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Utilizing Journaling in the Mathematics Classroom: A Handbook Guide for Teachers

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UTILIZING JOURNALING IN THE MATHEMATICS CLASSROOM: A HANDBOOK FOR TEACHERS

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To all who love and support me, from the bottom of my heart I love you all and I thank you. This is just the beginning. “There is no end to education. It is not that you read a book, pass an examination, and finish with education. The whole life, from the moment you are born to the moment you die, is a process of learning” – Jiddu Krishnamurti.

Abstract

A handbook designed for teachers to illustrate how to utilize journaling as an effective teaching practice in the mathematics classroom. This thesis was written to illuminate educators about the powerful research and proper strategies for implementing journaling in mathematics. The handbook provides three lesson plan samples using journaling in the mathematics classroom for grades 3-5, strategies and idea for implementing journaling in mathematics, and tips and activities for mathematical journaling. The goal of this handbook is to give teachers clarity, examples, guidance, and strategies on mathematical journaling.

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Chapter One: Introduction

Throughout the years, many teachers have been encouraged to include the practice of journaling in their mathematics classrooms (National Council of Teachers of Mathematics (2000, 2014; National Governors Association Center for Best Practice & Council of Chief State School Officers, 2010). Until now, it has been unclear as to why journaling needs to be a necessary component of the elementary mathematics curriculum. When students are actively engaging in diverse writing exercises across all subjects, it can confirm the theory that these writing exercises help children connect writing to their mathematics learning thus creating mathematical success (Casa, Firmender, Cahill, Cardetti, Choppin, Cohen, & Zawodniak, 2014).

The research conducted by NCTM (2014) has indicated that teachers receive limited guidance about eliciting journaling writing in the mathematics classroom. The Elementary Mathematical Writing Task Force (2015) was formed to compensate for this lack of journaling in mathematics education. The task force was created to provide teachers with research-based recommendations about mathematical journaling. Ultimately, the task force identified four types of mathematics writing that serve as the overarching goals of engaging students in mathematical reasoning and communication. These included exploratory informative, explanatory, argumentative, and mathematical journaling (Casa, et al., 2014).

Mathematical journaling is utilizing new information obtained from a textbook, classroom lesson, or other educational outside source and supplementing what is provided with personal writings; such as, annotations, labeled examples, pertinent definitions, and guiding instructions. Mathematical journaling is a useful tool that can further develop students' reasoning and communication while deepening students' understanding of mathematical concepts (Quinn

& Wilson, 1997). According to NCTM (2014), teachers need not only require students to keep a proper mathematical journal, but teachers' need to explicitly teach and coach students on how to journal in mathematics. Journaling keeps students engaged in learning, serving not only as a guide in helping with successful testing of mathematical concepts and knowledge, but in completing classwork and homework assignments (NCTM, 2014). Unfortunately, students rarely see the value of journaling, perhaps due to lack of effective implementation or from inadequate or improper teaching techniques (NCTM, 2014). It is important for teachers to introduce mathematical journaling as research has shown that the practice of integrating journaling helps students become successful mathematics learners (Casa, et. al., 2014).

As a future educator, I am genuinely interested in helping all children learn and develop through life, however there is a special place in my heart for the children who are underdeveloped mathematics. Children whom are identified as mathematically-challenged are not in my eyes "challenged", these children are simply where they are regarding their mathematical abilities. They are not behind; the children are just where they are in their educational journey. I aspire to mend the gaps and show every child they are capable of mathematical success. I view journaling as an important tool in students' overall learning success, particularly their mathematical success. I think it is essential for teachers to understand the pedagogy that supports students to practice mathematical journaling. However, it is fundamental that teachers guide their students to recognize the value in a mathematical journal, and how it deepens their understanding of the mathematical skills and concepts being taught.

In my personal experience, I have witnessed that much of students' mathematical frustration and lack of understanding are rooted in their lack of proper examples and

inexperience's with mathematical journaling. This deficit can be immediately alleviated with proper teaching of and executing the practice of mathematical journaling. As a preservice teacher, I have completed most of my two years of service-learning hours at a small elementary school, which is also my alma mater. I have followed the same class of 17 children from third grade to fourth grade. I am familiar with their academic endeavors and have a reasonable understanding of what each child is capable of, especially in relation to their learning and understanding of mathematical concepts. Student monitoring through my preservice work has afforded me the realization that students seem to have a lack of knowledge as it relates to effective mathematical journaling. I have presented lessons of effective mathematical journaling that involved exposing students to new mathematical material while engaging them in the writing process. One typical day of service learning, the substitute teacher in my classroom, informed me that I would be responsible for teaching the mathematics lesson for the day. I saw this as an opportunity to incorporate my newly found knowledge of mathematics instruction. I was familiar with the students, as I had worked with them for almost two years. I knew they would be up for the challenge, the challenge of how I wanted them to learn this new content. I gave explicit instructions on what to write in their notebooks as well as how and where to put definitions, labels, and examples. After seeing students understand the material by using journaling, I deemed the mathematics lesson well-received and successful. Thus, the idea of creating a teacher handbook was born. At the time, I was naïve to the idea of personal reflections in mathematics, but I now know its place and value.

The purpose of the lesson with mathematical journaling was to provide the students with the tools to create their own mathematical journal for the concept being discussed. Guidance was

provided to students to explicitly write the pertinent definitions, label their examples, and write instructions on how to solve the problem. Simplified definitions and problem–solving examples were also extrapolated from the provided mathematic textbook, and students demonstrated the content in their mathematical journal. Students reacted positively to this teaching practice, by expressing their enjoyment of the lesson and demonstrating mastery in the content.

However, mathematical journaling was very rarely used during their mathematics learning and was not formally introduced to the students by their teacher. Seeing the seldom use of mathematical journaling in the classrooms, has thus prompted me to further research mathematical journaling and the effectiveness of its practice within the mathematics classroom. Appropriately executing mathematical journaling in the classroom will take time and present challenges; however, the benefits are unequivocally worth the effort (Page & Clark, 2014). The purpose of this thesis is to help teachers think beyond the traditional boundaries of mathematics instruction and pursue the success that likely follows the implementation of mathematical journaling. Therefore, this thesis will offer a rationale for integrating mathematical journaling and literature review as well as a teacher handbook for implementing mathematical journaling. The handbook incorporates lesson plan samples utilizing journaling, and a thorough exploration of how and why to implement mathematical journaling in the elementary mathematics classroom.

Chapter Two: Literature Review

Introduction

In 1989, the National Council of Teachers of Mathematics (NCTM) implemented the Curriculum and Evaluation Standards for mathematics. NCTM created these standards to serve as the backbone of the reformation for mathematics classrooms throughout the United States. The purpose of these standards has been to ensure constant improvement and positive change in mathematics as it relates to the curriculum, programs, and teacher practices. One standard specifically addressed the need for incorporating writing into the teaching of mathematics. NCTM posited that the integration of writing activities provides students a platform to deepen their understandings of concepts and principles being learned, offers students opportunities to effectively and constructively communicate mathematically, and draws focus as it relates to their feelings towards mathematics to improve their attitudes towards the subject. Later, NCTM (2000) suggested that within mathematical journals, students may include explanations for solving specific algorithms (problems), restating detailed solutions to exercises as if they were writing a textbook, essays about what it means to prove something, or reports describing the significant contributions of well-known mathematicians.

According to McIntosh (1991), writing techniques vary, but can include pictorial journals, used by elementary and middle school students, learning logs, journals, blogs, expository writing, and creating writing activities. However, over time, the lines distinguishing learning logs and journals have blurred (Dempsey, Kuhn & Martindill, (2009). Learning logs focus more on content, whereas journals focus on students' ideas and questions about a broad range of general topics. With journaling, students are also encouraged to reflect on anything they

consider relevant including feelings and understanding of content, carry on conversations with their teachers, or both. Learning logs, on the other hand, are less about "feeling" and more about understanding content. According to Gresham, (2008; 2018; 2019) journaling is an effective practice in the elementary mathematics classroom because writing about one's feelings and mathematical experiences also correlates to reducing the mathematics anxiety found in most students.

