

Using Math Journals to Encourage Students to Communicate their Understanding of Math Concepts

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Abstract: The purpose of this study was to enhance student understanding of math concepts, specifically number sense, through the use of math journals. The use of a math journal provided students with an effective tool to communicate their understanding of math concepts. We used student math journals to assess student learning during the intervention week. Students used the journals to help communicate their thinking to their peers. A series of five lessons were taught over a one week period.

We both have a background in teaching mathematics in K-5 grade levels, and have experienced teaching a variety of curricula and programs. The second author teaches at a Catholic School in Louisville, KY and would like to help students to effectively communicate their learning. The current math program uses worksheets to assess student understanding. The use of worksheets help students learn math but fail to encourage students to communicate their understanding of concepts. The worksheets are organized so that there is a right and wrong answer with no opportunity for students to verbally explain what's in their mind. Also, the worksheets do not encourage students to communicate their thinking with other students.

With the inspiration to improve student learning, we conducted a teacher action research for instructing mathematics to kindergarteners. One teaching strategy that we came across was the implementation of math journals. The implementation of math journals allowed us to follow the current math program as well as provide an effective way for students to communicate their understanding of math concepts. In this way, we used the math journals to supplement and/or replace the use of the worksheets. Thus, this study aimed to answer the following questions: What happens when we implement the use of student math journals during math class? In what ways does a math journal enhance student communication of understanding mathematical concepts?

According to the National Council of Teachers of Mathematics (NCTM), "Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge" (NCTM, 2013). This statement connects the NCTM with the ideas of the constructivist theory. The constructivist theory encompasses beliefs that learners "construct" their knowledge of a topic by experiencing and interpreting the world around them and by using their schema to build and make connections to new learning (D'Angelo, Touchman & Clark, 2012). Vygotsky viewed writing to be an important tool in helping the brain make connections from previously learned concepts with new information (Pugalee, 2004). His idea directly relates with the use of math journals in aiding the understanding of mathematics.

We introduced and implemented the use of math journals in the second author's kindergarten classroom. There were seventeen students who participated in the study over 5 lessons with two additional time periods for pre- and post- assessment. The hope was that the math journals would be a more effective way for students to communicate their understanding of math concepts and their learning to me as well as their peers. We planned to provide time for students to discuss and listen to each other's reasoning from their math journals.

Research Literature

National Council for Teaching Mathematics (NCTM) *Principles and Standards for School Mathematics* stresses the importance of students to be able to organize and communicate their mathematical thoughts (Goldsby & Cozza, 2002). “A journal is an ongoing record that people use to record their thoughts, occurrences, experiences, and observations. The use of journals in math classes provides students a tool to record their personal learning” (Kostos & Shin, 2010). There are many uses for implementing the use of math journals in a math class including recording daily notes and math problems; as an end of class resource where students explain what was learned and things they may still have questions about; and to answer or demonstrate a specific problem or reflection of a math topic (Burns & Silby, 2001). In this study, math journals were used to collect student writing that demonstrated student’s thinking about mathematical concepts. The goal was for students to effectively communicate their understanding of math concepts. Mathematical journaling encourages the development of student thinking and ability to communicate mathematical ideas (Kostos & Shin, 2010).

Math journals provided a way for students to construct, reflect, and document their thinking about math concepts. The constructivist theory promotes a learning environment in which teachers encourage student construction of knowledge rather than the teacher telling students the answers (Schunk, 2008). Kroll and Black (1993) explain:

Self-regulation is an additional component of the knowledge-construction process. In constructing knowledge, children modify their understandings as their theories and predictions are challenged by external events... [S]tudents should be provided with instruction and support in self-evaluation, with opportunities to reflect on the result of their individual actions... (p.424)

Math journals provided a resource for students to review prior thinking and build on or reconstruct their prior knowledge. As students’ thinking is challenged by newly learned concepts, they can use the math journal to reflect on their new learning. Math journals provide the student with a way of explaining their thinking. “Students metacognitive reflections on the learning process, that is, thinking about their thinking, can increase understanding” (Goldsby & Cozza, 2002, p.519).

