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Bringing Math to Life: Provide Students Opportunities to Connect their Lives to Math

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Abstract

Math journals provide students with opportunities to articulate their understanding of math concepts and/or their frustrations with the gaps in those understandings. The use of these journals supports metacognitive thinking to enhance understanding and application. This study examined the use of math journals by fourth grade students as a conduit for critical thinking, reflection, and real-world math application. For this study, student journal entries consisted of identification of a real-life event, narrative of both the problem's description as well as the rationale for choosing the problem, the use of a problem-solving strategy learned during class instruction, and the use of a numeric or pictorial model to arrive at the solution. Upon completion, students shared his/her journal entry with the entire class. Through this research, I witnessed evidence of growth in mathematical understanding and computation, and I saw students make a deeper connection to math's many real-life applications in their own lives.

Introduction

There exists mathematical walls built not with computation, but with ideals and stereotypes that evoke unnecessary fear and despair to find a solution. For some people, and I purposefully say, "people" as opposed to "student", the mere mention of mathematics or its application immediately sends panic or stress signals radiating through their body. One student, for example, in expressing her dislike for math stated, "Yah, my mom says she never liked math either." As an elementary educator, I'm constantly at battle with breaking down those walls, albeit ones created by the student himself or those passed onto the student by others. How can educators work against these emotions, fears and stigmas with math? How can we teach students to tackle without fear the puzzle math presents and to celebrate with exuberance, fortitude, and gratification the journey toward its successful solution? I have taught several grade levels, and I strongly believe that *real-life connections* to math and *time for student reflection* on the journey

are key to encouraging a more positive outlook toward mathematics. According to data from the Program for International Student Assessment (PISA), stemming from 63 of 64 countries that took part in its 2012 assessment, students who reported higher levels of math anxiety correlated to lower levels of performance than peers who stated lower levels of math anxiety. (Foley, Herts, Borgonovi, Guerriero, Levine & Beilock, 2017). Real-life connections provide a deeper understanding to the purpose of math concepts and skills. Student reflection, through discussion and writing, provides students an opportunity for a more detailed construction of their understanding as well as a moment to express emotions that are linked to a celebration and/or frustration with their current position in the journey of concept mastery. In his paper, *The Transition from Arithmetic to Algebra*, Richard Lodholz (1990) connects the central importance of understanding mathematical concepts to student presentation of information orally or through writing. He goes on to say that having students create their own problems when given proper parameters and/or specific criteria assists students in understanding the process.

Review of Literature

In Karen Scales'(2000) study of using math journals in a third and fourth grade classroom, she conveyed that positive outcomes from journal submissions included the benefit of witnessing a student's understanding of the mathematical concepts being taught, their attitudes toward the concept and their reflection or self-assessment of their learning. While some might still conceive of the notion of integrating math and writing as an awkward partnering, the National Council of Teachers of Mathematics (NCTM) has advocated for its complimenting nature since 1989. NCTM identified mathematical communication as a targeted goal for students. (Wilcox & Monroe, 2011) "Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge." (NCTM, 2019) They must be able to organize and communicate their mathematical thoughts, constructing knowledge

by interpreting their understanding and making connections to prior knowledge and real-world experiences. Pugalee (2004) compared the use of verbal and written understanding of mathematical problem-solving and found that writing is a more effective tool for supporting metacognitive mathematical problem-solving. Through writing, a self-awareness can emerge or deepen as was shown in the study by Kostos and Shin. (2010). In their study of math journals usage with second grade students, they determined the use of math journals increased mathematical thinking, increased student use of mathematical vocabulary, and improved assessment of students' understanding of the concept. An appropriate grade benchmark for integrating writing into mathematics does not appear to be a hurdle as evidenced by a study with Kindergarten students. Over a week's time, these students incorporated math journals for five math intervention lessons. In this study performed by Camahalan and Young (2015), "all students made a significant gain in their content knowledge as shown by the pre and post-test measures" (p. 47).