Journaling: Its Definition and Process in Mathematics

Journaling in the classroom has evolved over time (May, 2014). The idea behind journaling developed from the belief that learning results from writing as students record their questions and thoughts (Michigan.gov, n.d., p. 3), particularly the entry of the mathematical thought processed (Russell, 2018). According to Chang and Ku (2015), students' writing offers reinforcement of content, student self-reflection, critical thinking, and student metacognition (understanding of one's own thought processes). While students write, they must also sort through their previous understandings and evaluate new material to build connections between the information (Michigan.gov, n.d., p. 3). Similarly, journaling encourages students to think like mathematicians for they must learn how to effectively communicate their thoughts and ideas to others, a practice required of all professionals in the mathematics field. NCTM (2000) states that, writing should not be a separate entity from the mathematics curriculum but should include all of its components.

Academic-based journaling is the cognitive process of taking in information, analyzing and identifying the main ideas, and essential details, and reconstructing the information by authoring it in such a way that it is informative, concise, and easy to recall (Weimer, 2015).

Journal writing within the mathematics classroom has two core components (1) analyzing the material, and (2) offering personal reflections about the content. Specifically, the first core component may contain information from the text, lesson, or other educational course, annotations, labeled examples, pertinent definitions, and guiding instructions. The second core component may have the expression of ones' thoughts, feelings, and questions and/or frustrations about the content or topic (Clark & Page, 2016). The first core component might be colloquially thought of as traditional in-depth note-taking, while the second core component alleviates students' mathematics anxieties, internal frustrations, and creates a safe outlet to unambiguous comments and conversations that require teacher intervention or clarification (Kostos & Shin, 2010). When used with personal reflections, the combination creates the mathematical journal.

Journal writing in mathematics is a multi-faceted, multi-step activity. These steps include: (1) the initiation of writing prompts by the teacher, (2) making decisions about when to read student responses, (3) deciding how to respond to the student writing, and finally, (4) providing immediate feedback to student's responses or questions as to avoid mathematical errors and misconceptions (Kostos & Shin, 2010). Movement within journaling occurs in a unidirectional fashion. Specifically, prompts elicit student responses, student responses elicit teacher responses, and then the cycle begins again with a new prompt—sometimes related to what the teacher has read and responded to and sometimes not. However, as one repeats the journal writing cycle, the components begin to affect each other in bi-directional ways. Teacher prompts, such as "What do you understand/not understand in math class today?", offers teachers insights into students' thinking when encountering complicated problem-solving situations where students claimed that the problem was difficult and they did not understand (Watson,

2017). Journal entries based on teacher-initiated prompts can be a learning tool that helps students retain information while communicating mathematically. According to the National Institute for Literacy (2007), journaling fosters community in a classroom and, because writing is a social act, it is a vehicle for students to learn more about themselves and others. Alvermann (2002), believes that journaling raises the cognitive bar, challenging students to problem solve and think critically. She posited that there is "no other single action that requires students to be so grounded in a viewpoint that they can convince others, to know a process so thoroughly that they can explain it to someone else, or to grasp the nuances of an idea so deeply that they can convey it in a way that provokes thought and sparks discussion?" (Alvermann, p. 194).

It is important for teachers to use methods that are suited best for their unique teaching styles. When beginning the process many teachers choose to have students respond to mathematical journal prompts in a separate mathematical journal. Having a special mathematical journal that is different from everyday school materials can be very motivating for children as they learn new mathematics material (Watson, 2017). Some teachers have students respond to mathematical journal topics as part of a Math Notebook. The math notebook is one composition book holds a student's journal reflections, class notes, and practice activities. Still other teachers have students keep one journal in which they respond to a wide variety of prompts across different content areas (termed as a "Writer's Notebook").

The Effects of Journaling in Mathematics

Mathematics by nature is a hierarchal discipline. It is important to build on mathematics skills and concepts through scaffolding. When the curriculum moves too quickly or the concept takes longer to comprehend, a student may become overwhelmed as they struggle to catch up

(Katz, 2015). Why do so many elementary students experience such a significant struggle with mathematics? The research focusing on pin-pointing the onset, trajectories, and risk factors for learning difficulties in mathematics is rather limited (Morgan, Farks, & Wu, 2009). Mathematical journaling can serve as a bridge to guiding students to being mathematically confident and proficient. Research has proven that providing students with explicit mathematical journaling instruction will positively impact their grades, comprehension, mathematic vocabulary, and morale.

Clarke and Page (2016), did an exploratory study on the effects of elementary students when they kept mathematical journals. The teachers provided their students with the following: (1) sentence starters such as "Today in math I found…challenging, (2) questions focused on clarification of confusion by asking students to provide an example of a practiced problem, or to explain key concepts, and, (3) guided questions directly relating to a student's feelings regarding confidence and understanding by asking if they felt confident or frustrated during any point in the lesson. Students used their journals with class assignments and as a homework guide. Each were also presented with an increase in appropriately descriptive mathematic vocabulary. The study's results showed that students developed more confidence in their mathematical ability and felt more loved and cared for within the classroom environment. The study concluded that students that practiced proper mathematical journaling were more likely to develop a deeper understanding of mathematical concepts that lead them to a correct answer and were able to provide explanations for how they got a correct answer (Clarke & Page, 2016).

Teacher Beliefs and Practices Regarding Journaling in the Mathematics Classroom

According to NCTM (2000), journaling in the mathematics classroom can be a powerful change agent, particularly as it relates to students' understandings of the mathematics content being taught and to the first-hand experiences gained to help teachers bridge the gap from theory to practice. Numerous studies have been conducted on the effectiveness of journal writing. However, only a few studies have explored in-service teachers' own perceptions in this regard. Adednia, Hovassapian, Teimournezhad, and Ghanbari's (2013) study found that teachers perceived two major challenges with the utilization of mathematical journals within their own teaching practice. In order to properly engage their students in quality journaling, teachers felt the necessity to engage in in-depth reading of course materials and full participation in student discussions to be able to teach students to write quality journals. Teachers expressed internal conflicts between their teacher training background and the reflective nature of journal writing and its use in the classroom. While they expressed the usefulness and effectiveness of journaling as an effective learning tool in the mathematics classroom, they reiterated much difficulty using them in the classroom because of improper training and lack of experience in using them. Abednia, et.al., (2013) also found that all teachers believed that journaling in the mathematics classroom was a constructive and advantageous way for students to reflect upon their thinking, connect information that they know, and with what they learned and was directly connected to mathematical achievement. All teachers in this study thought that these three journaling benefits were directly connected to their student's mathematical success. Novice teachers saw the benefits of journaling in their own classrooms, but felt that the time involved responding to students in writing and/or in offering immediate feedback was very time consuming. Teachers with three or more years' service confidently believed that taking the time to answer/respond to

students writing and discuss student's thoughts and questions was more beneficial long term with regards to student gains and mathematical success. These experienced teachers also felt that immediate feedback did not necessarily have to occur in writing, but were just as effective through oral discussions about students' writings. In particular, one teacher stated, "Writing helps solidify concepts. Writing shows the students' understanding of the connections between the concrete activity and the abstract mathematic symbols and numbers." Other teachers in the study expressed beliefs that writing in journals helped students understand mathematics. They noticed great improvement in children's observation skills, reasoning skills, and expressive skills through the use of mathematical journaling. Not every teacher agreed that writing was beneficial to student understanding of mathematics, as indicated by one teacher who stated, "Writing seems to cause students to become confused (frustrated and want to quit) regarding math content". However, recent research shows that teachers' who model the appropriate use of writing with their students will create better writers in the classroom and less mathematics frustration (Gresham, 2019). Other studies have found that teachers who have incorporated journaling in the mathematics classroom have noticed greater gains in students' mathematics achievement, positive attitudes toward the subject, more peer interaction, and involvement in class discussions during math lessons (Clark & Page, 2016; Koston & Shin, 2010). Reflecting on the role of writing in learning allows teachers to recognize the power of this tool, making them more apt to use it with their students (Gresham, 2008).