Math journals also allowed for the teacher to understand student thinking and assess each students’ progress in understanding a topic (Burns & Silby, 2001). Student feedback, by use of math journals, can help to structure a teacher’s lesson planning by identifying the understandings or misunderstanding of student learning. Goldsby and Cozza (2002) state that “Student feedback can offer indications for changing, refining, and enhancing the instruction to provide more appropriate evaluation of, and remediation for, individual students” (p. 519).

There has been a significant amount of research on writing to learn, writing in math class, and the use of math journals. One study conducted by Pugalee (2004) compared the use of verbal and written understanding of mathematical problem solving. The study determined that the use of think-alouds and mathematical writing were both successful in students demonstrating metacognitive mathematical problem solving. The study concluded that writing is a more effective tool for supporting metacognitive mathematical problem solving than think-alouds.

In a second study, Kostos and Shin (2010) determined if the use of math journals as a form of assessment would better demonstrate student understanding of math concepts as opposed to tests in which a correct answer can be formulated without fully understanding the topic.

The findings established that the use of math journals improved students mathematical thinking, increased student use of mathematical vocabulary, and improved assessment of student understanding of the concept. The study concluded that math journals allowed students to “demonstrate a deeper understanding of mathematical concepts” (p. 230). Math journals also provided the teacher with a better assessment of student understanding of math concepts.

One argument against the use of math journals is that the journal would not be an effective tool for students with learning disabilities or who have trouble writing. However, there have been studies conducted that support the use of math journals for a variety of student learning levels. A study conducted by Teresa Gardner (2011) examined the strategy of writing to demonstrate learning in mathematics as a teaching strategy to help students with disabilities. The findings suggested that when struggling students are paired with advanced students to share their journal writing after working independently first, struggling students were able to observe their peers strategies resulting in a “greater understanding and the development of more advanced strategies” (p. 48). The main conclusion was that more research is needed in the area of instructional needs for students with disabilities and math journals. Journal writing can help students to describe their thinking which allows teachers to see where misunderstandings may occur.

Another study conducted by Baxter, Monroe, and Woodward (2001) was designed to explore the effects of class wide instruction on performance assessment tasks in combination with problem-solving instruction through tutoring. The main assessment procedure was performance based with the guidance of socially mediated interactions. The approach is similar to using math journals because the tutors prompted the students to share and explain how they solved the math problems. This method was done in combination of small group interaction and individual tutoring sessions. The study determined that students in the learning disabilities group grew significantly more than average-achieving and at risk students. The learning disabled children in the “highest group” learned to explain their learning in a sophisticated manner. The learning disabled students in the “lowest group” continued to lack understanding. The study concluded that all students improved with problem solving instruction and through tutoring. However, the progress of the students showed varying abilities to understand the math concepts presented.

There has been a significant amount of research supporting the use of journals in math classes (Carter, 2009). The use of math journals is supported by the constructivist learning theory. The research suggests that math journals are an excellent way for students to demonstrate their understanding. Research also supports the success of the use of math journals for teachers to assess and understand student thinking. The use of math journals is effective for students in enhancing their learning as well as providing an authentic assessment in which teachers can identify what students understand and in what areas students need more instruction.

Research Design

The purpose of this intervention was to enhance student understanding of math concepts, specifically number sense, through the use of math journals. The use of a math journal provided students with an effective tool to communicate their understanding of math concepts. We used student math journals to assess student learning during the intervention week. Students used the journals to help communicate their thinking to their peers. A series of five lessons were taught over a one week period. Additional two days were used for a pre and post assessment, making the total time of the intervention seven math class periods. The intervention participants consisted of seventeen kindergarten students. The kindergarten students’ role in the intervention

was to: listen and participate during the math lessons; record their understanding of the math concepts taught; and to share their thinking with a partner. The intervention was conducted by the second author with the help of a teaching assistant. The instructors read the student journals daily to formatively assess student understanding.

