and gentlemen. I can hear that you are having trouble with the journal question. Let me give you an example. I could write something that said I started with x pieces of jewelry. Then I went to the store and bought ten more pieces. I could also write that I started with 10 pieces of jewelry and added x number of pieces after I went to the store. This relates to me because I love jewelry."

Because of my intervention, students then began to write. I decided for this journal that I wanted everyone in the class to share their response. Not only would students be able to hear a variety of answers to the prompt, but they would also learn facts about their fellow classmates. The following dialogue highlights some of what was shared during the journal discussion.

Jamie's response. Jamie is a quiet girl who has a very positive outlook on life and school.

Teacher: "What did you put Jamie?"

Jamie: "I have x amount of shoes. I got ten more for Christmas. If x equals 7, how many more shoes do I have?"

Teacher: "I like how you added the x equals seven part to your problem. You must be a shoe lover just like me."

Jamie: [with a smile] "Yeah."

Teacher: "What is your favorite kind?"

Jamie: "Ballet flats."

Teacher: "Maddox, how many ballet flats does Jamie have according to the problem she wrote?"

Maddox: "17."

Addison's response. Addison is another quiet girl who normally does not participate even though she is one of the highest achieving students in the class.

Teacher: "Addison, what did you come up with?"

Addison: "I had x number of mini Kit Kat bars and I got 10 more. How much would I have if x equaled two?"

Teacher: "There's our chocolate lover. What else would you eat besides Kit Kats?"

Addison: "M & Ms."

Teacher: "Good choice. Bryan, how many Kit Kats does Addison have?"

Bryan: "12."

Liz's response. Liz has an outgoing personality and likes to participate. She has the tendency to be talkative.

Teacher: "Liz, what did you write down?"

Liz: "I had x number of Twilight paraphernalia and then I bought ten more Twilight related things. I now have x plus ten."

Teacher: "How did I know yours would be about Twilight Liz?"

Liz: [she says with a laugh] "I just couldn't help myself."

Teacher: "What is your vote, though? Team Jacob or team Edward?"

Liz: "Definitely team Jacob." [boos heard from other students in the room]

Teacher: "Well unfortunately now is not the time to debate who is taking what side. Let's move on."

Neil's response. The most interesting and unique characteristic about Neil is that he does not speak. He is labeled selectively mute. His journal response as recorded here was dictated by a fellow classmate.

Teacher: "Bryan, what does Neil have written down?"

Bryan: "He wrote I have drank x amount of soda. I brought ten more sodas to drink."

Teacher: "Nice job Neil, using the word more to represent the addition."

While I thought journal writing was going to be a struggle this day due to its rocky start, it turned out to be a beneficial session for both the students and me. While I gave a model for the students to mimic, not all simply followed my lead. Responses similar to Liz's and Neil's showed that students could adapt my example by expanding upon the situation they wrote. Students like Miranda and Alexis gave the class math problems to answer. The class enjoyed hearing what the other students had to say, and they got to know one another a little bit better along the way.

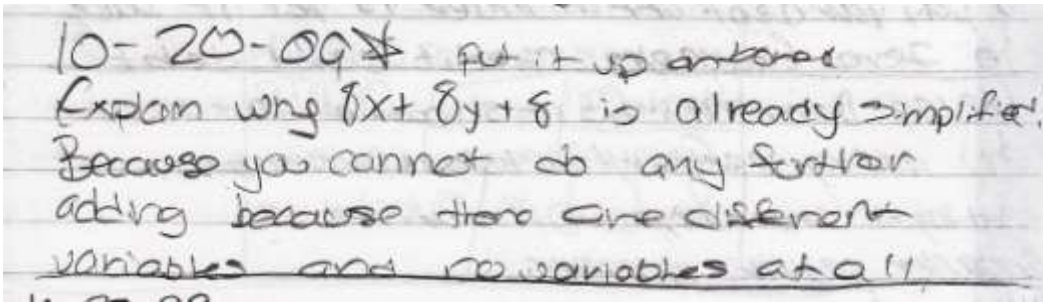
A Teacher's "Aha" Moment

Sharing journal responses was imperative to my study. Journal discussions allowed students to see and hear various ways to solve, explain, or answer journal prompts. While I knew journals and sharing to be beneficial based on my earlier research, it was not until this day of journal writing that I fully came to realize the magnitude of its worth.

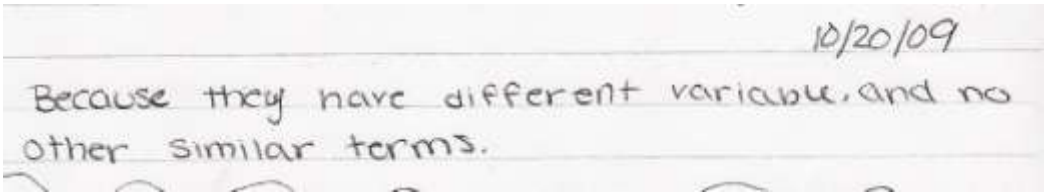
Before Journal Thoughts

Explain why 8x + 8y + 8 is already simplified. Why did I initially think this was a good prompt? It is not going to elicit much conversation. What is there to really say? I mean, there are no like terms to combine. That's why it's simplified. I guess we'll see what the kids have to say about it.

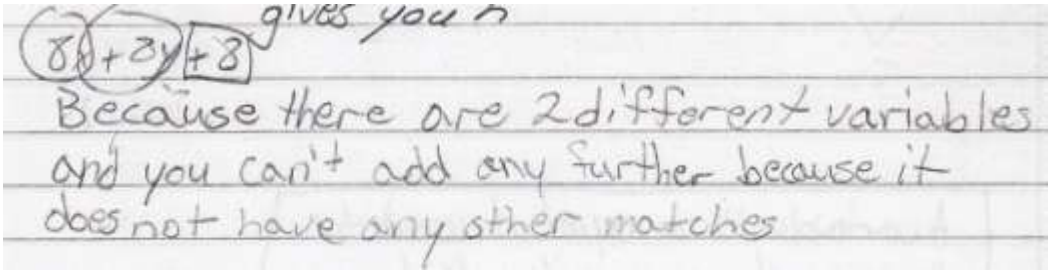
Liz's Journal


10-20-09 put it up above
Explain why 8x+8y+8 is already simplified.
Because you cannot do any further
adding because there are different
variables and no variables at all.

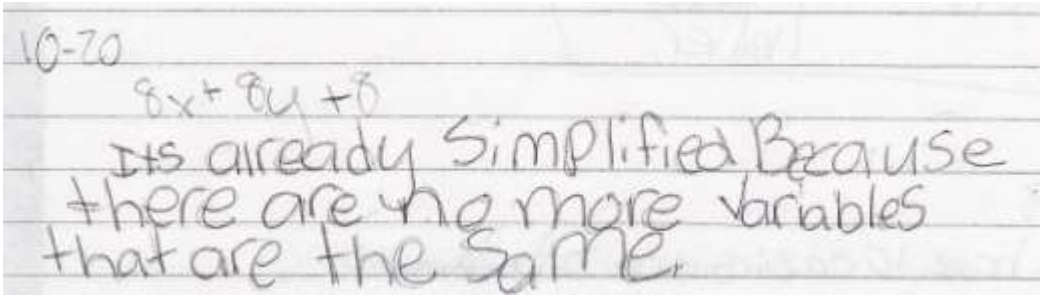
Lisa's Journal


10/20/09
Because they have different variable, and no
other similar terms.

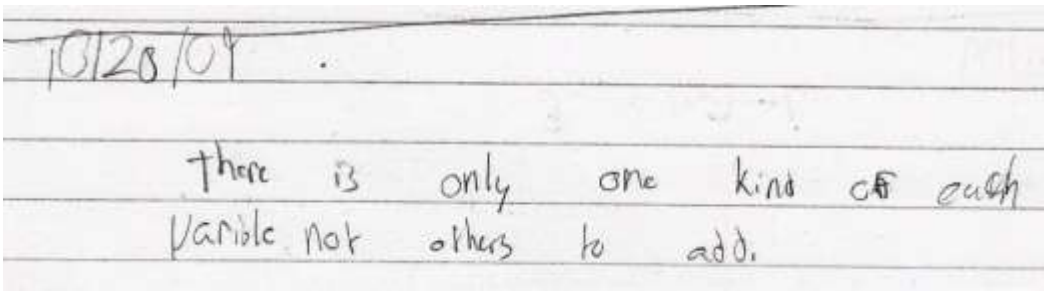
John's Journal


gives you n
8x+8y+8
Because there are 2 different variables
and you can't add any further because it
does not have any other matches

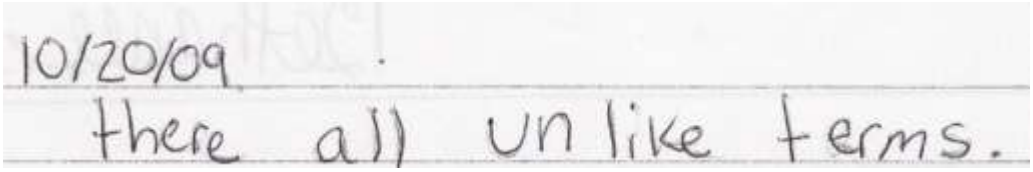
Roberta's Journal


10-20
8x+8y+8
Its already Simplified Because
there are no more variables
that are the Same.

Nick's Journal


10/20/09
there is only one kind of each
variable not others to add.

Cindy's Journal


10/20/09
there all unlike terms.