Types of Mathematical Journaling Approaches

Mathematically Creative Writing is a writing process in which the teacher encourages students to think creatively while documenting their mathematical ideas that extend beyond the

expected or intended outcome of a task, situation, or problem. Within the context of mathematical writing, the purposes of mathematically creative writing are to engage students in reasoning about and communicating originality, fluency, flexibility, and elaboration of ideas, problems, and/or solutions. Students' mathematically creative ideas may be expressed in formal or informal ways and for a wider or authentic audience. This type of writing requires an allotment of time for students to generate multiple ideas and a classroom context in which they come to see mathematics as an ongoing and dynamic process (Cahill, Cardetti, Casa, Choppin, Cohen, Firmender & Zawondniak, 2016).

Argumentative Mathematical Writing (Making Your Mathematical Case) is a style of writing that requires student to make claims, supporting the claims with evidence, evaluations, and recognizing the validity of others reasoning, and to help make sense and clarification of mathematical ideas through writing (Fox, 2017). Freewriting on the other hand allows students to write anything they want (in this case regarding mathematics). It is essential "dumping out" a person's thoughts, feelings, comments, and virtually anything they want to write down. Freewriting is usually limited to a time constraint and is thought of as a stress-relieving activity.

Teacher-Initiated prompts are initiated journal prompts that offers suggestions, questions, and thought-provoking statements given to students pre or post lesson. The prompts are designed to be a platform for students to elicit higher-order thinking and genuine self-reflection on how they feel, either confidently or unsure, regarding the mathematical content. The teacher then reads, and based off the student's responses, intervenes with additional instruction, encouragement, or both. Informative/Explanatory Mathematical Writing offers opportunities for students to describe and explain mathematical ideas. Students are asked to write descriptions of

mathematical concepts, representations, and definitions, among other tasks. They may also be invited to provide mathematical explanations. "Besides explanations for solving a problem, these might include writing about mathematical connections and making comparisons between different representations or comparisons to real-world applications of math" (Casa, Evans, Firmender, & Colennese, 2017 p. 147).

Exploratory writing is the making sense of math. This writing requires students to "use writing to make sense of their thoughts about mathematical concepts, problems, and their own mathematical ideas. This type of writing provides students with another modality in addition to, for example, participating in discussions and using manipulatives, to grapple with their mathematical ideas" (Cahill, Cardetti, Casa, Choppin, Cohen, Firmender & Zawondniak, 2016, p. 6). Climbing and Diving writing occurs when students are actively moving back (climbing) and forth (diving) through a mathematics topic. When they write about the uphill struggle, they have the chance to internalize and process information more willingly (Urquart, 2009).

Double Entry Journaling occurs through the scaffolding form of annotation. This scaffolding annotation provides teachers and students with a flexible space to identify and reflect on or respond to any genre of text for both reading and writing instruction in disciplines ranging from science and social studies to math and literature (Buffen & Miller, 2010).

Reflective Mathematical Journaling offers students time to reflect, internalize, and analyze personal thoughts and understandings of the mathematics content. This allows students to see how far they have come throughout the year and what challenging topics they were able to overcome and understand. Reflective journaling helps students reflect on past performances and set future goals (Coaty, 2017).

Finally, Expository Writing is writing to explain. Expository writing subsumes two categories: Persuasive/analytic writing or evidence-based writing (Roberts, 2019). Expository writing is text-based, meaning the writer is provided with a text excerpt; paragraphs from multiple mathematics textbooks explain the same concept, examples of problems either an algorithm or word-problem, etc. The student analyzes the given text/information and then, depending if it is persuasive or exploratory, writes an essay (typically the five-paragraph model) to convey one's perspective or informational standpoint based on the information provided within one's background knowledge. Venne (1989) and Miller (1990) researched the effects of initiated expository writing in the mathematics classroom by prompting students to explain mathematical procedures in detail. The results showed that when students analyze mathematical concepts with the idea of writing to explain, they develop a deeper understanding of the content and can thoroughly explain the algorithms/problems. Expository writing forces the writer to bridge the gap between their background knowledge and new information (text-evidence), thus becoming a better writer and a more proficient mathematician.

Benefits of Journaling in the Mathematics Classroom

Prior to NCTM's Standards (2000), journaling was seldom used in the teaching of mathematics. The first initiation of the NCTM Standards sparked the ever-progressing implementation of journaling in the mathematics classroom. NCTM has continued researching and advocating the use of journaling as an effective teaching practice. Since the standards implementation, several additional benefits have derived from the use of journaling in the teaching of mathematics (NCTM, 2014). These include: (1) the teachers gaining of important information from students' writing which can inform their instruction, (2) student gains with

practice in communicating mathematically, (3) students becoming better writers, and (4) the decrease of students' mathematics anxiety (Gresham, 2019; NCTM, 2014). "Writing in mathematics can also help students consolidate their thinking because it requires them to think about their work and clarify their thoughts about their ideas" (NCTM, 2000, pg. 61).

Research on journaling in mathematics has shown that students feel a sense of ownership of the mathematical material being learned (Van Der Molen, 2015). The utilization of mathematical journaling in the classroom serves as a positive platform for students to address their feelings and attitudes regarding the mathematical content. Journaling provides students an opportunity to reflect on problem-solving strategies while offering a place for inconsequential personal learning assessment. It also offers students time to reflect on their strategies and assess their personal learning while implementing the practice of putting their knowledge into words both verbally and in writing. With journaling the mathematical instructional focus is shifted from computation to problem-solving and real-life application. As students are afforded engagement in the writing process, teachers can gain insight into children's abilities, understandings, misconceptions, and opinions of the content being taught (Yow, 2015).

According to Dempsey, et.al. (2009), journaling creates a documented portfolio-like recording of student growth and progress as well as being an open-ended and naturally differentiated assessment tool. Journal writing provides opportunities for students to broaden their perspective about mathematical topics. Journaling allows for (1) unique teacher insight into the conceptual building blocks of the content the student has acquired and understands, (2) provides students with a quality, personal resource with algorithm analysis and definitions that the students understand and are familiar with (part one of mathematical journaling), (3) allows

teachers to recognize patterns of frustrations and misconceptions, and (4) elicits student in higher-order thinking (HOT) by having them communicate the problem-solving strategies and reflections (ImagineLearning, 2017). Journals are designed to be an academic resource and personal outlet, and depending on the teacher, they may or may not be graded. Regardless of whether a journal is graded, it serves a great place to explore mathematical ideas and improve mathematical skills. Journaling drives students to broaden their perspective about mathematical topics (Watson, 2010). Journaling allows students to spend time on personal reflection regarding their mathematical learning without fear of criticism or retribution. Finally, journaling has been shown to alleviate student stress and steers mathematical attitudes in a positive, constructive direction (O'Hara, 2018).

Chapter Three: Methodology

Mathematical journaling in this thesis is defined as combining algorithm analysis and personal reflections regarding content. I have researched how beneficial this practice is for teaching and facilitating learning. With this knowledge, I can astutely recognize that my personal struggle with mathematics, as well as the continuing struggle we see in elementary students today, can be alleviated through the implementation of journaling in the mathematics classroom.

Throughout my primary and secondary education, I struggled in mathematics. My efforts to succeed in mathematics were limited to me copying problems from the board, listening to the explanations, and using the textbook as an additional resource. However, this was not enough for me to be mathematically successful. When it came time for independent practice, I inevitably failed to understand the basic mathematic concepts and the associated algorithm. It was only with an incredible amount of repetition that I learned how to complete any mathematics problem.

Sadly, this was also true in many of my classes. However, when I took *Elementary Mathematics for Teaching,* I found myself not only succeeding, but excelling in the content. The first semester in college in which I took elementary education courses, to my surprise, I got straight A's for the first time in my life. It took me nearly 14 years until I learned how to be a successful student, ultimately landing me on the Dean's List for five semesters in a row.