Introducing writing to math curriculum can take a variety of forms. In the article, *Integrating Writing and Mathematics*, Wilcox and Monroe (2011) explore two different approaches, or levels, to the integration of writing and mathematics: writing with revision and writing without revision. These two levels are further reduced to six different strategies: learning logs, think-write-share, note-taking/note-making, shared writing, class books and alphabet books. In my research design, I used a combination of these approaches and I followed an action research methodology to guide my practices. An action research model was a good fit for my research design because the procedural structure aligns with the implementation of math journals as a new form of action in my instruction with the goal of producing both real-life math connections for my students and for providing reflective opportunities to detail growth and

struggles. Susman and Evered (1978) view action research as a cyclic process with five phases: *Diagnosing, Action Planning, Taking Action, Evaluating* and *Specifying Learning*.

The action research model is also exemplified by my students through their own use of the problem-solving model outlined later in Table 2. In essence, both my students and I were diagnosing a problem, planning, taking action, and evaluating whether or not the outcome produced meaningful results.

Purpose of the Study

Based on benchmarking scores from several standardized tests administered at my elementary school in the rural Midwest, many students struggle with Mathematics. From basic mathematical rigor such as multiplication facts to mathematical language acquisition to the application of math strategies for real world problem solving, students need instruction and opportunities to deepen their understanding and share their concerns for mastering these areas. This year, our school is implementing a school-wide goal to improve our math instruction and commitment to mathematical literacy.

The purpose of this study is to evaluate students' understanding of math concepts and their real-world application through the use of math journals. It also seeks to reveal narratives detailing successes and productive struggles as identified by students via their own writing. Additionally, this action research seeks to inform teacher best practices in the classroom. The three research questions included:

Are students successful in relating mathematical concepts to real-world experiences?

Can students reduce math anxiety levels through the use of writing in math journals?

How does the use of math journals in the classroom impact the change in best practices within the classroom?

Math instruction and literacy are intertwined and as such students should feel empowered by deepening their understanding and/or detailing their concerns with math concepts through the use of written expression in journals. Additionally, students should have opportunities to create real-world problems connecting their learning to an authentic experience. Albert and Anots (2000) allowed students the opportunity to take home a math journal and provide an example of using math in their daily lives outside of the school environment. Students' examples included monetary costs from a trip to McDonald's, recipes for cooking, and costs at a sale. The mathematical practices of the Common Core Standards (2018) state that students should make sense of problems and persevere in solving them. Math journals support this standard in providing students opportunities to work through their understandings and frustrations. As educators, we strive to continuously evolve instructional practices to meet the 21st Century needs of students, multidisciplinary opportunities such as this one also support authentic learning experiences. (Lombardi, 2007). In carrying out this research, I provided my students with key design elements found in authentic learning experiences as outlined by Lombardi's (2007) overview of *Authentic Learning in the 21st Century*, which includes the criteria of Real-World Relevance, Reflection, Collaboration, Interdisciplinary Perspective and Multiple Interpretations and Outcomes. (p. 3) She advocates for real-world problem solving while immersing students in the active engagement of learning. In this overview, she brilliantly outlines what defines authentic learning, why is it so critical to education and the successes it yields. I am committed to providing my students with authentic learning experiences that connect to their lives and the world around them.

Methodology

In following the action research design model referenced earlier, I began by *diagnosing* the problem: lower math anxiety through reflective writing and provide opportunities for math concept practice through real-life scenarios meaningful to students. Next, I moved to *action planning*. I brainstormed ways to engage my students in best practices that would address these focal areas. I chose a variation of learning logs that I'll refer to as Student Math Journals, which students use in the classroom for detailing new concepts, models, and reflections. Additionally, I used two whole Class Shared Math Journals which focused on the creation of real-world math problems pertaining to current math skills being taught. One last reference to journaling was born from a personal conference where parents of a student shared the emotional and mental frustration over math homework being exhibited by their student at home. I suggested the use of a shared journal between the student and myself to be used during moments of hardship and frustration. The student could detail frustrations, confusion, or questions regarding the homework and return the journal to me with each assignment. As a last component of this study, I administered a Pre- and Post- Math Self Efficacy Survey (*Table 1: Math Self-Efficacy Survey*) to gather personal data about student perceptions of their own confidence and feelings regarding math instruction.