After Journal Thoughts

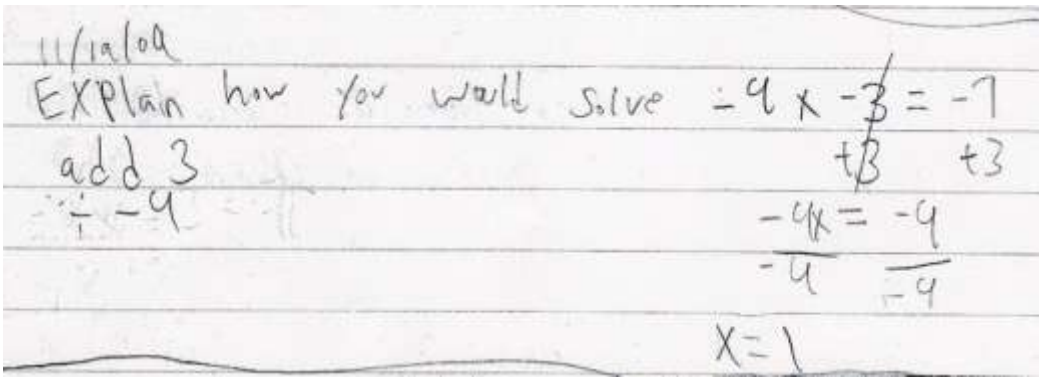
Wow. Could my assumptions have been any more wrong? This prompt did draw out different responses from the students and really put me in check. I'm the teacher. I think about concepts more technically than the students do. Of course I would use the jargon "like terms" because I go directly to the specialized term. Come to think of it, that is almost like a copout though. Because my students are not really familiar with the vocabulary word "like terms," they had to really digest what that meant in their explanations. They had to phrase "like terms" in their own way, which was much more difficult than me simply using the term itself without any explanation as to what it meant. While my kids certainly benefited from their journaling today, I think I might have learned the most. Journaling can and does open your eyes to new mathematical possibilities. If it can happen to me, it can certainly happen to my students.

Figure 2. First person vignettes and journal entries showing varied responses.

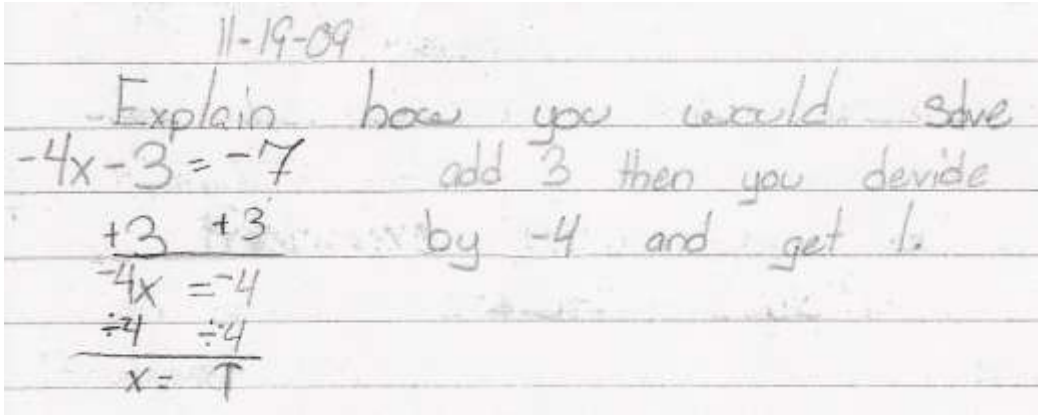
A Day of Explanations

Besides focusing on various types of journal responses and real-world connections, I incorporated journal prompts that called for students to explain their mathematical thinking. When students can explain how they solved a problem, they demonstrate a higher level of mastery. On this day of journal writing, students responded (see Figure 3) to the prompt "explain how you would solve $-4x - 3 = -7$."

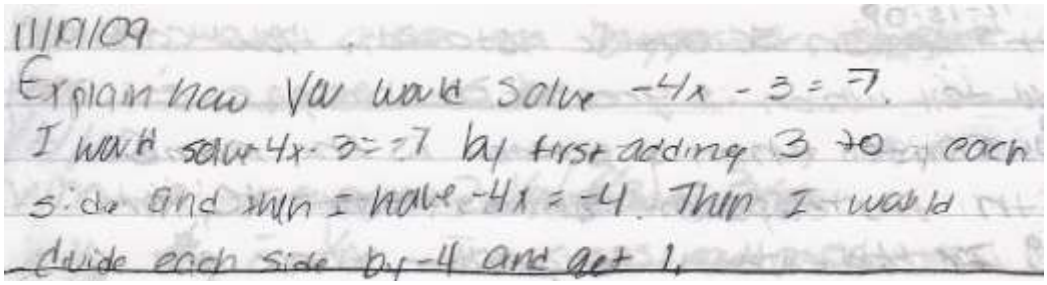
Neil's Journal


11/19/09
EXPlain how you would solve $-4x - 3 = -7$
add 3
÷ -4
$+3 \quad +3$
$\frac{-4x}{-4} = \frac{-4}{-4}$
$x = 1$

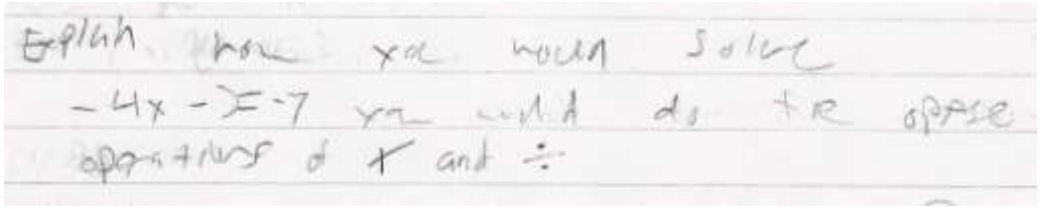
Christine's Journal


11-19-09
Explain how you would solve
$-4x - 3 = -7$ add 3 then you devide
by -4 and get 1.
$+3 \quad +3$
$-4x = -4$
$\div 4 \quad \div 4$
$x = 1$

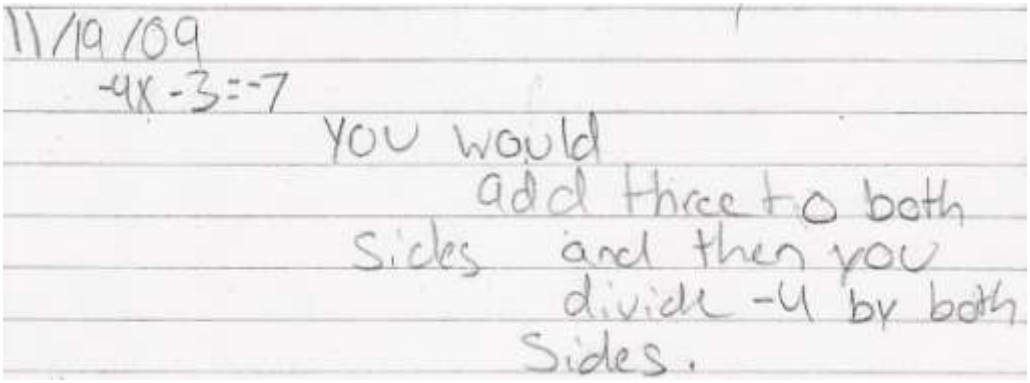
Liz's Journal


11/19/09
Explain how you would solve $-4x - 3 = 7$.
I would solve $4x - 3 = 7$ by first adding 3 to each side and then I have $-4x = -4$. Then I would devide each side by -4 and get 1.

Tad's Journal



Cindy's Journal



Kari's Journal

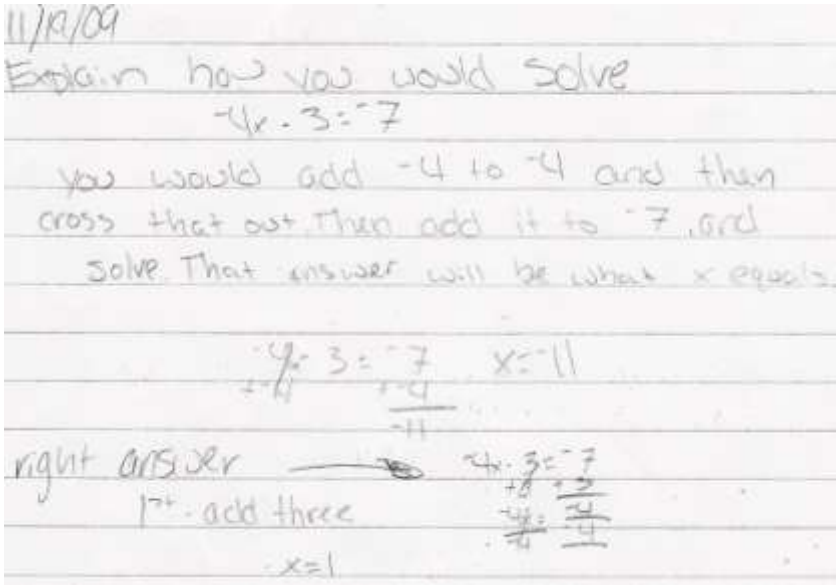


Figure 3. Student journal responses showing math explanations.

After individual writing time, students discussed their journals as an entire class. At this point in the study, I conducted most discussions in either small groups or with the entire class. This decision was based on data that I collected during my student interviews (see Figure 4).

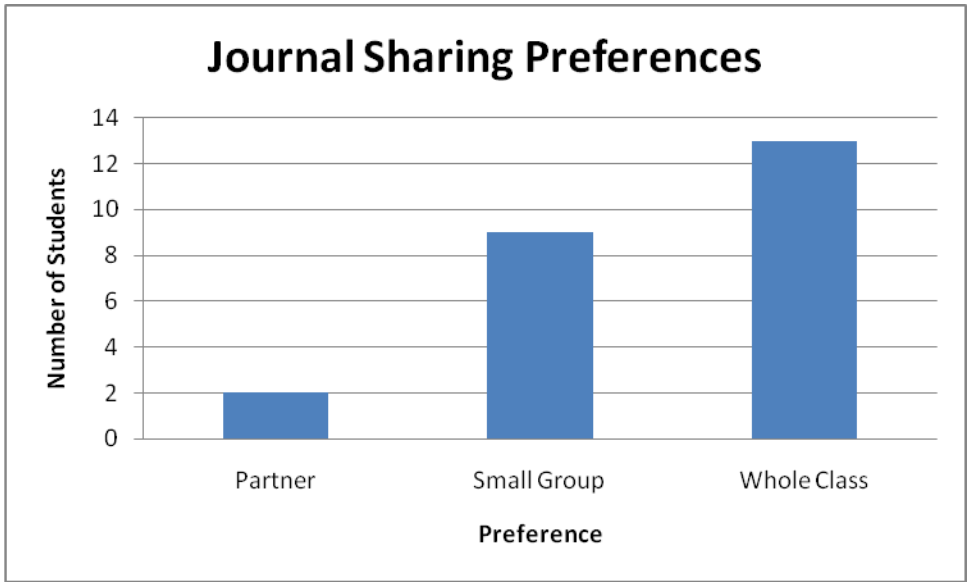


Figure 4. Journal sharing preferences graph.