Through nearly 100 hours of service learning, I noticed a common reoccurrence in elementary school students struggling in mathematics. Students show a significant lapse in focus, organization, and thus ultimate success in the mathematics classroom. If these students have a lapse in focus and organization how can they have success? I could see myself in many of the students that I observed. I began to wonder, why did it take me so long to find mathematical success? Through the research for this thesis, I found that the answer lies within the idea and implementation of mathematical journaling. My inspiration for this study was to alleviate the stress, disorganization, and negative feelings that accompanied elementary mathematics. Only after beginning the process of Honors in the Major (HIM), did I discover the unparalleled benefits that complemented writing in mathematics, or for this thesis, mathematical journaling. All I ponder was, "Why is this not more widely utilized and why had I never heard of this before?" Most importantly, I wondered how I could successfully create a resource for teachers that encompasses mathematical journaling. I have witnessed teachers become so frustrated regarding their students' mathematics performance and motivation. When I considered the students struggles, I kept noticing the lack of student reflection and the utilization of mathematical journaling as a teaching practice.

Understanding how to provide students with the use of mathematical journals became my goal. Therefore, I wanted to provide teachers a useful handbook for the implementation of journaling in the mathematics classroom. By allocating the proper tips, strategies, and ideas to teachers, mathematical journaling would ultimately result in long term benefits for students.

Creating the Teacher Resource for Utilizing Mathematical Journaling

Prior to my thesis research, I thought that simply creating lesson plans specifically tailored to algorithm analysis in mathematical journaling, would be enough. I now know that algorithm analysis is most definitively not enough. Only when combining algorithm analysis and personal reflections through mathematical journaling, can one facilitate effective mathematics learning. This handbook will provide detailed lesson plans that are written for mathematical journaling, research based tips, strategies, and ideas that guide the teacher in using mathematical journaling. My goal is to offer knowledge of how and why this practice is a useful teaching tool.

Through my education courses at UCF, I have learned, the most effective strategies to teach mathematics to children. I have also learned how to recognize the process in which children learn mathematics, and how to identify common misconceptions. In theory and clinical practice, I know how to identify mathematical mistakes and identify the misconceptions and how to potentially guide struggling learners in the right direction. These courses stand as my backbone for my understandings of algorithm analysis in mathematical journaling. After reading dozens of research articles, book experts, and expert written blog posts, I have identified some of the most effective ways to implement writing in mathematics, primarily pertaining to the personal reflection aspect of the mathematical journal. Through the accumulated knowledge of reading research-based journaling strategies I believe have learned how to properly use personal

reflections as a tool for success. For example, I see the importance of how to isolate and implement higher-order thinking prompts (HOT), provide an outlet for mathematics frustration, and/or give one-on-one attention to a student who has expressed struggles in their journal. Additionally, I have also had opportunities through education courses to engage in writing in-depth lesson plans while participating in practiced facilitating learning in the classroom. The methodology for this thesis is to create a multitude of teacher resources for incorporating mathematical journaling in the classroom, all with the hopes that through this practice, future elementary students can find and achieve success.

Chapter Four: A Teacher Handbook for Implementing the Use of Journaling in the Mathematics Classroom

This handbook serves the purpose of guiding teachers for implementation of journaling in the mathematics classroom. This handbook provides three lesson plan samples using journaling in the mathematics classroom for grades 3-5, strategies and ideas for incorporating journaling in mathematics, and tips and activities for journaling in the mathematics classroom. The goal of this handbook is to give teachers clarity, examples, and strategies on mathematical journaling.

Lesson Plan Sample Using Journaling in the Mathematics Classroom for Grade Three

I. General Information for Lesson Plan

   A. Title: Single digit multiplication by multiples of ten (10-90).

      1. Mathematical Domain: Number and Operations in Base Ten.

   B. Grade Level: Third Grade

   C. Duration: Sixty Minutes

II. Objective

   A. Students will compute single digit multiplication by multiples of ten with 80% accuracy.

III. Teaching Strategies

   A. Mathematical journaling

   B. Manipulatives: Base ten blocks

IV. Necessary Background Knowledge

   A. Clear understanding of place value

   B. Proficient in basic multiplication facts (0x0-9x9)

V. Materials

   A. Teacher materials

      1. A way to display information to the class (large classroom white board)

      2. Base ten blocks, class set.

   B. Student Materials

      1. Pencil

      2. Colored Pencils

      3. Mathematical Journal

VI. Teaching Content through Journaling

A. Introduction

1. Today we are going to work on multiplying single digits with factors of ten.
    a. **Journal Prompt**: What are single digits? Explain how you know.
    b. **Journal Prompt**: How do you know what the factors of ten are?
    c. **Journal Prompt**: Explain why is any number multiplied by “zero” equal “zero”.

B. Manipulatives

1. Use base ten blocks to introduce the content.
    a. **Journal Prompt**: How do you feel about using base ten blocks to learn multiplication?
2. Provide examples for the students to practice with the manipulatives.
    a. 50 x 9, 30 x 4, 10 x 9
    b. **Journal Prompt**: How did using the base ten blocks make you feel about factors of ten multiplied by single digits? Was anything confusing or frustrating?

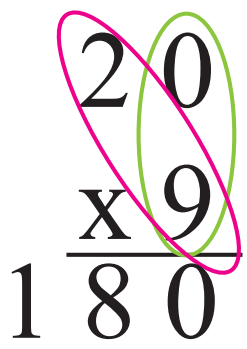
C. Understanding factors of ten multiplied by single digits.

1. **Journal Prompt**: Why it is important to understand place value? Label a five digit number with each corresponding place value.

D. Demonstrating an example.

1. When multiplying, start in the ones place. Move right to left.
2. See example below.

a.



First- 0x9=0 write the 0 in the ones place

Second- 2x9=18 write the 18 in the tens place, the 1 will be in the hundreds place

Figure 1: Example demonstrating moving right to left in single whole digit multiplication by a factor of ten.

b. **Journal Prompt**: Why do you start in the ones place in multidigit multiplication? Explain why this is important to solving the problem correctly and show an example.

E. Showing work.

1. How to show work for standard form:

a.

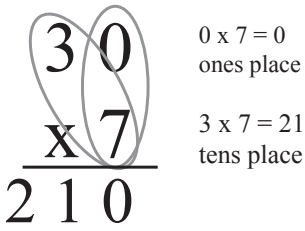


Figure 2: Example of how to show work in standard form.

2. How to show work for base ten drawings.

a.

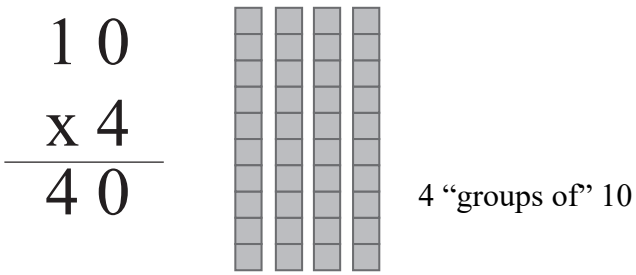


Figure 3: Example of how to show work with base ten drawings.

3. **Journal Prompt:** We have learned two ways to solve this type of multiplication problem. Which way makes the most sense to you and why? Show an example and explain how you know the answer is correct.

VII. Conclusion

A. **Exit Slip Journal Prompt**: Today I learned…

B. **Personal Reflection Journal Prompt**: When it came to the mathematics lesson today, I feel…

See student journaling sample below.