The use of math journals aligns with the Kentucky Common State Standards (KCSS) in the areas of math, communication, and writing. Math standards were achieved in the area of counting and cardinality. The math concepts taught during the intervention included: as many as, equal to, ten-frames, more, fewer, and comparing groups. These math concepts align with the KCSS kindergarten standards of knowing number names and the count sequence, count to tell the number of objects, and comparing numbers. Students wrote for a purpose using words, numbers, and drawings which aligns with the KCSS writing standards. Students explained their thinking to a peer which aligns with speaking and listening standards.

The goal of this intervention was for students to demonstrate an understanding of the math concepts taught during the intervention lessons by communicating their thinking in writing and verbally. Prior to the intervention, students were pre-assessed on their knowledge of content including: as many as, equal to, ten-frames, more, fewer, and comparing numbers. During the intervention, students were formatively assessed on their understanding of the content knowledge by their journal entries and observations of their communication describing their thinking. These two variables were assessed through a daily rubric as shown below (Figure 1). After the intervention lessons, students completed a post-test assessing the same content knowledge that was pre-assessed.




	 Completion	 Show Thinking	Explain 
☺ (2 points)	I completed the task.	I used pictures, numbers and/or words to show my thinking.	I was able to explain my thinking to a partner.
☹ (1 points)	I completed most of the task.	I tried to use pictures, numbers and/or words to show my thinking.	I needed help explaining my thinking to a partner.
⊗ (0 points)	I did not complete the task.	I did not use pictures, numbers, or words to show my thinking.	I was not able to explain my thinking to a partner.

Figure 1. Assessment Rubric for Intervention

The intervention plan was conducted during math class over a five day period. Table 1 illustrates each lesson focusing on a pre-assessed math concept. Day one’s lesson topic was “as many as” and “equal to.” Day two’s lesson topic was ten-frames. Day three’s lesson topic was the concept

of “more.” Day four’s lesson topic focused on the concept of “fewer.” Day five’s lesson topic was “comparing groups” using the terms “equal to,” “more,” and “fewer.” Each day, students were required to complete a journal entry pertaining to the day’s topic. After writing in their journals each day, students shared their mathematical thinking to a partner. The authors observed and documented our observations of student sharing ideas with each other using the rubric mentioned above. The authors checked each student’s journal entries for understanding every day. Then the authors gave feedback to each student by completing the rubric. The information gathered from the journal helped us to work one on one with any students who were still not able to understand the concepts presented.

Table 1

Overview of 5-Day Lessons

Day	Topics	Assessment
1	As many as; equal to	Each day: <ul style="list-style-type: none"> students were required to complete a journal entry, students shared their mathematical thinking to a partner. Teachers: <ul style="list-style-type: none"> observed and documented observations of students sharing ideas with each other, checked each student’s journal entries for understanding, gave feedback to each student by completing the rubric, and worked one on one with students who were still not able to understand the concepts presented.
2	Ten-frames	
3	More	
4	Fewer	
5	Comparing groups	

Day one’s lesson began with a SMARTBoard lesson designed to introduce the topic of “as many as” and “equal to.” Following the introduction,, students played a SMARTBoard game on moreStarfall.com comparing two sets with “equal to” or “not equal.” After the game, students were guided to use manipulatives to compare sets of objects. Next, the authors introduced the math journals and rubric. We used the document camera to read, explain, and model lesson one’s journal entry. We modeled the expected behaviors of the rubric including the journal entry and how to explain one’s thinking. Students then independently demonstrated understanding of one-to-one correspondence by answering the following journal prompt, “Count the objects in your cup. Make another set with an equal number of objects. Record.” After students wrote in their math journal, they shared their work with a partner using the terms taught in the day’s lesson. When students were finished sharing, we asked students to explain “equal to” and “as

many as.” Finally, we previewed the next day’s lesson by explaining to students that on the next day we would be learning about something called ten-frames.