Therefore, I called upon students to bring up their journal to the opaque projector and share their explanations. Students witnessed how others explained the same problem. Some students used the words “opposite operations” in their explanation. Others stated which operations to use. Some actually solved the problem along with their explanation. Whether they used complete sentences, bulleted lists, or fragments, students expressed themselves mathematically through the written word.

Because many of the journal prompts centered around explaining mathematical thinking, I collected data throughout the study pertaining to mathematical explanations. Each test that students took throughout the study contained one open-ended response question where students had to show and explain their work. Each open-ended response contained multiple parts with the total of all parts equaling four points. Shown below are the scores from the three tests that were taken. Over time, scores in the one and two range diminished while scores of three and four increased.

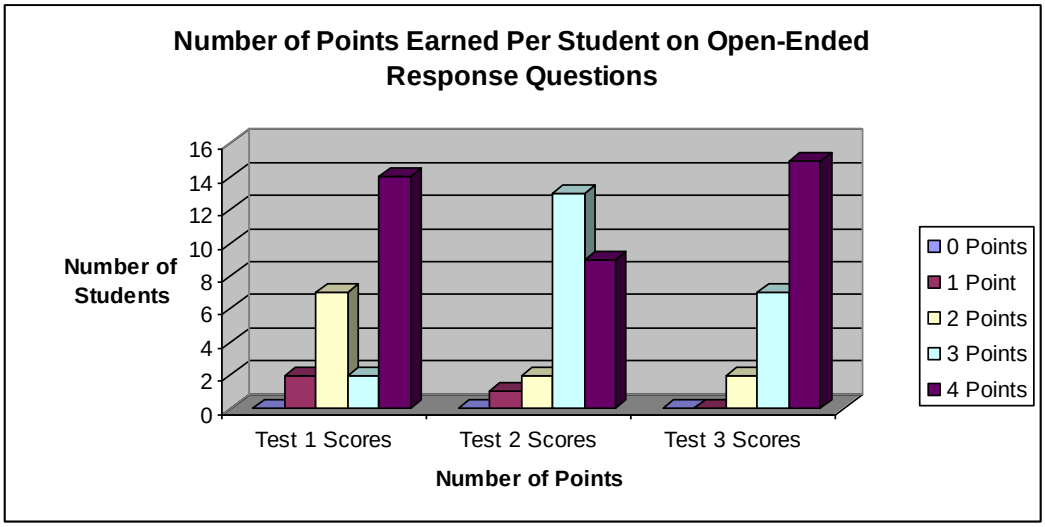


Figure 5. Open-ended response scores graph.

A Day Without Journals

Due to the fact that students only wrote in their journals twice a week, other instructional strategies were incorporated throughout the study. These included but were not limited to: cooperative group work, discovery learning,

kinesthetic learning, and whole group instruction. Even on these non-journal days, I continued to observe my students. In particular, I looked for those moments where students were able to solve problems multiple ways, explain how they solved a problem, make connections between math content and their real lives, and converse with others about their math work. During a search-and-sign review activity, I witnessed students using journal writing focus skills.

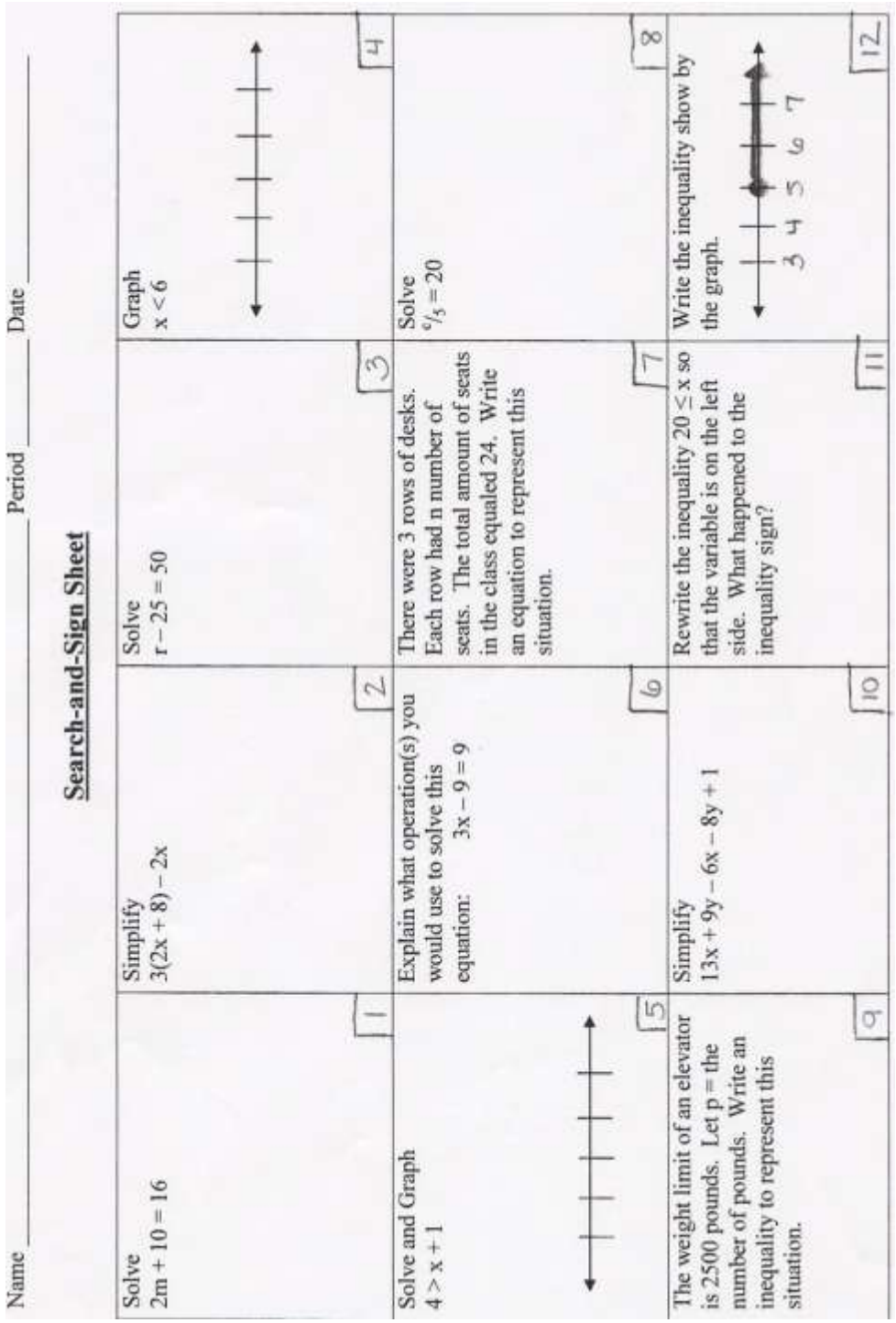
For this review activity, each student received a search-and-sign board (see Figure 6) and selected a partner for the activity. The students switched papers with their partners, answered one question on the partner's board, and then signed their name on the selected question. After both partners were finished, the pair discussed solutions and methodologies. Upon receiving a signal from me, students found a new partner and repeated the process, selecting an unsolved question on this partner's board.

To begin the activity, James partnered with me, as there was an odd number of students. We switched papers, wrote a written response to one of the questions, and shared our responses.

Teacher: "James, which question did you answer?"

James: "I did one of the middle ones [square six]. I wrote that I would solve by doing the opposite. I would add and divide."

Teacher: "I like how you used the word opposite and told me which two operations you would use for the two-step equation. I answered this one [square



Name _____ Period _____ Date _____

Search-and-Sign Sheet

Solve $2m + 10 = 16$ 1	Simplify $3(2x + 8) - 2x$ 2	Solve $r - 25 = 50$ 3	Graph $x < 6$ 4
Solve and Graph $4 > x + 1$ 5	Explain what operation(s) you would use to solve this equation: $3x - 9 = 9$ 6	There were 3 rows of desks. Each row had n number of seats. The total amount of seats in the class equaled 24. Write an equation to represent this situation. 7	Solve $^{c}/_{5} = 20$ 8
The weight limit of an elevator is 2500 pounds. Let p = the number of pounds. Write an inequality to represent this situation. 9	Simplify $13x + 9y - 6x - 8y + 1$ 10	Rewrite the inequality $20 \leq x$ so that the variable is on the left side. What happened to the inequality sign? 11	Write the inequality show by the graph. 3 4 5 6 7 12

Figure 6. Search-and-sign sheet.

one]. I subtracted ten from both sides of the equation and got 2m equals six. Then I divided each side by 2 and got the final answer of m equals three."

James: "Ok."

Even though I gleaned excellent information from James, I realized that I needed to remove myself from this activity so that I could observe the other conversations. From this point, I only intervened if students had questions or I needed to steer students in the right direction. The result of my stepping out of the activity was having one group of three students because of their odd number. Now that I was not part of the activity, I recorded various conversations. Gabe explained square one to his partner.

Evan: "You subtract ten to each of these. Then divide each side by two. Cross it out and m equals six."

In another part of the room, two girls discussed their responses.

Kari: [explaining square five to her partner] "Wouldn't you minus one? Then the arrow would go this way and point to the left."

Cindy asked Addison about the inequality problem in square five where the variable was on the right side.

Cindy: "Don't you follow the arrow [to graph the inequality]?"

Addison: "The variable is not on the right side to follow the arrow. You have to have it on the left side to follow the arrow. Switch the sides and flip the sign."

Liz explained square nine to her partner Sara.

Liz: "The weight limit in the problem is 2,500 pounds so p has to be less than or equal to 2,500 pounds."

I fittingly summed up my thoughts on this activity in my field log.

> *There was awesome math communication going on in this class and we were not even writing in our journals! Students were asking each other questions and explaining what they did to solve problems. They were using correct terminology and being specific in the steps they took to solve the problems. I was so happy that I remembered to take a step back and watch the action as it unfolded. I was really proud of the initiative taken by these students today!*

Figure 7. Field log quotation.