Table 1: Math Self-Efficacy Survey

1. How do you feel about Math?
    a. Strong/confident
    b. Good
    c. Struggle sometimes
    d. Not Good
2. What don't you like about Math?
3. Does writing about Math you understand it better?
    a. Yes
    b. No

c. Maybe

4. Do you use Math outside of School?
5. If so, when?
6. Would you call yourself a Mathematician?
7. What advice would you give others that struggle with math?

Student Math Journals

At the start of our 2018 school year, I provided students with a composition notebook for math writing purposes. Thirteen students received notebooks. One student who requires one to one assistance with math is not present during my math instruction but instead works with our intervention teacher. This student is not a part of the research to follow. From late August to the present, students use these journals to detail math concepts, copy examples, create new models, list math vocabulary, and reflect upon learning. Consistently, I convey to students that these journals are a math book of their own creation providing knowledge, examples and references similar to a real textbook. Students can refer to their journal to review concepts covered. Additionally, these journals serve as an outlet to celebrations and frustrations experienced on our math journey. From an educator standpoint, these journals provide me with a glimpse into the personal feelings of each student as they share their thoughts and emotions about different mathematical concepts. It also provides me with authentic work samples illustrating mastery and/or areas for growth. Within these journals, I respond to student reflections but not with a scheduled consistency. These student journals provide anecdotal additions to my research.

Shared Class Math Journals

The heart of my research took place from the (2) Shared Class Math Journals that students alternated taking home. Each of the 13 students in my fourth grade class, had (2)

opportunities to create real-life connections to the math concepts being practiced in class. Each of the two class journals included a check off list of criteria to consider.

Table 2. Student Check-Off List of Criteria to Include in Journal Entry.

- ❑ Identify a Real-Life Event
  - ❑ Review other journal entries written by your peers, before writing your entry.
  - ❑ Think of a real-life event
  - ❑ Think about the mathematics needed to solve the problem
  - ❑ Ask yourself, "Do I understand what I am trying to find out? Does the event model how I will use mathematics?"
- ❑ Use our Classroom Problem-Solving Strategy
  - ❑ 1. Understand the problem.
  - ❑ 2. Devise a plan to solve the problem.
    - ❑ Use charts, graphs, pictures and diagrams when necessary
  - ❑ 3. Implement a plan. Try your strategy. Solve
  - ❑ 4. Reflect on the problem and check if your answer is reasonable.
- ❑ Show Off Your Journal Skills
  - ❑ Using complete sentences, describe your real-life event and the strategy that you used to solve the problem.
  - ❑ Tell what worked and what didn't work, if applicable.
  - ❑ Share information about who helped you solve your problem.
- ❑ Share the Journal Entry with the Class
  - ❑ Review your entry carefully to make sure that you understand what you have written before sharing it with the class.
  - ❑ When sharing your entry with the class, be prepared to accept from your peers suggestions regarding other possible strategies.

Within the checklist is the following schema for problem-solving. This schema provided an opportunity for my students to engage in action research as well. These four steps, while still profoundly relevant, date back to 1957 in Polya's book, *How to Solve It*:

1. Understand the problem.

2. Devise a plan to solve the problem.

3. Implement a plan. Try your strategy. Solve.

4. Reflect on the problem and check if your answer is reasonable.

Another component of the journals provided by me were several multiplication strategy examples for students and parents to reference for assistance while creating these problems at home. Since this research entailed a *school to home to real-life connection*, I did not want families to feel frustrated with the strategy their child was attempting to use to solve a problem. Per emails and conference conversations, parents share that they are often inexperienced with some problem-solving strategies now covered in Common Core curriculum. In some cases, this inexperience leads to frustration and helplessness in truly wanting to support their child's mathematical academic success. The examples provided in the journal were intended to ease those frustrations. They included:

Algebra: Multiplication Comparisons using a Model

Multiply Using the Distributive Property

Multiply Using Expanded Form

Multiply Using Partial Products

Multiply 2-Digit Numbers with Regrouping

Finally, I provided a journal entry example written using the checklist as a guide of expectations of format. For the taking action step of my action research, each day, over the course of approximately one month, two different students took home one of the two Shared Class Math Journals. The following day, they returned with their entry and shared them under the document camera with the class. A brief class discussion followed where students could evaluate the problem. For accuracy in coding the results of this research, I did not have students make suggested corrections, but those corrections were discussed.