On day two, our lesson began with a short review of the concepts learned on day one. We introduced ten-frames using manipulatives, ten-frames, the document camera and SMARTBoard. Students were given the opportunity to use ten-frames and counters. Students were verbally told various numbers from 0-10 to show on their ten-frames. After practicing together, we used the document camera to read, explain, and model lesson two’s journal entry. We reviewed the expectations on the rubric. Students then independently demonstrated understanding of ten-frames by answering the following journal prompt, “Roll a die. Put counters on a ten-frame to equal the number you rolled. Record and repeat.” After students had the opportunity to create and record a few numbers on the ten-frames in their math journal, they shared their work with a partner using the terms taught in the day’s lesson. The next day lesson was previewed to students by mentioning that tomorrow we would be learning about the concept of “more.”

On day three, the lesson began with a brief review of “as many as,” “equal to,” and ten-frames. We explained to students that we would be learning about the concept of “more.” To introduce this concept, I read *The Very Hungry Caterpillar* by Eric Carle (1987). We projected the book onto the SMARTBoard using the document camera. While reading, each time the caterpillar “was still hungry,” we would point out that he wanted “more” to eat. Then, we used groups of objects from around the room to compare which group had more. For example, we counted the number of boy and the number of girls in our class to determine which group had more. After comparing sets, we read, explained, and modeled a similar question to the day’s journal entry. Day three’s journal prompt was, “The number of counters on my ten-frame is more than 4. What might my ten-frame look like?” In order to keep students from completing the task exactly like my demonstration, we choose to alter my base number to show possibilities for more than 8. We used the teacher’s journal to model how to earn all smiles on the rubric. Students independently demonstrated their understanding of more by completing the journal prompt. Students then shared their work with their partner using the terms taught in the day’s lesson. When students were finished sharing, we reminded students that today, we learned about “more” and that tomorrow, we would learn about “fewer.”

On day four, the lesson began with a brief review of “as many as,” “equal to,” ten-frames, and “more.” We explained to students that we would be learning about the concept of “fewer.” To introduce this concept, we viewed, sang, and did motions to “Five Little Monkeys” on *YouTube* (<http://www.youtube.com/watch?v=PUPxmO9Eyug>). The song was projected onto the SMARTBoard. While viewing, singing, and completing the song motions, we would pause the recording after each monkey was “snapped” by the alligator. We would explain that now we had fewer monkeys. Then, we used groups of objects from around the room to compare which group had fewer. For example, we counted the number of student chairs and the number of teacher chairs to determine which group had fewer. After comparing sets, the instructors read, explained, and modeled a similar question to the day’s journal entry. Day four’s journal prompt was, “The number of counters on my ten-frame is fewer than 6. What might my ten-frame look like?” In order to keep students from completing the task exactly like our demonstration, we chose to alter my base number to show possibilities for less than 2. We reviewed the rubric and used it to verbally check our work. Students independently demonstrated their understanding of “fewer” by completing the journal prompt. Students then shared their work with their partner using the terms taught in the day’s lesson. When students were finished sharing, we reminded students that today we learned about “fewer,” and that tomorrow we would learn about “comparing groups.”

On day five, the lesson began with a brief review of “as many as,” “equal to,” ten-frames, “more” and “fewer.” The teachers explained to students that we would be using what we know about “equal to,” “more,” and “fewer” to compare sets of objects. To introduce this concept, we viewed “Comparing Numbers” from Brainpop Jr. (<http://www.brainpopjr.com/math/numbersense/comparingnumbers/>) on the SMARTBoard.

After viewing the video, we completed the easy quiz as a class. The instructors read the questions and answers as students did a sign language “yes” or “no” for each multiple choice question. Next, students participated in a game that compared sets of objects on the website moreStarfall.com. After applying our knowledge comparing sets through the interactive game, the instructors read, explained, and modeled how to complete the day’s journal entry. Day five’s journal prompt was, “Take a scoop of red cubes and a scoop of green cubes. Count how many in each group. Is the red group more than, fewer than, or equal to the green group? Record.” We then reviewed the rubric and used it to verbally check my work. Students independently demonstrated their understanding of “equal to,” “more,” and “fewer” by completing the journal prompt. Students then shared their work with their partner using the terms reviewed in the day’s lesson. When students were finished sharing, we reminded students that today we learned about comparing numbers, and that next week we would take our assessment.