Change Is Needed

At this point in the study, I was pleased how students used multiple ways to solve problems, related math to their real lives, explained their math thinking, and used journal skills during non-journaling activities. The downside was, students were beginning to get bored with the same journal routine. Having done the same process for three months, students began to lose interest. This caused negative behaviors in class. Students were very loud and boisterous upon entering class. They talked incessantly and were not in their seats getting started on their journals when the bell rang. Students continuously asked to go to the bathroom during this time when they needed to be journaling. All in all, I was beginning to get extremely frustrated with how students were acting. It was time

for a change. My solution: offer choice in journal prompts. Instead of having to all answer the same prompt, students were now given the option of picking one out of two journal prompts to answer. Sharing of journals changed slightly due to the fact that two journal prompts now existed. I had students share answers usually with those who completed the same prompt. Then we discussed journals as an entire class.

As part of my interview of students, I asked them if they liked the ability to pick which prompt to answer (see Figure 8). The majority of students preferred being able to choose.

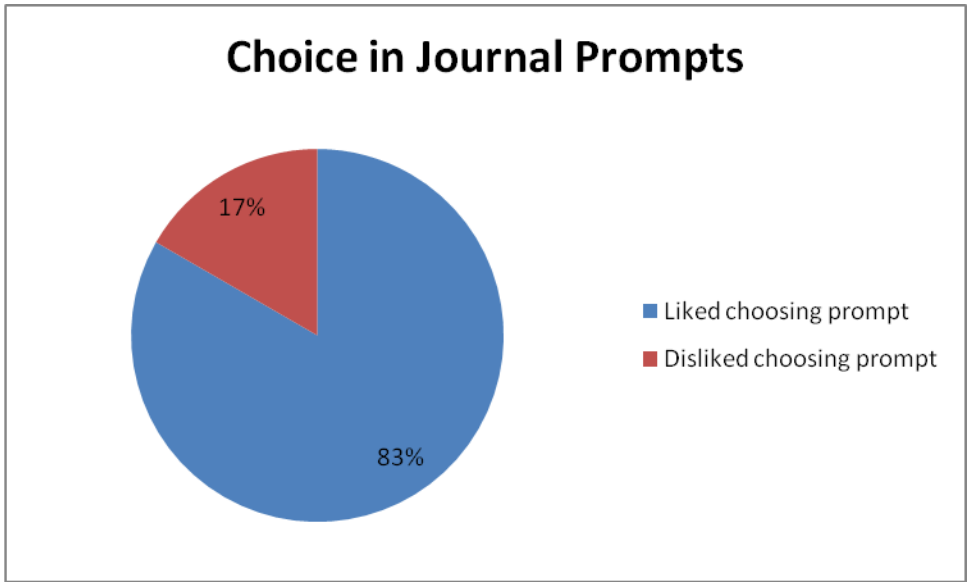


Figure 8. Choice in journal prompts graph.

Because most students were receptive to the change, I observed a decrease in the aforementioned negative behaviors. Most students began to refocus themselves at

the beginning of class and my frustration level decreased. Here is what the students had to say about choice in journal prompts.

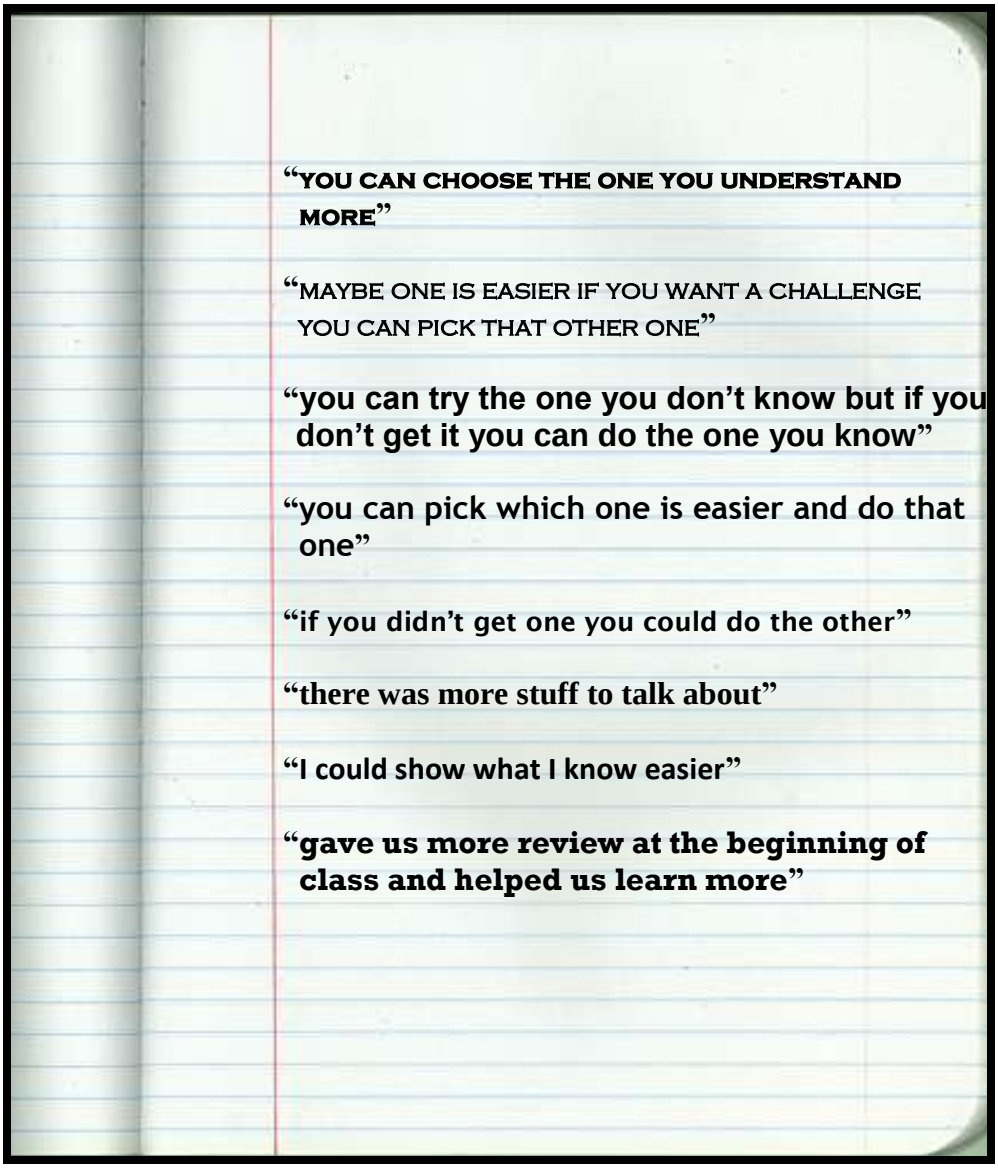
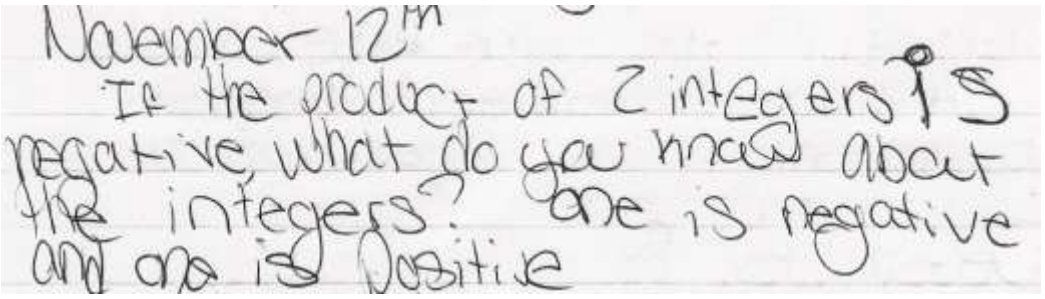


Figure 9. Pastiche on choice in journal prompts.

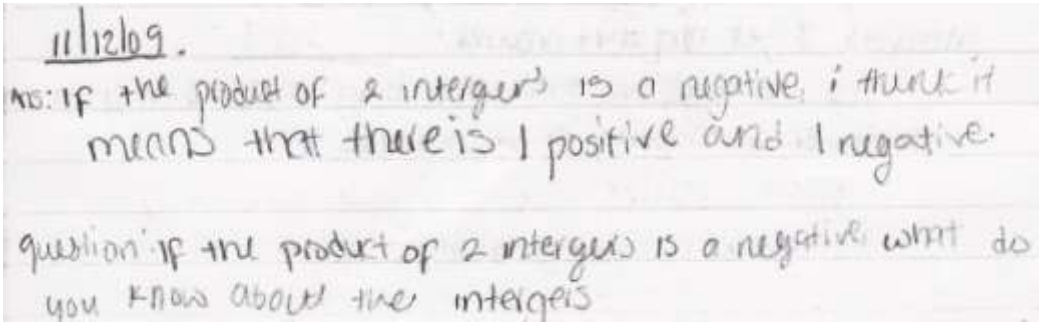
A Day of Two Prompts

During this particular class session, students came in and responded to one of two prompts pertaining to the multiplication and division of integers. The first one was, “If the product of two integers is negative, what do you know about the integers?” The second prompt was, “If a is positive and b is negative, what will a divided by b be?” On this particular day, the majority of students chose the second prompt (see Figure 11) with only a handful selecting the first one (see Figure 10).