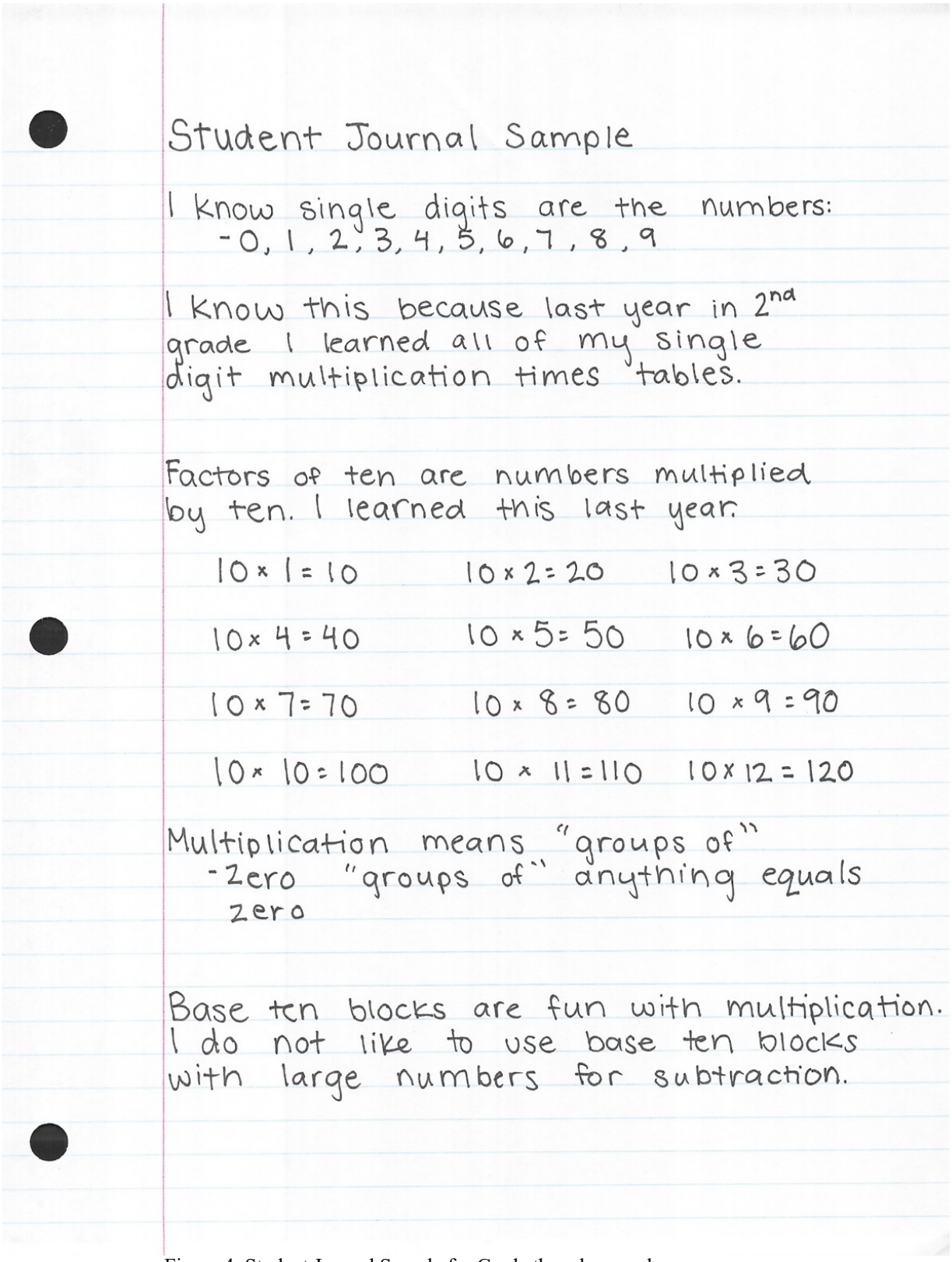
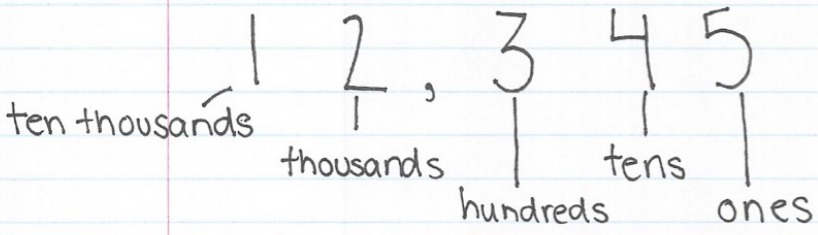


Figure 4: Student Journal Sample for Grade three lesson plan.

Using base ten blocks for this type of multiplication is super easy! I only need to use rods, lots of rods.

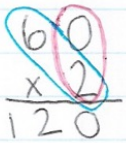
If you don't keep track of place value it is easy to get the answer wrong and become confused.



You cannot get the correct answer to a multidigit multiplication problem if you do not start in the ones place.

0 x 7 = 0 ← ones place
5 x 7 = 35 ← tens place

Standard form is easiest for me, it is straightforward. Drawing pictures takes to long.



I know my answer is correct because I started in the ones place, and I know my basic facts.

Today I learned how to correctly solve single digit numbers multiplied by factors of ten.

Math class today was fun because I understood the lesson and know I can do my homework correctly.

Lesson Plan Sample Using Journaling in the Mathematics Classroom for Grade Four

I. General Information for Lesson Plan

   A. Title: Multidigit Multiplication in Expanded Form

      1. Mathematical Domain: Numbers and Operations in Base Ten

   B. Grade Level: Fourth Grade

   C. Duration: Sixty Minutes

II. Objective

   A. Students will use expanded form to multiply two whole two digit numbers with 80% accuracy.

III. Teaching Strategies

   A. Mathematical Journaling

   B. Manipulatives: Base ten blocks

IV. Necessary Background Knowledge

   A. Clear understanding of place value

   B. Proficient in basic multiplication and addition.

V. Materials

   A. Teacher Materials

      1. A way to display information to the class (large classroom white board)

      2. Base Ten Blocks, Class Set

   B. Student Materials

      1. Pencil

      2. Colored Pencils

3. Mathematical Journal

VI. Teaching Content through Journaling

A. Introduction

1. Today we are going to work on multiplying two, two digit numbers. We will learn to solve them in expanded form.

    a. **Journal Prompt**: Show an example of the following problem solved in expanded form 746 + 29. Explain how you solved it, and what it means to use expanded form.

    b. **Journal Prompt**: How do you feel when you see this problem, 43 x 67? Write three words that describe your feelings about multidigit multiplication.

B. Manipulatives

1. Use base ten blocks to introduce to content.

2. Provide examples for the students to practice with the manipulatives.

    a. 24 x 11, 39 x 15, 19 x 19

    b. **Journal Prompt**: How did using the base ten blocks make you feel about multidigit multiplication? Was anything confusing or frustrating?

C. Place value importance for solving multidigit multiplication.

1. **Journal Prompt**: Why it is important to understand place value? Label a six digit number with each corresponding place value.