Three types of formative assessments were used in our intervention. The first formative assessment was the pre-test that assessed student’s prior knowledge of the concepts “as many as,” “equal to,” “ten-frames,” “more,” fewer,” and the task of comparing groups. Students were assessed on their journal entries as well as their ability to share their mathematical thinking with their peers. These data collection methods required observation as well as reviewing each student’s journal daily. The criteria assessed were presented on the rubric. The observations and student journals served as a way to help “catch” student misunderstandings. Students who did not seem to grasp the concepts were pulled by my teaching assistant for review and also were presented with the information in a different way. The summative assessment was the post-test that assessed student’s understanding of the concepts “as many as,” “equal to,” “ten-frames,” “more,” fewer,” and the task of comparing groups.

Results

The purpose of our research project was to discover what would happen when we implemented the use of math journals during math class. We also wanted to know if the math journal would be an effective way for students to enhance their communication of understanding mathematical concepts. In order to conduct my research, we needed to introduce math journals to our class. Prior to modeling each journal entry, we provided the class with an interactive mini-lesson to introduce each day’s topic. We modeled how to complete the math journal entries daily. We also modeled how to effectively communicate the thinking involved in completing the math journal entries. Each day, the rubric was reviewed and explained. After each day’s mini-lesson, hand-on task, and teacher modeling, we provided students with time to complete their own journal entries and share with a partner.

The first data that we collected was a pre-test. The pre-test assessed students on their prior knowledge of math concepts including: “as many as,” “equal to,” “ten-frames,” “more,” “fewer,” and comparing numbers. During the research, we documented student progress through observations, rubrics, and daily journal entries. The final documentation was the post-test that assessed the same concepts assessed on the pre-test.

The preliminary impression was that we were thrilled with the use of math journals because we were able to detect student misunderstandings at a much deeper level than the worksheets that accompany the existing math program. From this data, we were able to work individually with a few students who did not understand the concepts. We find it very insightful listening to students while communicating their thinking to their peers.

Students were thrilled to be given their own personal math journals. Their enthusiasm, participation, and interest remained high through the intervention. Students were often disappointed that we were only going to complete one journal entry per day. Students expressed their appreciation and enthusiasm for the interactive journal tasks over their previous worksheets.

One measure used during the intervention was the daily rubric score. Students were assessed on completing the task, showing their thinking, and by their explanation of their thinking to another student. On days one through four, all students completed the journal task. One student completed half of the task on day five. We contributed this to the fact that day five's journal entry required students to complete the given task two different times. The student only completed half of the required assignment. On all five days of the intervention, all students were successful in using pictures, numbers and/or words to show their thinking. Student's ability to explain their thinking to others increased during the intervention. Students were gaining confidence and learning to communicate their thinking as the intervention ensued. Student results from the daily journal rubrics can be seen in Figure 2 below.

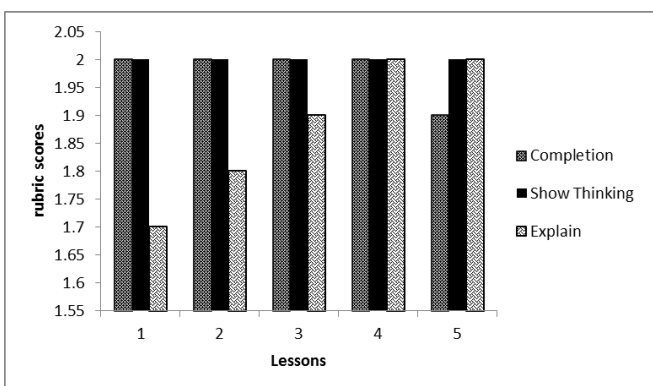


Figure 2. Daily Journal Rubric Results

The use of student journals as a daily summative assessment was very successful. Students were assessed on completion of the task, use of symbols, words, and/or numbers to explain their thinking, and student ability to share their thinking with a partner. Since students were not assessed on the correctness of their responses, they felt comfortable trying without being overly concerned about getting the correct answer. The use of the math journals helped us to see where students had misconceptions. This helped us to work with students who did not understand concepts, which led to more students understanding the concepts. The journal tasks were much more useful in understanding the areas students needed to work on as opposed to my prior use of worksheets. During the intervention, we saw a gradual increase of student understanding of math concepts. Although we saw this increase in understanding, we noticed that some students did not complete day five's journal entry correctly. We feel that this is due to the two part problem posed as well as the fact that this task required students to synthesize the information that was

taught during the week. This task seemed more difficult for some students than the other journal entries. The accuracy of student journal entries is shown in Figure 3.