Addison's Journal


November 12th
If the product of 2 integers is negative, what do you know about the integers? one is negative and one is positive

Gail's Journal


11/12/09.
AS: If the product of 2 intergers is a negative, i think it means that there is 1 positive and 1 negative.

question: If the product of 2 intergers is a negative what do you know about the intergers

George's Journal

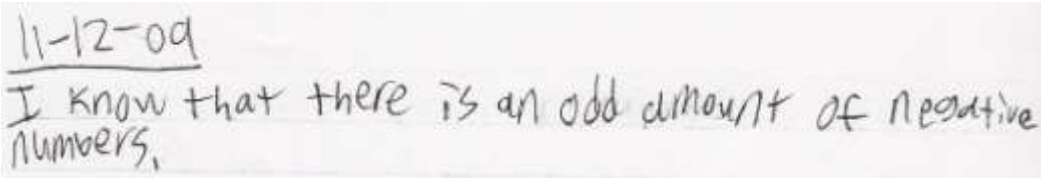
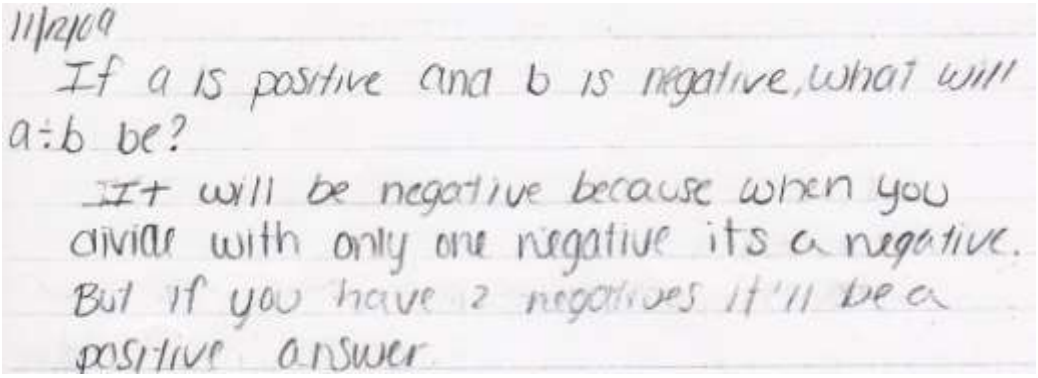
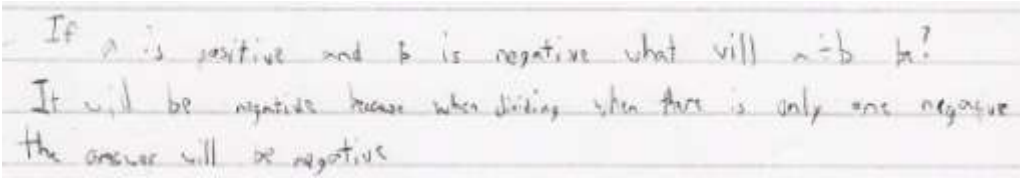

11-12-09
I know that there is an odd amount of negative numbers.

Figure 10. Student journal responses to prompt one.

Lisa's Journal


11/12/09
If a is positive and b is negative, what will a÷b be?
It will be negative because when you divide with only one negative its a negative. But if you have 2 negatives it'll be a positive answer

Evan's Journal


If a is positive and b is negative what will a÷b be?
It will be negative because when dividing when there is only one negative the answer will be negative

Sara's Journal

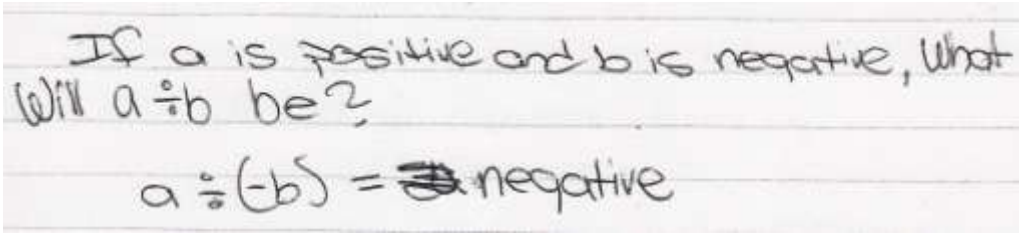

If a is positive and b is negative, What Will a÷b be?
a÷(-b) = negative

Figure 11. Student journal responses to prompt two.

After journal writing, we shared answers as an entire class. I had George and Gail share their journals to Prompt One so that students could hear how the same answer could be stated two different ways. I also wanted the class to hear George's response, because he generalized the rule for any number of integers that could be multiplied together. Lisa and Evan each verbalized their similar but different answers to Prompt Two. We then compared responses to both prompts, reiterating that the rules for multiplying and dividing integers are the same.

Neil's Story

Neil's Perspective

One more day in pre-algebra. I see Ms. DalPezzo standing at the door to the classroom. She says, "Hi Neil. How are you?" again. Ugh, does she not know by now that I am not going to respond? I give her my usual head nod. There is another journal prompt on the front board. I think journals help me understand the math problems better, but I hate when we have to share the journals. I only ever listen to what my partner or group has to say. I hope Ms. DalPezzo decides to have us share as a whole group. That way I will not feel as strange because the focus will be on other students sharing what they wrote. Whew! Another day of journal sharing is over. I knew Ms. DalPezzo would not call on me.

Ms DalPezzo's Perspective

Here comes Neil down the hall. I will say hi to him and ask him how he is doing. As usual, he does not respond. I thought if nothing else, I could get him to answer one word to that question, but he has been unresponsive all year. I am glad to see Neil is writing in his journal. I wonder if he feels the only way he can express himself is through the written word since he does not verbally communicate with me, my aide, or the other students. At least the journal is providing me with some way to see into his mathematical thinking. I think we will share journals as a whole group today. I wish I could get Neil to participate in journal sharing. I have gotten other reluctant students to come up and share their journals. I know if I push the issue, though, I will embarrass Neil and the other students' frustration levels will rise. I think it is best not to pressure him.

Figure 12: Layered story.

Neil became one of the most interesting students to observe during the study. Neil came to me from the Children's Home of Easton, having been placed there because of truancy issues at his home school in Philadelphia. Dewey (1997/1938) writes, "there are likely to be some who, when they come to school, are already victims of injurious conditions outside of the school and who have

become too passive and unduly docile that they fail to contribute" (p. 56). In a sense, this was Neil. All of the teachers on my team quickly came to notice that Neil would not speak to any of us. When asked questions, he responded with non-verbal cues such as shaking his head and pointing. The students were also quick to draw attention to the fact that Neil would not speak. I would hear complaints during the study when students were paired with him because of the fact that he did not talk.

About half way through the study, I met with one of Neil's counselors. She had officially labeled him as selectively mute due to social anxiety. To help with his verbal communication, she wanted to implement an incentive program where I was to mark on a behavior sheet if Neil said something to me or asked me for help. She would then reward him for this behavior.

Excited that Neil might now speak because of the incentives program, I continued with class as usual. I repeatedly said "Hi" to him and asked how he was doing, but still received no oral response. I asked why he did not have his homework done, and he would still simply shake his head or point to his locker. I continued to partner him with other students in hopes that he might find comfort with one of them. I even had Neil stay after class one day because he was having trouble finishing a quiz. I thought I could get him to speak if it was just the two of us in the room. As I talked to him to try and figure out what his math difficulties were, he kept backing up towards the door of the classroom. I could

tell he felt very uncomfortable and was hoping to leave. It did not matter what tactics I tried. Neil would not speak.

I began to feel defeated until I came to a realization. I had been harping on the fact that Neil would not communicate verbally instead of focusing on the fact that he was communicating to the class through the written word via his math journal. I had been missing the very essence of my study which was to get my students to express themselves mathematically. Sure, a large part of that was the verbal sharing piece, but if I could at least get Neil to complete the written component, I accomplished something. During the study, Neil faithfully completed his journal entries (see Figure 3). He had been communicating mathematically with everyone all along. I just wish I could have realized this sooner. Neil's case reminded me why I implemented journals in the first place.

"Summing" It Up

Math journals had become the voice for not only one student in my classroom, but also for all of them. As the data collection period came to an end, I compiled all the "voices" of my students via their surveys and interviews. Overall, I "heard" that while most students disliked journals, they found them to be beneficial to learning math.

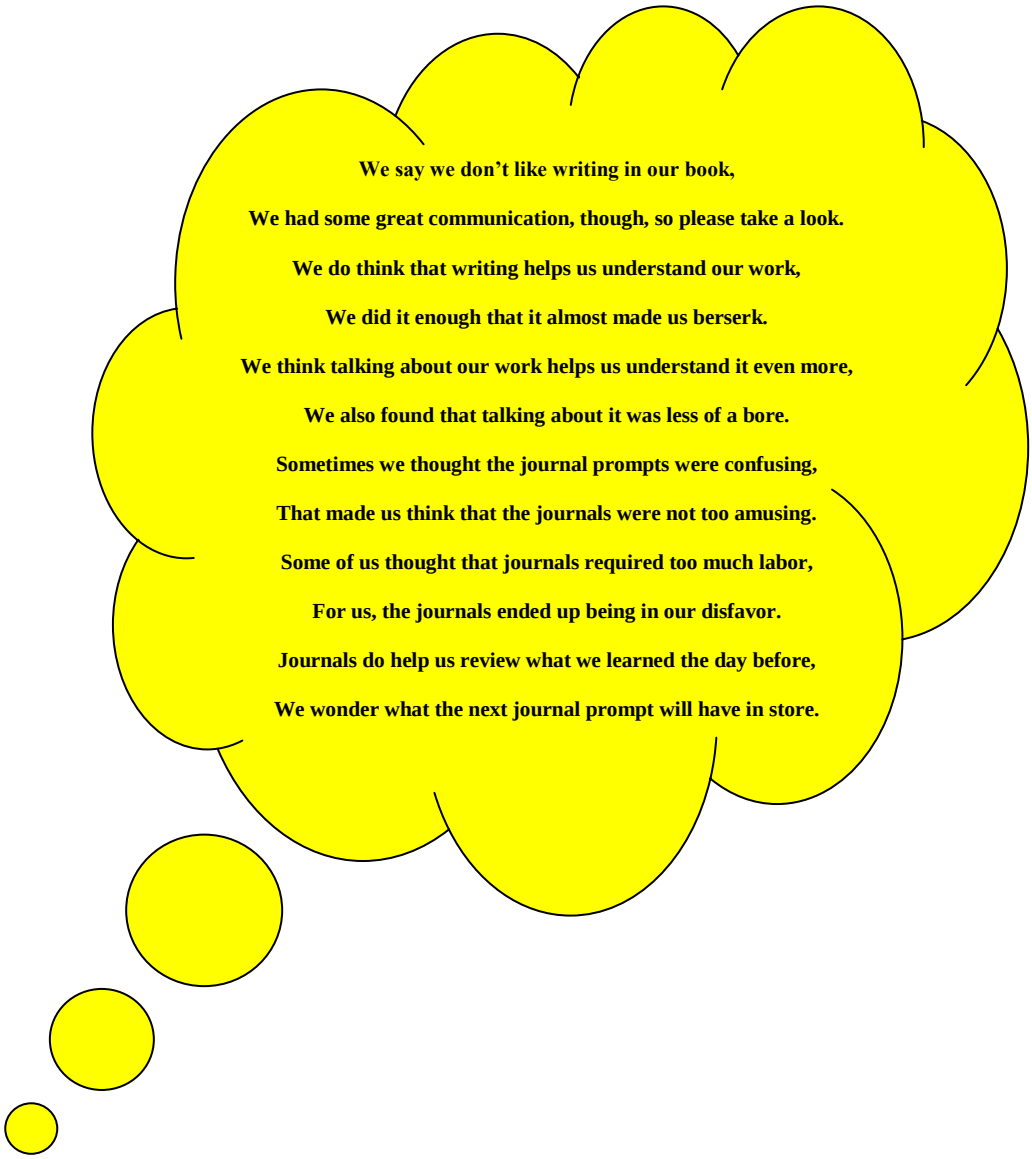


Figure 13. Final thoughts on journals from the students' perspectives.