The *Evaluating* step of this process involved a coding system. The take home journals were coded using a rubric of understanding/mastery as to the level of inclusion of the checklist of content. This coding of "High Entry, Middle Entry, and Low Entry" (Albert and Antos, 2000) was not communicated in the journal itself, but only in data viewable by me. Writing in its grammatical and structural sense was not evaluated during this research.

Table 3: Shared Class Math Journal Coding Rubric

<u>High Entry</u> ● Constructs a creative response that identifies a real-life event and includes a plan to solve the problem. ● The entry provides accuracy in set-up and solution. ● The written explanation provides detailed information explaining a personal real-life connection to its use. <u>Medium Entry</u> ● Constructs a response that identifies a real-life event and solves the problem. ● The entry illustrates some understanding of the set-up toward the solution, but the solution is incorrect. ● The written explanation provides some information explaining the personal real-life connection to its use. <u>Low Entry</u> ● Constructs a problem that identifies a real- life event or is missing a real-life event.

- The entry illustrates very little, if any, understanding of the set-up toward the solution and the solution is incorrect.
- The written explanation is unclear or missing altogether.

Student-Teacher Communication Journal

The last journal component was a spontaneous addition emanating from a parent conference where the parents shared overwhelming frustration with the level of emotion and obstinance exhibited by their child when attempting to complete math homework at home. I suggested a journal where the student and I could converse back and forth to defuse and deflect frustrations away from the parents. The goal was to channel those frustrations into questions that I could answer or explain the following day. This journal will be referred to in my results as an anecdotal reference to the benefits of connecting one to one with a student through journaling.

At the conclusion of the research, students, once again, completed the Math Self-Efficacy Survey (*Table 1: Math Self-Efficacy Survey*) to share feedback on the use of math journals as it related to their anxiety, confidence, and relatability to its application in their lives. The use of this survey provided evidence toward they remaining step of the cyclic action research model entitled, *Specifying Learning*. The data from my system of coding the journals as well as student reflections in their own journals were additional results pertinent to the step of *Specifying Learning*.

Results

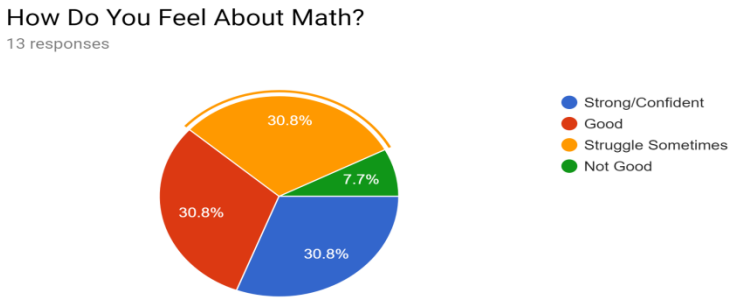
The purpose of this study was to integrate writing and real-world connections into math instruction through the use of math journals. Could providing students reflective journaling time reduce math anxiety levels and are students successful in relating mathematical concepts to real-world experiences? Consideration was given to the examination of journals as a reflective,

metacognitive exploration and as a one-to-one tool to communicate with a struggling math student. Also, did this research serve to improve my instructional practices as I strive to meet the needs of my current and future students?

Surveys

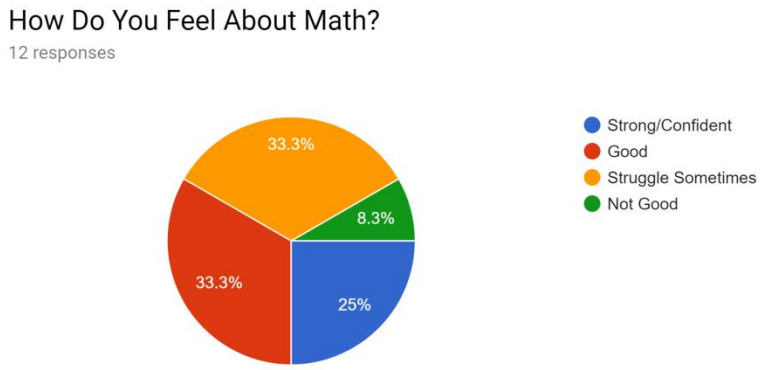
To begin, students completed a Pre-Research Math Self-Efficacy Survey using a Google Form (*Table 1: Math Self-Efficacy Survey*). Student responses to the question, "How Do You Feel About Math?" were pretty encouraging with only 1 of my 13 students responding, "Not Good". The breakdown of responses is illustrated in the Google Pie Graph below. *(Figure 1: Pre-Research, How Do You Feel About Math?)*

Figure 1: Pre-Research, How Do You Feel About Math?