Student/Day	Day 1	Day 2	Day 3	Day 4	Day 5	Entries w/ Correct Answer
Student 1	✓	✓	✓	✓	✓	5/5
Student 2	✓	✓	✓	✓	✓	5/5
Student 3	✗	✓	✓	✓	✓	4/5
Student 4	✓	✓	✗	✓	✓	4/5
Student 5	✗	✗	✓	✓	✗	2/5
Student 6	✓	✓	✓	✓	✓	5/5
Student 7	✓	✗	✓	✓	✓	4/5
Student 8	✗	✓	✓	✓	✗	3/5
Student 9	✓	✗	✓	✓	✓	4/5
Student 10	✓	✓	✓	✓	✗	4/5
Student 11	✓	✓	✗	✓	✓	4/5
Student 12	✗	✓	✓	✓	✗	3/5
Student 13	✓	✓	✓	✓	✓	5/5
Student 14	✓	✓	✓	✓	✓	5/5
Student 15	✓	✓	✓	✓	✓	5/5

Student 16	✘	✓	✓	✓	✘	3/5
Student 17	✘	✘	✘	✓	✓	2/5
# correct per day	11/17	13/17	14/17	17/17	12/17	67/85
% correct per day	65%	76%	82%	100%	71%	79%

Figure 3. Journal Entry Accuracy

✓ = Journal Entry was completed with the correct answer

✘ = Journal Entry was completed with an incorrect answer

All students made a significant gain in their content knowledge as shown by the pre and post-test measures. The use of journals as well as students communicating their thinking impacted student success on understanding the math concepts presented during the intervention. Many students were able to master the topics assessed by the pre and post-tests. Figure 3 shows the data in each student’s progress in chart form. Figure 4 illustrates the data of each student’s progress in bar graph form.

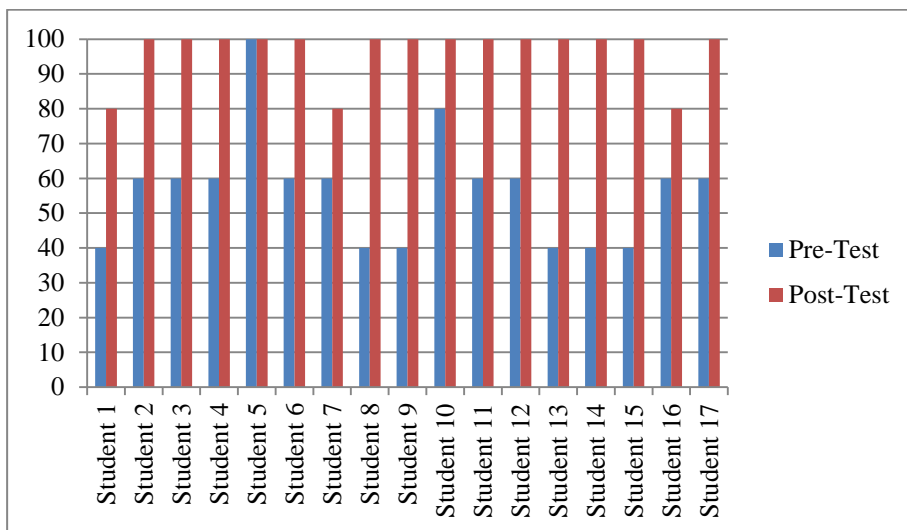


Figure 4. Student Pre and Post- Assessment Percentages Chart

The research demonstrated the use of student math journals increased student understanding of the topics. Student math journals increased our awareness of student misconceptions, allowing us to help work independently with them and increase student understanding. Compared to last year's teaching approach and student learning output, students understood the math concepts better when they verbalized their thinking and listened to a peer share their thoughts. In the previous school year, the math instruction was the traditional routine of lecture, practice and drill method. There was no opportunity for students to verbalize their understanding of math. The assessment was simply to cross check the students' response and quantify correct answers for grading .