D. Demonstrating an expanded form example.

1. See example.

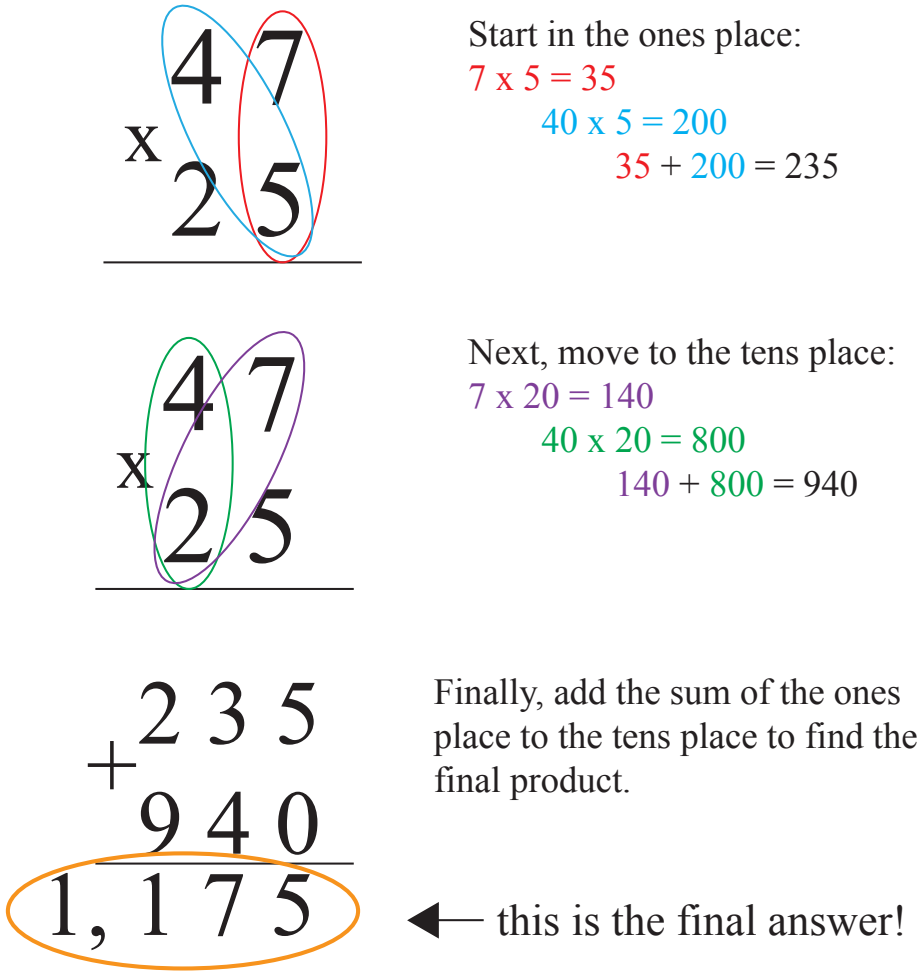


Figure 5: Example demonstrating expanded form solving multidigit multiplication

2. **Journal Prompt:** Explain the steps of expanded form for multidigit multiplication. How does breaking the problem down into individual place value problems result in the correct answer? Demonstrate expanded form 59 x 31.

VII. Conclusion

A. **Journal Prompt**: The most challenging thing about today's lesson was…

B. **Journal Prompt**: I need more practice with…

See student journaling sample below.

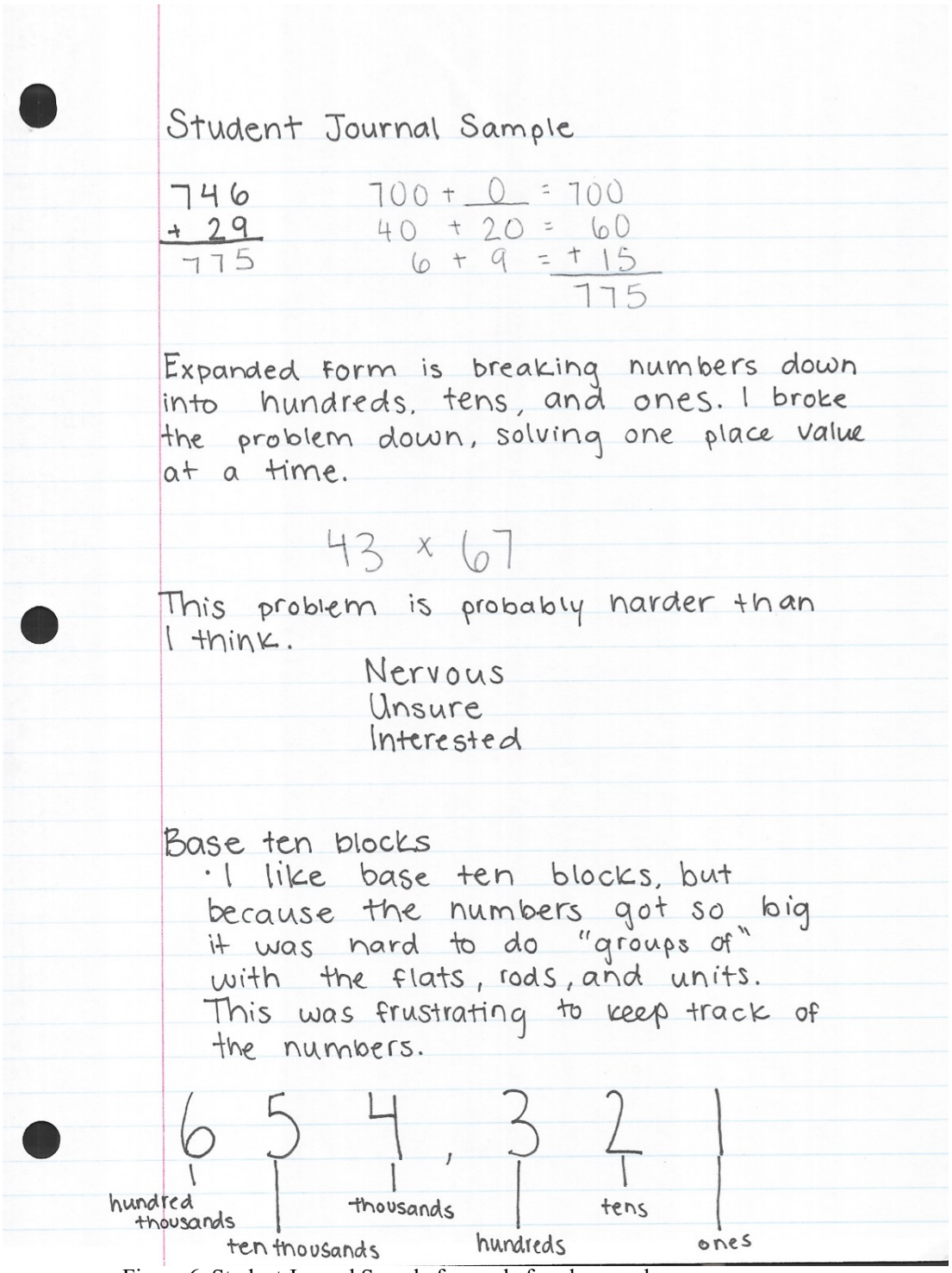
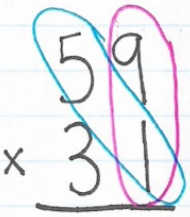


Figure 6: Student Journal Sample for grade four lesson plan.



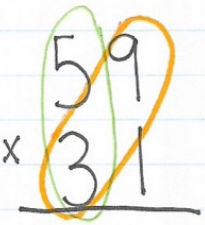
In expanded form, break down the numbers into ones and tens.

Start with ones place.

$9 \times 1 = 9$

$50 \times 1 = 50$ → because the 5 is in the tens place, it is really a 50

$9 + 50 = \boxed{59}$



Move to tens place.

$9 \times 30 = 270$

$50 \times 30 = 1,500$

$270 + 1,500 = \boxed{1,770}$

Add it all together!

$$\begin{array}{r} {}^{1}1,770 \\ +\ \ 59 \\ \hline \boxed{1,829} \end{array}$$

← final answer!

The most challenging thing about todays lesson was remembering to correctly multiply both tens places.

Lesson Plan Sample Using Journaling in the Mathematics Classroom for Grade Five

I. General Information for lesson plan

   A. Title: Multidigit Multiplication in Standard Form

      1. Mathematical Domain: Numbers and Operations in Base Ten

   B. Grade Level: Fifth Grade

   C. Duration: Sixty Minutes

II. Objective

   A. Students will use expanded form to multiply two whole three digit numbers with 80% accuracy.

III. Teaching Strategies

   A. Mathematical Journaling

   B. Manipulatives: Base ten blocks

IV. Necessary Background Knowledge

   A. Clear Understanding of Place Value

   B. Proficient in basic multiplication and addition facts

V. Materials

   A. Teacher Materials

      1. A way to display information to the class (large classroom white board)

      2. Base Ten Blocks, class set

   B. Student Materials

      1. Pencil

      2. Colored Pencils

3. Mathematical Journal

VI. Teaching Content through Journaling

A. Introduction

1. Today we are going to work on multiplying two, three digit numbers in expanded form.

a. **Journal Prompt**: Show an example of the following problem solved in standard form 70 x 9. Explain how you solved it, and what it means to use standard form.

b. **Journal Prompt**: How do you feel when you see this problem, 621 x 397? Write your thoughts about a multiplication problem this large.