Data Analysis

Introduction

"Data analysis is the process of systematically searching and arranging the interview transcripts, fieldnotes, and other materials that you accumulate to increase your own understanding of them and to enable you to present what you have discovered to others" (Bogden & Biklen, 1998, p. 157). An entire semester's worth of data meant nothing to me in a huge binder. I had to find ways to arrange the data into manageable units so that I could lift meaning and patterns from what I collected. Therefore, I analyzed my data both during and after data collection.

Analysis During Data Collection

Field log analysis. According to Ely, Anzul, Friedman, Garner, and Steinmetz (1991), "the log contains the data upon which the analysis is begun and carried forward. It is the home for the substance that we use to tease out meanings and reflect upon them as they evolve" (p. 69). I housed every piece of data that I collected during my study in my field log. Surveys, interviews, journal responses, quizzes, tests, and observations all made up the entity that was my log. Once assigned a spot in the log, however, each piece had to be carefully analyzed through reflections, memos, and coding. To simply leave the data in the log was not enough. I had to actively work with each piece ascribed to it.

Coding analysis. Now that my data was contained in my field log, I had to go back and read each data piece. As I did this, I assigned codes, or notes, to represent units of meaning in my study. Each code was placed in an alphabetized and paginated coding index. This way, I could easily access and locate all similar codes found in various parts of the field log. Upon reflecting on my codes, I made adjustments to them as necessary. Some codes had to be dropped, while others were added or reworded to be more specific (Hendricks, 2006). Reviewing the codes helped to narrow my focus in determining the patterns and themes emerging in my study.

Student work analysis. As I added student work to the log, it too had to be examined. A large part of the work I collected were the journals themselves. Each month I photocopied student responses so that I had my own version to add to my log. Looking at these entries allowed me to talk to my students about what they could improve upon in future journal writing and what they were already excelling in. I reflected on trends that I found and wrote those thoughts down in my log.

The other large quantity of student work I saved was student quizzes and tests. Upon analyzing these documents, I coded where I saw students applying the skills they practiced during journal writing. I made graphs to better analyze my findings and see exactly how students scores may or may not have been impacted by journal writing.

Survey and interview analysis. Not only did I consider observations and student work, but I included student surveys and interviews as well. I looked at the survey given at the onset of the study to determine what opinions my students had about mathematics communication. To measure any change in attitudes and feelings, I administered the same survey at the conclusion of the study. To make meaning from the surveys, I analyzed them, tallying up student responses. Graphs and charts helped me to make further meanings from the surveys.

At the midpoint of my study, I interviewed the students as a way of member checking. Bogdan and Biklen (1998) remind us to "try out ideas and themes on subjects. They can be used as resources in preliminary analysis" (p. 163). In my interviews, I asked the students what they currently liked about mathematics journals and what could be done to improve writing in them. Coding and analyzing these results helped lead to changes in the study.

Methodological memo analysis. In addition to interviewing students at the midpoint of the study, I completed a methodological memo entitled "Mid-Study Data Assessment." I listed all field log observations, surveys and interviews, and student work gathered up until that point. Included with the chronological list were insights gleaned from each piece of work I collected, along with a rationale for collecting that work. This process allowed me to see what data I had already collected and what data I needed to collect in the future to

complete my study. As I analyzed the data that I already collected, sub-questions emerged which helped focus the remainder of my study.

Analysis through the educational philosophers. As I collected data, I read various educational philosophers. These included: Dewey, Freire, Delpit, Dowdy, and Vygotsky. After reading each philosopher, I wrote reflective memos. There I connected pieces of my data to the viewpoints of the educational theorists. I did this by selecting quotes from the authors that reflected what was occurring in my study. Reflecting on my data through the eyes of these philosophers helped me gain insight into the study and the learning process of my students.

Analysis After Data Collection

Field log anaylsis. Upon completion of my study, I continuously reread my log. I added any information that I could remember to my field notes. I adjusted codes where necessary and made updates to my coding index. What I did after the study was complete was very similar to what I had done during the data collection process. Ely, Vinz, Downing, and Anzul (1997) sum up this process the best by writing, "qualitative analysis requires that the researcher go back again and again over the accumulated log material in a process that for many has a cyclical feel" (p. 175).

Student work analysis. After collecting the remainder of student work, I looked back at the codes that I had assigned to various aspects of their work. I made sure these codes still described what I was seeing in their work. Putting

similar journal responses together helped me better organize them according to skill sets that we worked on. Those skill sets included showing multiple representations of answers, making real-world connections, and explaining their math work. I also combined the smaller graphs I had created earlier to make more comprehensive ones. These pertained to data I collected on student achievement levels based on quiz and test data.

Survey and interview analysis. After the study's completion, I analyzed the post-survey from students. By re-administering the pre-survey, I compared how student responses stayed the same or changed. I used this information to draw conclusions about student attitudes toward math journals and math communication. I also briefly looked through the student interviews to see how opinions changed or stayed the same from the midpoint of the study to the end.

Bin and theme analysis. Because I coded all elements of the field log namely, observations, student work, and surveys and interviews, I had to make meaning out of all of those codes. The way I did this was to group codes into similar categories. Each category was called a bin. I arranged my bins into a graphic organizer, which aided in extracting meaning from each one. From each bin, I developed a theme statement. The theme statements were the major findings as supported from data from my log. Ely et al. (1997) write, "a theme can be defined as a statement of meaning that (1) runs through all or most of the

pertinent data, or (2) one in the minority that carries heavy emotional or factual impact" (p. 206).

Summary

Data analysis was an ongoing part of my study on mathematics journals. I had to analyze data throughout the collection process so that it could aid me in future data collection and instruction. Examination included the field log, student work, surveys, and interviews. Analysis also took place through the eyes of the educational philosophers. In addition, I had to analyze data upon completion of my study so that I could form conclusions. Once again, the field log, student work, surveys, and interviews had to be examined. Bins and themes resulted from my final analysis work and led me to my findings.

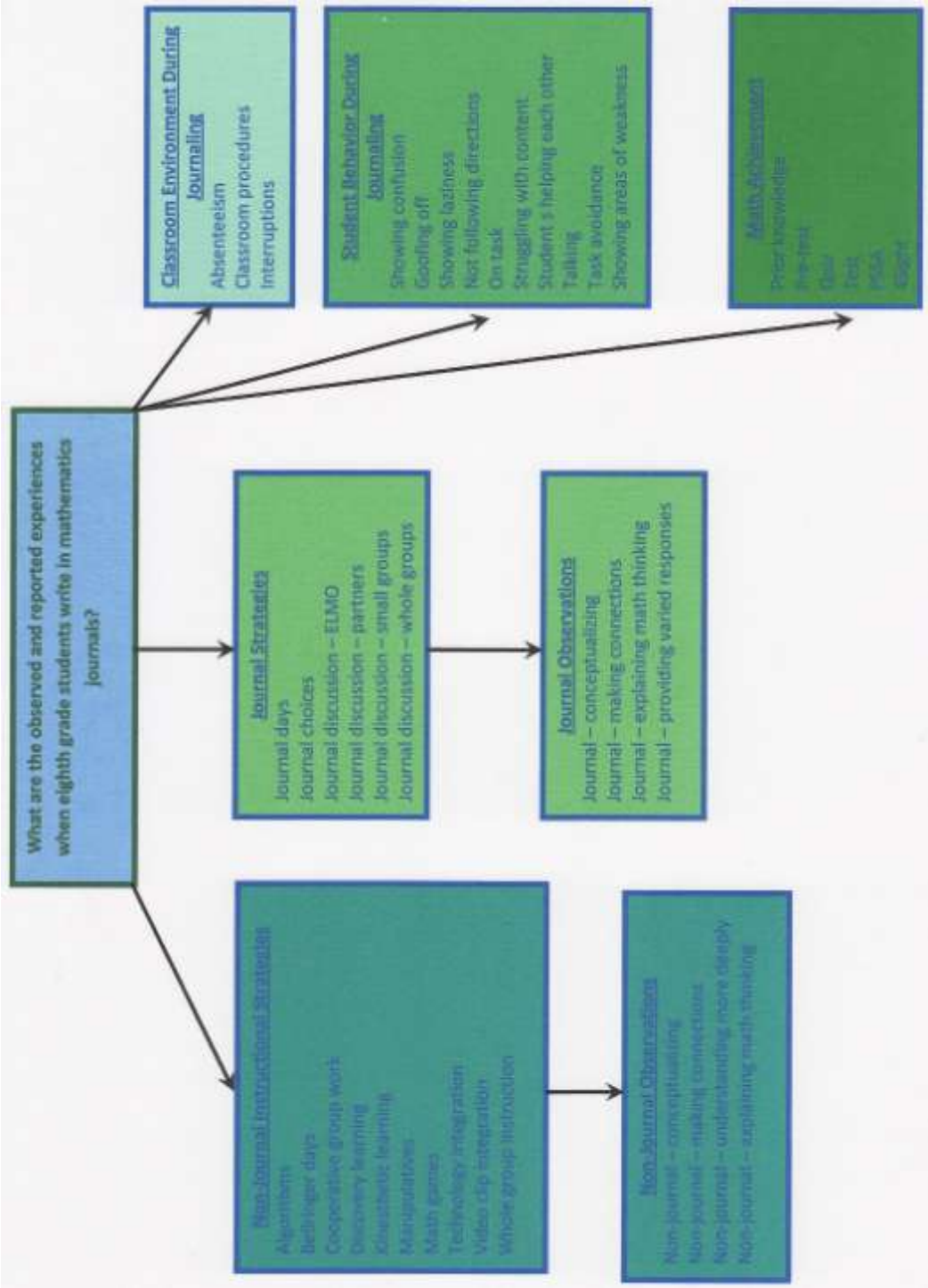


Figure 14: Graphic organizer of codes and bins.