Reflection of Study and Action Plan

We began this research project in response to the analysis of current teaching practices and their effectiveness on student learning. We felt that there was a significant problem with the use of worksheets to assess student knowledge of mathematical content. With this analysis, we also realized that we were not remaining true to my philosophy that students should be able to communicate their learning in written and verbal form. These concerns lead us to look into ways that we could assess student learning as well as provide a tool that students could use to communicate their thinking with others. As we conducted research on ways to improve our current teaching practices, we were guided to the strategy of math journals.

There is a significant amount of research supporting the use of writing in mathematics. The National Council of Teachers of Mathematics (NCTM), a trusted and valued organization for teachers, highly supports the use of math journals. The NCTM supports the use of math journals as a form of teacher assessment as well as a tool for students to communicate their thinking. The NCTM's *Curriculum and Evaluation Standards* (1989) state, "The assessment of students' ability to communicate mathematics should provide evidence that they can express mathematical ideas by speaking, writing, demonstrating and depicting them visually" (p. 214). We used this research to support the implementation of math journals as a formative assessment of student learning. This research also helped us to create the journal assessment rubric that included evaluating student's ability to complete the given task; show their thinking through the use of pictures, numbers and/or words; and share their thinking with a peer. Furthermore, we used the National Council of Teachers of Mathematics (NCTM) idea that "Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge" to pre-assess students prior knowledge and to design and implement lessons in which students would experience new learning and expand on their prior knowledge.

The NCTM provided us with a significant amount of research to defend the use of journals in mathematics. The research within the NCTM also led me to a theoretical framework that supported the use of math journals to solve our dilemma. We used the constructivist theory to design journal tasks that would help students construct their mathematical knowledge (D'Angelo, Touchman & Clark, 2012). The principles of the constructivist theory influenced our decision to model to students how to complete and show thinking for the journal entry each day. We used Vygotsky's (as cited in Pugalee, 2004) idea that writing is an important tool in helping the brain make connections from previously learned concepts with new information to decide on the tool of journals to improve student learning.

To enhance our instructional design, we used peer-reviewed studies that conducted research on the effectiveness of the use of math journals. We used Goldsby and Cozza's (2002) idea that student feedback can help to structure a teacher's lesson planning by identifying the

understandings or misunderstanding of student learning in order to create the next steps in my planning as well as to effectively support students who were not grasping the concepts. We used Kostos and Shin's (2010) research to support the use of the math journal as an effective formative assessment.

There are many aspects of the intervention that influenced the results. One component that positively impacted student learning was the thorough explaining and modeling of the topics and expectations. Another component of the instruction plan that improved student learning was when students constructed their knowledge through use of manipulative and journal entries rather than the teacher telling students the answers (Schunk, 2008). Student learning was also positively impacted due to the lessons being interactive and engaging through the use of manipulatives and technology. Learning was slightly hindered at the beginning of the intervention due to shy students not feeling confident about sharing their mathematical thinking. Learning was also impacted by the fact that students had never worked on a math journal before. Some students needed time and practice to figure out how to be successful in completing the journal tasks.

Students achieved a variety of learning outcomes during the intervention. Kostos and Shin's (2010) idea that the use of math journals improves students mathematical thinking, increases student use of mathematical vocabulary, and improves assessment of student understanding of the concepts was evident during the research. Students grew in their ability to organize and communicate their mathematical thoughts (Goldsby & Cozza, 2002). There was an increase in student understanding of the math concepts presented during the intervention.

The results from the post-test indicated that 82% or fourteen out of seventeen students were able to correctly answer all questions. This leads to the determination that 82% of the class mastered the content. Because these students understand the content, we plan to extend their learning by having them design their own journal prompts for a peer to complete. The journal prompts created will require students to use correct terminology and will need the teacher's approval before the prompt will be given to another student. Students will then switch with a partner and complete a peer's journal prompt. These students can also help their peers who are struggling.