B. Practice standard form with organized placement/place value.

1. Showing work and organizing the problems worksheet, found in Appendix A.1.

a. **Journal Prompt:** How does the worksheet help you solve the problems in standard form? Using the worksheet, show your work in your journal.

2. Demonstrate how to solve and show work in standard form.

a.

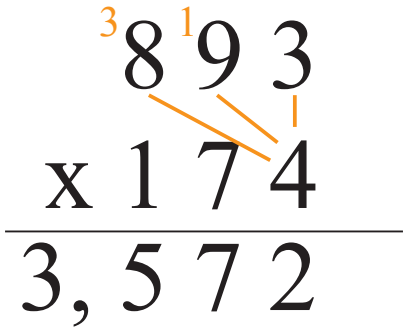


Figure 7: Step one in triple digit multiplication; solving the ones place and showing work.

b.

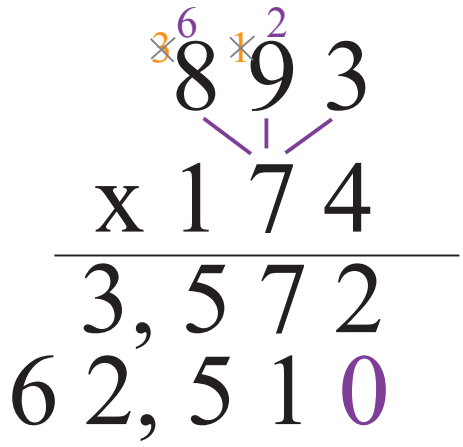


Figure 8: Step two in triple digit multiplication; solving the tens place and showing work. Work from the ones place has been removed to emphasize the work in the tens place.

c.

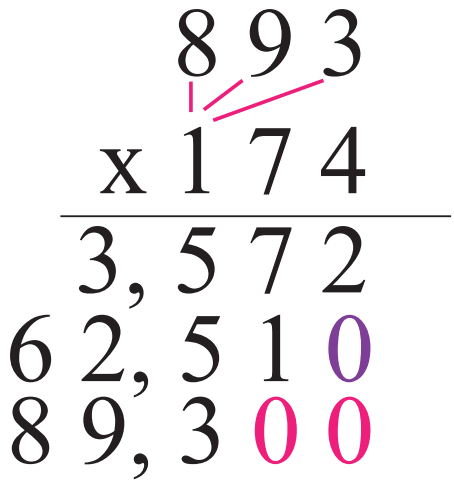


Figure 9: Step three in triple digit multiplication; solving the hundreds place and showing work. Work from the ones and ten place has been removed to emphasize work in the hundreds place.

d.

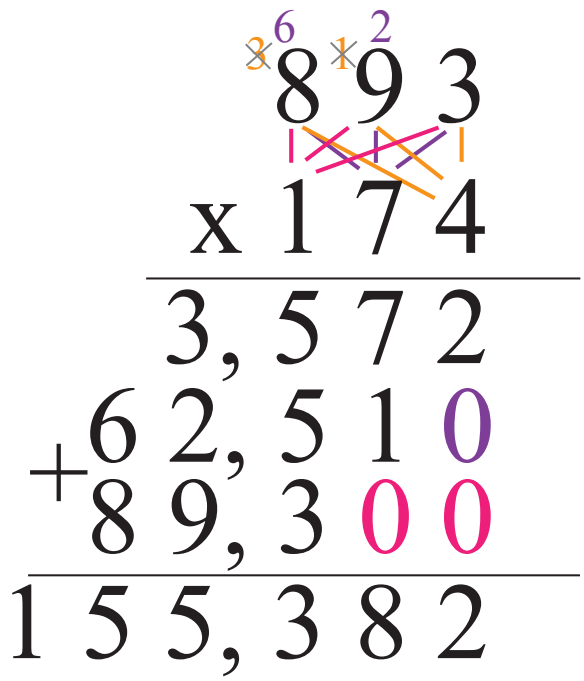


Figure 10: Step four in triple digit multiplication. Add all products from the ones, tens, and hundreds place to calculate final answer. All work is shown here to illustrate final product.

3. **Journal Prompt**: What is the most challenging part of solving these problems in standard form and why?
4. **Journal Prompt**: Clarify why it is important to write neatly and go slowly when completing triple digit multiplication.
5. **Journal Prompt**: Show an example without the worksheet but with colored pencils and write important things to remember when solving and explain each step in the problem. 398 x 215.

VII. Conclusion

A. **Journal Prompt**: Today in mathematics I learned… my favorite part was…

B. **Journal Prompt**: After mathematics today, I feel…

See student journal sample below.

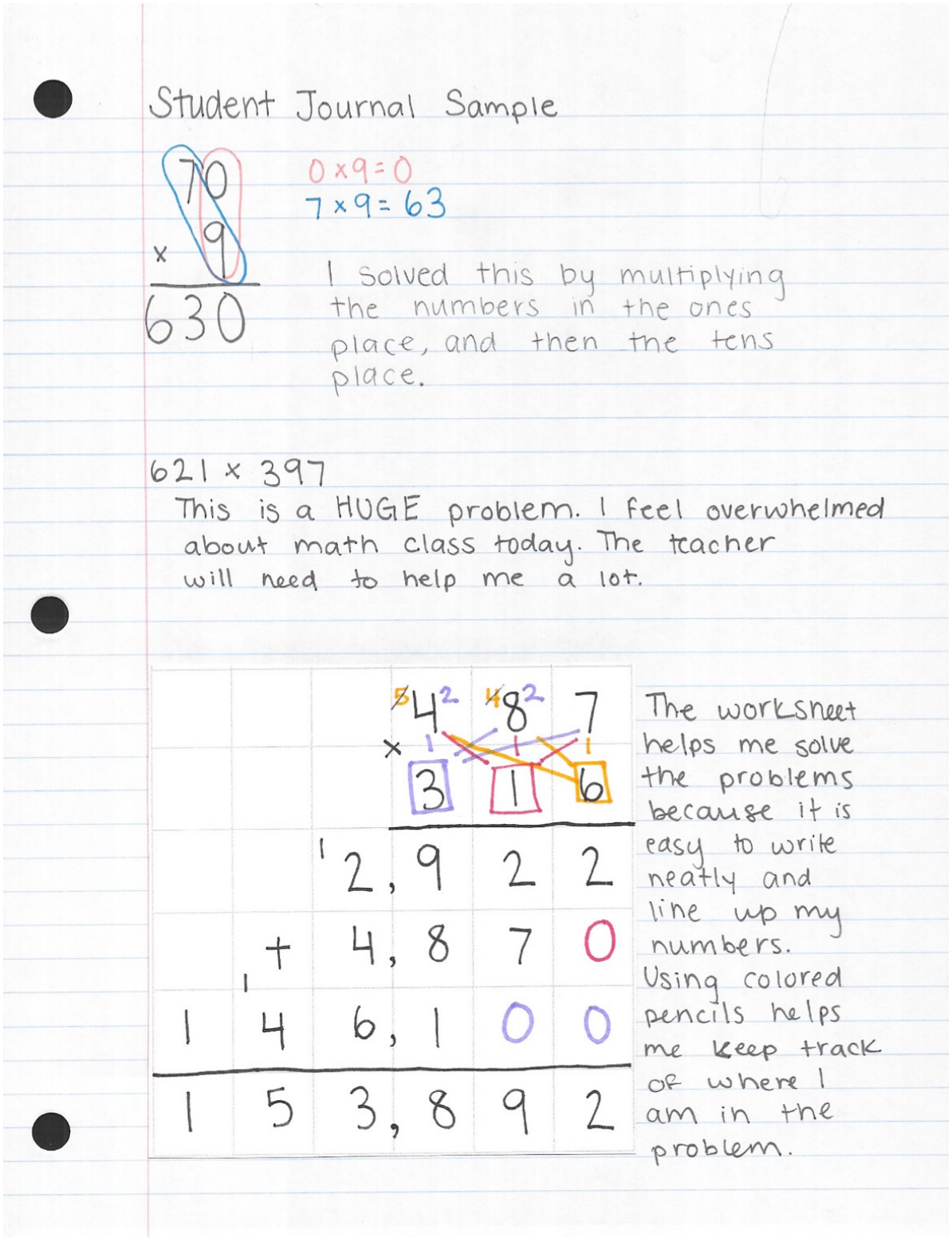
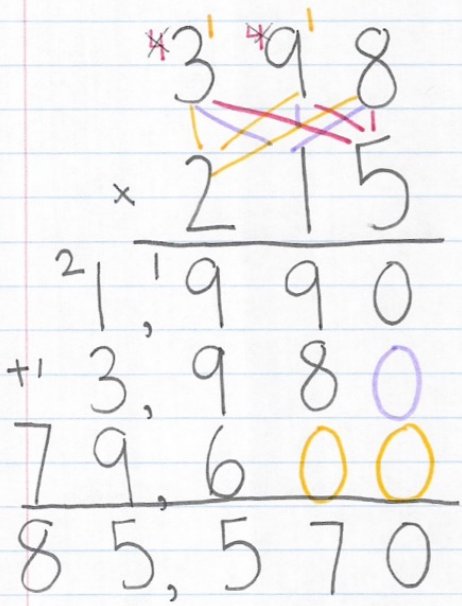