Comparatively, as evidenced in the figure below, little emotion shifted after providing students with the Shared Class Math Journal for use. (*Figure 2: Post-Research, How Do You Feel About Math?)* Ongoing use of the Student Math Journals will continue during class instructional time until the end of this 2018-2019 school year.

Figure 2: Post-Research, How Do You Feel About Math?



When asked "Does writing about math help you understand it better? (like using your journal)", 53.8% of students, prior to the research, replied "Maybe". (*Figure 3: Pre-Research, "Does writing about math help you understand it better? (like using your journal)*") The percentages shown in Figure 3 change minimally following the time period of using the Shared Class Math Journal. The slight changes are shown in *Figure 4: Post-Research, "Does writing about math help you understand it better? (like using your journal)*". And, it should be noted that Student #9, referenced in *Table 4: Student Data* relocated to a new district and did not participate in the Post-Research Math Self-Efficacy Survey.

Figure 3: Pre-Research, "Does writing about math help you understand it better? (like using your journal)".

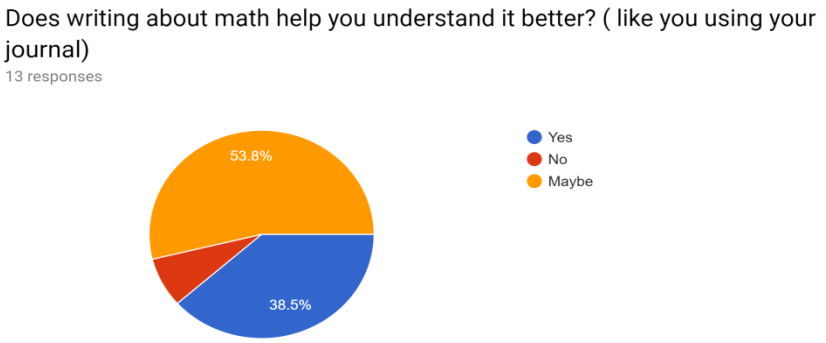
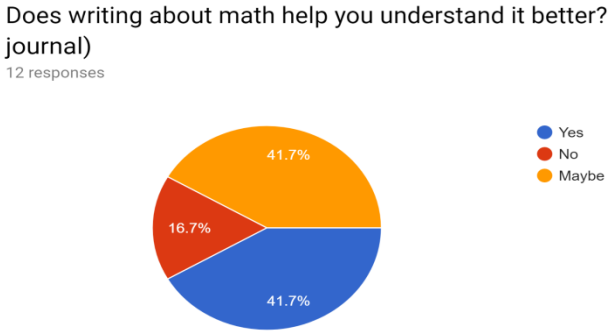


Figure 4: Post-Research, "Does writing about math help you understand it better? (like using your journal)".



Journals

In responding to the essential research question regarding effectiveness of students being successful in relating mathematical concepts to real-world experiences, the system of coding supported their abilities do such with 50% of the 26 entries as High Level entries, 46% of the entries resulted in Medium Level coding, and less than 1% were Low Level. *Table 4: Student Data* presents the coded results of each student's two journal entries as well as the multiplication solution strategy performed. Each student is represented numerically.