The post-test data determined that 18% or three out of seventeen students partially mastered the learning objectives. Next steps for these students include re-teaching, small group instruction, and peer tutoring. According to the post-test, there are no students who did not master the learning objects. Per our observations, we believe that this is due to the fact that the teaching assistant and we noted misunderstandings through observations and other formative assessments such as journal entries. With this knowledge, we immediately intervened to help the student. The steps that we used to ensure that students would be successful are the same steps that we would use if the data showed that there were students who were not able to master the content. These steps include but are not limited to pre-assessment, frequent checks for understanding, re-teaching, peer tutoring, small group instruction, student practice, and presenting the information in a different way.

The overall implementation of the intervention was successful. We videotaped a portion of day five's lesson. The video was approximately 25 minutes and included the teachers demonstrating the journal entry as well as students completing and sharing their journals. The video allowed us to reflect on any area on which we need to improve. We need to help students to be more comfortable with explaining their mathematical thinking. We think that as we continue to practice and model this skill, then it will be more natural for our students as well. Reviewing

the video helped us to recognize how we incorporated the principle of “teaching for all children.” We modeled appropriate completion of the journal. We demonstrated to student how to share their thinking. We included picture clues on the rubric. We used technology to increase student engagement. We provided extra assistance such as modeling, prompting, and cuing for those students who needed it. We included the use of tangible manipulatives to enhance student understanding.

As we continue to teach math, we will include the same approach to performance learning. Although we only implemented a short 5-day lesson, which is a major limitation of the study, the impact to student learning and to use as teachers is profound and long-term. We are inspired by the positive results of the intervention that we plan to continue the use of math journals this year. We also plan to replace the use of worksheets completely next year and implement journals instead. In the future we would like students to self-assess using the journal rubric. We would also like to provide journal entry choices for some of the math topics covered.

During the intervention we collaborated with other professionals to ensure that our design and research supported student learning. We collaborated with the school’s kindergarten team. We explained the research project and the literature supporting the use of math journals. We shared my journal prompts, lesson plans, and other tools used to implement the lessons with the team. We also collaborated with colleagues in the Graduate Studies Program to ensure a successful study. We, together with our colleagues, have noticed a trend in classrooms that are becoming dominated by testing with less focus on teaching the whole child. We all agree that while testing is important, student engagement is what truly increases achievement. Collaborating with our colleagues reinforced the research design to include interactive lessons, opportunities for students to share their thinking with peers, and create a learning climate that encourages students to create their own learning through teacher assistance.

Recommendations for future implementation

First we would like to use the role of the second author as the K-2 Levels Coordinator to explain the research project and the results during one of the faculty-levels meetings. Additionally, we want to explain and train other teachers to show the significant impact that the journals made in understanding students comprehension of the math topics. At the trainings and workshops, we will inform and explain how the journal entries provided an excellent opportunity for students to discuss and communicate their learning thus enhancing their mathematical understanding. We will explain the interactive nature of the math journals. We plan to propose the use of K-2 math journals as an extension or as a replacement to the current math program.

In the future, we plan to confront issues of diversity that affect teaching and student learning with a variety of best practice strategies. We will pre-teach vocabulary for struggling and ELL students. We plan to continue to model assignments and expectations for all learners. We will use the strategies of preferential seating and proximity to strengthen students focus on learning. We will continue to use picture clues, visuals, and manipulatives to enhance student participation and learning. We will continue to be mindful and incorporate Gardner’s multiple intelligences in all lessons. We plan to continue the use of pre-assessments in order to identify prior knowledge of topics. We will continue to help students make connections about what we are learning to real world examples to provide significance to our learning. We will provide choices for journal entries to enhance differentiation. We will continue to attend professional development opportunities and collaborate with peers in order to continue to be an effective teacher.

The use of student math journals as formative assessment is a very helpful tool. Students are able to complete their work without the threat of being wrong. The instructor is able to use the results to see specifically where student misunderstandings of a topic occur. The use of math journals also proves to be a successful tool in enhancing student communication about their thinking with one another.

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