Findings

***Journal Observations*: Journal writing allows students to make connections between math and the real world and to explain their math thinking. Both of these skills can lead to students providing varied responses to math prompts and students conceptualizing math concepts.**

When designing the journal prompts for the study, I made sure to target the areas of making connections and explaining math thoughts. When students make connections between math and their lives, they see relevance to what they are doing in school. Sometimes I had students write about examples that were specific to them and their interests (see "A Day of Real-World Connections"). Other times I had them relate math to the world in general. For example, one day students wrote about a situation that involved negative numbers. Responses included temperature, credit cards, debt, a math teacher's job, wrong answers when playing Jeopardy, owing money, and losing yardage in football. These responses showed different ways that the prompt could be answered. They were all correct, but unique answers. In their study, Goldsby and Cozza (2002) also found that journals allowed students to connect to their learning.

The other target skill was to get students to explain their mathematical thinking. I specifically used the word "explain" in prompts where that was the goal (see Figure 3). As it turned out, though, even on days when the word "explain" was not used, students still provided written explanations (see Figures

10 and 11). During the course of the study, students not only described how they solved problems, but they also stated what the error was in someone else's work. I would complete problems incorrectly, and students had to explain what the errors were. Each time students answered prompts where an explanation was needed, they did so in their own way. This led to a variety of answers. Through their explanations, some students were able to generalize math concepts and look at the bigger picture (see Figure 10: George's Journal). In this example, George only needed to write about multiplying two integers. His answer, however, applied to multiplying any amount of integers. George formed a deeper understanding of multiplying integers because he was able to generalize a rule. Clarke, Waywood, and Stephens (1993), as well as Jurdak and Zein (1998), also found that students who journaled were better able to understand larger math concepts instead of isolated algorithms.

***Journal Strategies*: When given choice in journal prompts and journal discussion techniques, students are more likely to produce better journal responses as they are motivated to complete the task.**

While following the same routine with journal prompts was important, it did lead to some monotony. Giving students choice became a way to break up the boredom of journals for the students.

To begin the study, students only had one journal prompt per journal session. They had to answer what was presented to them. In other words, there

was no choice. I saw some confusion amongst the students due to the fact that they might not necessarily understand or know how to answer the prompt. Some students sat there waiting until it was time to discuss the journals before writing anything down. The purpose of the study was not to have students copy down someone else's ideas, but to originate their own. On days like this, there was less variety of answers due to the fact that students were relying on each other for answers.

Once students were given choice, namely two prompts, they seemed more at ease. Most of the students perceived there to be one easy prompt and one hard prompt. I cannot say I necessarily designed them that way, though. Students chose the prompt they thought to be on their ability level, which allowed them to write more freely and rely less on their classmates. The quality of the journal responses improved due to this change.

Having students select how to share journal entries also led to better journal responses. Most students preferred small and whole group sharing of journals (see Figure 4). Sharing in front of more people led to higher levels of conscientiousness from the students. They did not want to be perceived as dumb, but rather wanted to show off what they knew. I even had students asking me beforehand how we were going to share journals that particular day. On one specific occasion, Janice asked if we could share journals in front of the entire

class using the ELMO. I obliged because I knew that acquiescing could result in a positive outcome.

***Non-Journal Instructional Strategies*: While journal writing and sharing is a sound instructional strategy, other methods of instruction need to be incorporated into the mathematics classroom to address the needs and bolster the achievement of all learners.**

Students learn in many different ways. Journals benefitted those students who learn linguistically through words. Writing in the journals exposed students to written communication techniques. Sharing journal responses with other students addressed the needs of students who learn interpersonally with others. Disclosing answers to prompts allowed for discussion amongst students. Certainly answering journal prompts pertaining to math helped those students who learn logically and mathematically or spatially. There were no stipulations on how students had to answer the prompts. For example, they could have made t-charts displaying their work and explanations. Students could have drawn pictures or diagrams to help them solve the problems.

My instruction would not have been complete, however, if it had not been for the other instructional strategies I incorporated throughout the study. I addressed the needs of bodily-kinesthetic learners by having students use math manipulatives, such as algebra tiles. I showed video clips involving songs to attend to the needs of my musical-rhythmic learners. Doing this also allowed me

to integrate technology into my lessons just as using the Mimio and ELMO did. I also had students work in other forms of cooperative groups completing such tasks as math review games. I taught some concepts using more of a constructivist approach with discovery learning, while I taught other topics using more of an algorithmic approach through whole group instruction. These strategies, in addition to journals, were necessary in order to deliver instruction that was multi-faceted.

***Non-Journal Observations*: Students display similar behaviors, like those observed during journaling, even when not engaged in the journal writing process. These behaviors include making connections and explaining math thinking.**

Because journal prompts focused so heavily on the areas of making connection and explaining math thinking, I observed students on non-journal writing days to see if they could apply those skills to new situations. Based on what I saw, students were able to transfer what they practiced during journal writing sessions. A prime example of this was when students completed a Search-and-Sign review activity (see "A Day Without Journals, Figure 6, and Figure 7). Students explained their work when verbally communicating with their partner. Students also had to represent real-life situations with math problems.

Other instances where I saw students employ journal skills occurred during whole group instruction. As I questioned students, I asked them how they

got their answers. They responded by explaining the process they used to figure out the problem. I also took time during whole group instruction to relate math to real-life situations. One day when we discussed inequalities, we came up with situations involving an amusement park where you would need to know about inequalities. Responses included getting straws for your friends, being a certain height to ride a ride, and paying admission to get into the park.

Students also utilized their explanation skills during cooperative group work. I saw students offering assistance to each other. If one student was confused, another student explained what to do. This happened during a group activity where students calculated their reaction times to catching a ruler. Students calculated their reaction time by substituting a measurement into the given expression and solving. I saw one student helping his partner when she got confused with the substitution and solving part. He verbally explained what to do, followed by showing her on paper. Therefore, this student not only demonstrated his oral explanation skills, but also demonstrated his ability to communicate via written form. Students continually used journal skills during times of non-journal use.

***Classroom Environment*: Students can produce meaningful journal responses and share significant findings despite disruptions that negatively affect the classroom environment during journaling.**

Each journal session took place at the beginning of the class period. It became part of the routine on Tuesdays and Thursdays. Having it at the beginning of class, however, did have some drawbacks. Interruptions occurred during this time. For one, I had to come around and check students' homework. Secondly, students left to go to the bathroom, nurse, or office. In addition, absent students had to inquire about missed work. This really came to a head during October when absenteeism skyrocketed due to swine flu and similar illnesses. Some days it just seemed like students were doing everything but journal writing. When I looked at what students had written, though, I was surprised. Despite these factors that negatively influenced the classroom environment, students were somehow able to still complete their tasks which, in turn, led to meaningful discussions.

***Assessment*: Students who journal are more likely to show progress on assessments in the area of explaining math processes because this is an area of focus during journaling.**

During the course of the study, I monitored the assessments that the students took. My main focus was to see if students could explain their mathematical thinking on these exams. The first set of tests I examined were the chapter tests that students took at the end of each unit. Each of these tests included a multi-step, open-ended response question where students had to explain their math thinking and show their work. It was scored out of four points.

Over the course of the three tests, the number of students who earned a score from zero to two decreased, while the number of students who earned a score from three to four increased. By the end of the third test, the number of students who received three points increased because those students earned four points instead (see Figure 5). Similar gains in achievement levels were noted by Jurdak and Zein (1998).

The other assessment I looked at to track student progress in the area of math explanations were the 4Sight exams. Only two of these tests were given during the course of the study, but students did show gains in the open-ended response category. Similar to the unit tests I gave, each 4Sight open-ended response included multiple parts where students had to show work and explain their math processes, with all parts totaling four points. According to the data I collected, the overall score for students on the open-ended item was a 24.79 for the first test and a 29.26 for the second test. While scores did not skyrocket from the first to the second test, there was still an increase nonetheless. Some of this can be attributed to the fact that additional content needed to be taught.

***Student Behavior*: Even though students may frequently exhibit negative behaviors while journaling, they can produce worthwhile journal responses and hold important journal discussions. These behaviors include talking, goofing off, showing laziness, and task avoidance.**

In a perfect world, each student would come into class every day, follow the rules, and do as he/she is told. Certainly in a typical classroom, students act in ways that are not ideal. So was the case during journaling. At first, students did act like I expected them to. Once they settled into the routine and became comfortable, though, behaviors started to change. Students appeared disinterested in writing in their journals. Talking began to increase and most of it was not because students were assisting each other with answering the journal prompt. Some students were even out of their seats goofing off by the tissues, hand sanitizer, and trashcans in the back of the room. Many of these behaviors subsided to a degree, however, when I instituted choice in journal prompts which led to an increase in student motivation. These negative behaviors differed from the ones mentioned in the study conducted by Di Pillo, Sovchik, and Moss (1997) who found students to be highly motivated and on task during journal writing.

Despite that fact that students did not seem interested in journals, at least from outward appearances, they continually surprised me with their responses. I kept thinking to myself, “Where and when did they have time to come up with this?” I thought they were too preoccupied with other things, but apparently they finished their journal before acting inappropriately. Response quality dipped slightly during the height of the misbehaviors, but rose back to its original state after I instituted choice in prompts. Because students maintained quality journal responses, significant conversations pertaining to journals ensued.

Next Steps

Based on the positive findings from my study, it appeared that continuing mathematics journals would benefit my students. I plan on continuing journal writing for the remainder of the year. Journaling enabled students to see multiple representations of mathematical answers, to explain their math thinking, and to make connections between math and the real-world. To best meet the needs of my students, I made adjustments to the study as it progressed. Out of those changes have come further sub-questions and perhaps future action-research ideas.