Table 4: Student Data

Student	First Class Shared Journal Entry	Solution Strategy	Second Class Shared Journal Entry	Solution Strategy
1	High	Model	High	Model
2	Medium	Partial Products	Medium	Regrouping
3	High	Regrouping	High	Expanded Form
4	High	Partial Products	High	Regrouping
5	High	Model	Medium	Model

6	High	Distributive	High	Regrouping
7	Medium	Model	Medium	Partial Products
8	Medium	Model	Medium	Model
9	Medium	Regrouping	High	Model
10	Medium	Model	High	Model
11	Low	Expanded Form	Medium	Model
12	High	Partial	High	Other (word form to number form)
13	Medium	Model	Medium	Model

The multiplication strategies listed were helpful from an educator perspective to provide insight into which methods individual students felt comfortable modeling. The Multiplication Model which uses an algebraic comparison method was performed the most. It was applied 50% of the time with 13 out of 26 entries showing its varied use. For example, Student #1 wrote the following problem (I have changed the student names that were referenced in the problem to random names of individuals not in my fourth grade class):

Lily has 4 times as many ornaments as Mark. Together, they have 25 Ornaments. How many ornaments does Lily have?

Lily	n	n	n	n
Mark	n			

5 x n = 25, n = 5, 5 x 4 = 20

Lily has 20 ornaments.

Mark has 5 ornaments.

Student #1 says, " I did this problem because it's getting close to Christmas."

Attitude and Cooperation

Students openly displayed excitement or displeasure in having an opportunity to take the journal home. Most would voluntarily ask if it was their turn to take home the journal. Upon conclusion of a peer presentation of his journal entry, students raised hands eagerly desiring to be the next mathematician to take home the journal. Only two students showed hesitation in taking home the shared class journal. Regardless of receptiveness, their commitment to creating a problem on the evening of receiving the journal coupled with their follow-through in returning it the next day was commendable. If I appeared forgetful of the journal presenter's inclusion to our math instructional time, students were quick to remind me that they had their journal problem to share with the class. Placing the problem under the document camera allowed all students an auditory and visual experience with each student's work. Time for discussion also allowed for questions and/or suggestions toward its creation or solution.

Discussion

According to Richard Sagor and Charlene Williams (2018), action research can be viewed as a small idea where the researcher examines data of his/her own work in order to improve performance. This relatively simple concept can yield powerful results in transforming the pedagogy of classroom teachers. Through my research, it is clear that planning action, then taking action allows one to reflect upon the necessary future actions that serve to improve both student and teacher achievement.

The multiple components of this research yielded results that were both valuable and complacent. Helping fourth grade students to make personal connections to math proved

evident from the criteria met in the middle to high level of assessment. Yet discerning the benefit of writing as a mode of clarity and improvement to ease math anxiety was not overwhelmingly evident based on the responses of students in the pre and post self-efficacy surveys. As an educator, I certainly see the value in allowing students a medium by which to narrate their understanding, their successes, and their frustrations because I was provided reflective content detailing the productive struggle of my students which could drive the interventions necessary to help them become more successful and less anxious. Whether or not, fourth grade mentality processes this information as metacognitive progress is a factor to consider in its value to them personally. Moving forward, I will provide reflective opportunities at the beginning of a new concept as well as at its closure. These data points will allow a greater breadth of growth that we can celebrate as achievements to boost confidence and reduce anxiety. The individual student journals provided insight for my teachings and assessment by virtue of reading words such as, "I am good with partial products for multiplication, but not as good at regrouping." Also, the student journals allow for students to new concepts, vocabulary words, strategy methods, and sample problems. The recording by their own hand provides an additional level of engagement not provided by simply using the conventional textbook.

The impact of integrating literacy and math is documented not only through this study but also in the many studies that I have noted. Authentic learning as indicated by Lombardi (2007) is an opportunity to elevate student's interest and understanding of topics. Being a strong advocate for the benefits of our written voices, I will continue to incorporate a math journal into my instruction. The dialogue provided by the students in their personal journals illustrated raw, emotional details of their understanding or struggles that I would not have known had I not incorporated the use of writing in my math curriculum. Honest, forthright celebrations of conquering multi-digit multiplication as well as simple details of struggling with fractions

provided me a deeper understanding of the ups and downs of their journey and how I can adjust my lessons to address these areas of productive struggle. This research provided my students with reflective practices to process their own journey. Through this research, I witnessed evidence of growth in mathematical understanding and computation, and I saw students make a deeper connection to math's many real-life applications in their own lives. The journals became a valuable resource to the student's themselves as well as to myself as their facilitator.

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