The first area I would look into would be having the students write the journal prompts. Throughout my entire study, I selected the journal prompts by either using questions from the textbook series or by using questions that I created. If students created their own prompts, however, they might take more ownership over the entire journaling process. It could be used as a motivating factor, therefore, eliminating negative behaviors like the ones I encountered in my study. As Dewey (1997/1938) writes, “the intensity of the desire measures the strength of the efforts that will be put forth” (p. 70). If students yearn to answer journals because of having written their own prompts, then they will create meaningful journal entries.

Another thought I had after the completion of my study would be to have students comment on each other’s journals. This could happen as students share

journal responses with one another. Sharing could turn into students reading the responses of others and then giving those students written feedback in the journal itself. Verbal communication could be sharing the comments and students discussing how to make the current journal entries better or have more description. This would give students the opportunity to act as teachers for a day, offering constructive criticism to their classmates.

Because there was such a focus on making real-world connections during my study, I also wondered what might happen if students provided lists of real-world topics they would like to see mentioned in their math work. While I tried to include issues that mattered to my students, I am sure I missed certain topics of interest. The more the topics captivate the students, the more apt they are to want to respond to journal prompts and interact in class. Vygotsky (1978) writes, "writing should be meaningful for children, that an intrinsic need should be aroused in them, and that writing should be incorporated into a task that is necessary and relevant for life" (p. 118). Incorporating student interests could be the key to Vygotsky's idea.

Another adaptation I could see making to my original study is to conference with students about their journals. Unfortunately, I did not have time for this during my study, but would like to make time for it in the future. Each student and I could have a bi-weekly conference where we discuss questions, concerns, and difficulties the student is having with journal writing. We could

also focus on ways to make the student's writing better. This would allow for better monitoring of student progress with journal writing.

All things considered, I am pleased with the results of my study. I spent many hours preparing for, implementing, and writing up this study. I see myself using math journals in future years of teaching. Completing this study has given me the courage to implement positive changes in my classroom. While change is not necessarily easy, it challenges and invigorates the mind. With any luck, I have challenged and invigorated the minds of my eighth grade pre-algebra students.

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Appendix A

MORAVIAN COLLEGE

August 25, 2009

Amy DalPezzo

Dear Amy DalPezzo:

The Moravian College Human Subjects Internal Review Board has accepted your proposal: "Math Journals: A Means of Mathematics Communication." Given the materials submitted, your proposal received an expedited review. A copy of your proposal will remain with the HSIRB Chair.

Members of the committee, however, urge you to proofread your informed consent forms as they contain some grammatical errors.

Please note that if you intend on venturing into other topics than the ones indicated in your proposal, you must inform the HSIRB about what those topics will be.

Should any other aspect of your research change or extend past one year of the date of this letter, you must file those changes or extensions with the HSIRB before implementation.

This letter has been sent to you through U.S. Mail and e-mail. Please do not hesitate to contact me by telephone through e-mail should you have any questions about the committee's requests.

George D. Brower
Chair, Human Subjects Internal Review Board
Moravian College

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Appendix B

August 31, 2009

Dear _____

I am completing a Master of Education degree at Moravian College. Their program focuses on salient research methods that allow educators to collect data in their own classrooms in order to improve their teaching methodologies.

As a requirement of the program, I will be conducting a study in which I analyze the effects that mathematics journal writing has on the students. By completing this study, I hope to increase student achievement in mathematics through journal writing. I would also like to see students become fonder of writing about math. Lastly, I hope that by increasing student achievement and bolstering attitudes, student engagement in my class will increase.

Data collection during the study will take place in numerous ways over the course of September, October, November, and December 2009. I will be observing student behavior during the course of each class period and recording those findings on a check sheet. I will also be surveying and interviewing students to get their perceptions on and attitudes about journal writing during math class. Lastly, I will be collecting student work samples, mainly through class work, quizzes, and tests.

All students will be involved in these writing activities as part of the regular mathematics curriculum. Students' participation in the study, however, is completely optional and will not effect their grade in any way. Students may withdraw from the study at any time without penalty. If that situation should arise, I would not use any data from those students in my study.

Names of students participating in the study will be kept completely confidential. Only pseudonyms will be used when referencing students. Minor adjustments may be made to student work to ensure confidentiality. Only I will have access to the research data and information, which will be kept in a secure, locked area. After completion of my research, all documents will be destroyed.

If questions about the study arise, please do not hesitate to speak with me at school. You may also contact my advisor, Dr. Charlotte Rappe Zales, by phone at _____ or by email to _____ Please complete the bottom portion of this form. Thank you for your time.

Sincerely,

Ms. Amy DalPezzo

Ms. Amy DalPezzo

I attest that I am the assistant principal of the teacher completing this research study. I have read the above consent form and have received my own copy. Ms. Amy DalPezzo has my permission to complete this study at our school.

_____ 9/2/09

Assistant Principal Signature Date

Appendix C

August 31, 2009

Dear Parents or Guardians,

I am completing a Master of Education degree at Moravian College. Their program focuses on salient research methods that allow educators to collect data in their own classrooms in order to improve their teaching methodologies.

As a requirement of the program, I will be conducting a study in which I analyze the effects that mathematics journal writing has on the students. By completing this study, I hope to increase student achievement in mathematics through journal writing. I would also like to see students become fonder of writing about math. Lastly, I hope that by increasing student achievement and bolstering attitudes, student engagement in my class will increase.

Data collection during the study will take place in numerous ways over the course of September, October, November, and December 2009. I will be observing student behavior during the course of each class period and recording those findings on a check sheet. I will also be surveying and interviewing students to get their perceptions on and attitudes about journal writing during math class. Lastly, I will be collecting student work samples, mainly through class work, quizzes, and tests.

All students will be involved in these writing activities as part of the regular mathematics curriculum. Your child's participation in the study, however, is completely optional and will not effect his/her grade in any way. Please be advised that your child may withdraw from the study at any time without penalty. If that situation should arise, I would not use any data from your child in my study.

If you should decide to allow your child to take part in the study, his/her name will be kept completely confidential. Only pseudonyms will be used when referencing your child. Minor adjustments may be made to student work to ensure confidentiality. Only I will have access to the research data and information, which will be kept in a secure, locked area. After completion of my research, all documents will be destroyed.

If questions about the study arise, please do not hesitate to call me at school at _____ or email me at _____ You may also contact my advisor, Dr. Charlotte Rappe Zales, by phone at _____ or by email to _____. This study has been approved by our building principal, _____ who can also be reached at the same telephone number as I. Please complete the bottom portion of this form and return to school. Thank you for your time.

Sincerely,

Ms. Amy DalPezzo

☐ My child has permission to be a participant in a study on mathematics journals conducted by Ms. DalPezzo

☐ My child does not have permission to be a participant in a study on mathematics journals conducted by Ms. DalPezzo.

_____	_____	_____
Child's Name	Parent/Guardian Signature	Date

Appendix D

Pre-Survey on Mathematics Journals

Directions: Circle a 1 through 5 for each statement depending on how you feel. Be honest.

1. I have used a math journal in previous school years.

Y N

Yes No

(If you answered yes, go to #2. If you answered no, skip #2.)

2. I liked writing in my math journal.

1	2	3	4	5
Strongly Agree	Agree	Don't Care	Disagree	Strongly Disagree

3. I like writing about my math work.

1	2	3	4	5
Strongly Agree	Agree	Don't Care	Disagree	Strongly Disagree

4. I think writing about my math work is easy.

1	2	3	4	5
Strongly Agree	Agree	Don't Care	Disagree	Strongly Disagree

5. I know how to write about my math work.

1	2	3	4	5
Strongly Agree	Agree	Don't Care	Disagree	Strongly Disagree

6. I think writing about my math work helps me understand math better.

1	2	3	4	5
Strongly Agree	Agree	Don't Care	Disagree	Strongly Disagree

7. Estimate how much time you spent in your math class last year writing about your math work (e.g. once a month, twice a week, etc…).

8. I like talking about my math work.

1	2	3	4	5
Strongly Agree	Agree	Don't Care	Disagree	Strongly Disagree

9. I think talking about my math work helps me understand math better.

1	2	3	4	5
Strongly Agree	Agree	Don't Care	Disagree	Strongly Disagree

Please share any other thoughts you have on the topic of math communication and math journals

Appendix E

Interview Questions

Name _____ Date of Interview _____

Tell me how have you liked or disliked writing in the math journals so far.

Explain if the journals have or have not helped you get better at math.

Do you like discussing the journals best with a partner, group, or whole class? Why?

Describe what could be done to make writing in the math journals better.

Please share anything else you would like to tell me about the math journals.

Appendix F

Post-Survey on Mathematics Journals

Directions: Circle a 1 through 5 for each statement depending on how you feel. Be honest.

1. I like writing about my math work better now.

1	2	3	4	5
Strongly Agree	Agree	Don't Care	Disagree	Strongly Disagree

2. I think writing about my math work is easier now.

1	2	3	4	5
Strongly Agree	Agree	Don't Care	Disagree	Strongly Disagree

3. I know how to write about my math work better now.

1	2	3	4	5
Strongly Agree	Agree	Don't Care	Disagree	Strongly Disagree

4. I think writing about my math work helps me understand math better now.

1	2	3	4	5
Strongly Agree	Agree	Don't Care	Disagree	Strongly Disagree

5. I like talking about my math work more now.

1	2	3	4	5
Strongly Agree	Agree	Don't Care	Disagree	Strongly Disagree

6. I think talking about my math work helps me understand math better now.

1	2	3	4	5
Strongly Agree	Agree	Don't Care	Disagree	Strongly Disagree

7. I like the topics and problems we wrote and talked about in class.

1	2	3	4	5
Strongly Agree	Agree	Don't Care	Disagree	Strongly Disagree

8. I spent enough time writing and talking about my math work.

1	2	3	4	5
Strongly Agree	Agree	Don't Care	Disagree	Strongly Disagree

9. I liked using my math journal to write about my math work.

1	2	3	4	5
Strongly Agree	Agree	Don't Care	Disagree	Strongly Disagree

Please share any other thoughts you have on the topic of math communication and journals.