Figure 11: Student journal sample for grade five.

The most challenging part of solving these problems is to remember to add the zeros in the tens and hundreds place. It is also hard to keep work neat enough for me to solve it without making mistakes.

When I write my problems and show my work neatly, I don't make silly mistakes and mix up numbers. Going slowly stops silly mistakes.



- Solve ones place after regrouping the extra tens, cross out numbers so I don't get confused.
- Solve tens place, ADD ZERO
- Solve hundreds place, ADD ZEROS regroup carefully.
- ADD the numbers together for final answer ☺

Today in mathematics I learned how to neatly solve triple digit multiplication in standard form. My favorite part was using the worksheet and colored pencils.
I feel okay about today. I need more practice.

Why Students Should Journal

Through mathematical journaling students will simultaneously improve their handwriting, writing skills and confidence, mental health, and illuminate the teacher on the students' academic strengths and weaknesses. Additionally, mathematical journaling strengthens a student's communication skills, provides individualized self-reflection about what they have learned, and critical analysis of the mathematical problem-solving process (TeacherVision, 2007).

Journaling activates a student's thought process. Journaling is most effective when it is not graded, but it is used as a way for students to express feelings, thoughts, and develop one's voice (TeacherVision, 2007). The more a student writes, and develops the muscle memory of pencil to paper, the easier and less intimidating writing becomes. "The journal records the student's individual travel through the academic world; at the same time, it serves well when formal papers or projects need to be written" (Fulwiler & Young, 1982 p. 18).

Journaling requires students to physically write their thoughts and feelings. "Writing and thinking about a problem through your journal can give the distance and perspective you need to take control of the situation. That, in turn, reduces the physiological effects of stress that negatively affect your overall health and your immune system" (Werrell, 2015 p. 1).

When students journal, it is with the pretext that the journal is shared with the teacher. A student's journal provides a window into their thinking (TeacherVision, 2007). This information will help a teacher isolate a student's difficulties in school and life, their strengths and weaknesses, and with what a student needs guidance with.

Journaling provides the foundation of mathematical communication by teaching and guiding students to coherently communicate and articulate their misconceptions or struggles with a mathematical topic. "Communication makes mathematical thinking observable and therefore facilitates further development of that thought. It encourages students to reflect on their own knowledge and their own ways of solving problems. Throughout the early years, students should have daily opportunities to talk and write about mathematics. They should become increasingly effective in communicating what they understand through their own notation and language as well as in conventional ways" (NCTM, 2016 p. 128)

When a student writes a mathematical journal entry, they must reflect on what they have learned. The reflection becomes a vital tool for teacher assessment in understanding student's progress. Giving students feedback on their journal entries is essential. "It is important to remember that students writing serves two major purposes – as a learning tool for students to reflect on mathematics and as an assessment tool to help teachers learn about what students understand and how they reason. Teacher's should use students' papers to help them (the teacher) reflect on their lessons and think of way to further support the students learning" (Burns, 1995 p. 187). The student needs to think critically and thoughtfully when writing about how they solved a problem. Journaling will scaffold the student to engage in the thought process required in solving mathematics problems.

How to Implement Mathematical Journaling in the Classroom: Tips and Strategies

Mathematical journaling is a vulnerable activity. Journaling asks students to write their thought process, mental challenges, and feelings about what they are learning and their understanding of the mathematical content being presented. It is important to offer students

opportunities to feel comfortable with the writing process and not feel judged on their thoughts. "Teachers who know how their kids learn can guide them and lead them to grow in their learning. Teachers who know their students as unique individuals can help them to navigate the often confusing and anxiety filled lives that they lead" (Schultz, 2015 p. 1). Mathematics anxiety can hinder students mathematical understanding and cause feelings of frustration. To understand student's mathematics anxiety, a teacher can target instruction and gauge emotional sensitivities through the implementation of a mathematics anxiety survey. A sample of a Mathematics Anxiety Survey is provided in Appendix A. The Mathematics Anxiety Survey lists a variety of statements and reasonings as to why a student might have mathematics anxiety. The survey elicits the student to reflect on their reasoning and struggling. Therefore, the information provided from the survey will guide the teachers into understanding their students' mathematical confidence and attitude. Once student's levels of mathematics anxiety have been determined opportunities through journal prompts can be utilized. Journal Prompts (See Appendix E) offers guidance for students to reflect their thoughts. For example, "Today I was frustrated when….?" or "I am struggling to correctly… when I… in this problem". Learning your students' mathematics anxiety and frustrations may take time, but the aforementioned survey could offer insight to gauge students' thoughts as they can also write about their answers to the survey through journaling. The Student Interest Inventory (See Appendix B) will jumpstart the teacher-student relationship in an authentic way. The student interest inventory provides a comprehensive list of a student's family, personal likes and dislikes, as well as how they prefer to learn. The information collected form the survey and inventory will prove most effective when

the student realizes the teacher has made the connections with sensitive topics, personal interests, and learning styles.

What does a Mathematical Journal look like?

- Mathematical journals should be separated from other subjects, and be its own spiral or composition notebook, or a small binder. The notebooks should have their own special place in the classroom, either in the student's desk, or specific shelf in the classroom (TeacherVision, 2007).

When Should Students Journal in Mathematics and for how long?

- A lesson that has journaling incorporated in its entirety, such as the lesson plan samples, demonstrates proficiency in the mathematical journaling pedagogy. Mathematical journaling throughout the lesson provides an authentic experience of the metacognition regarding mathematics. However, if students writing stamina is underdeveloped or the students are in grades K-2, excessive writing may cause mental and physical fatigue. Therefore, in these circumstances journaling in the beginning and end of mathematics might prove most efficient and effective. For each journal entry, allocate between five to seven minutes for the students to write and reflect. Students should journal with every mathematics lesson (Russell, 2018). Create a dialogue of what to do if a student finishes their journaling early or too quickly; such a dialogue might include prompts such as, "Try and write two more details about…" or "Do another example of… except when you explain your thinking and how you solved it, explain it in a different way". It is important to keep their pencils moving, continuing the mathematical thought-process.

How to Start a Mathematical Journal.

- Creating a daily routine for journaling is critical for continuity and success. When first introducing journaling, start with open-ended mathematics questions such as those provided in Appendix C and Appendix F. This type of questioning will encourage the students to engage in the thought process of how they feel about mathematics and their opinions on the subject (TeacherVision, 2007). Students who are unfamiliar with journaling might be more eager to participate if you encourage them to think about their thinking of a familiar activity (TeacherVision, 2007). For example, "How did you choose what you wore to school today?" A response that would require further thinking and justification would be, "I wore leggings and a sweater because its cold outside", such a journal entry would demonstrate that the student has not fully engaged in critical thinking and the writing process. A high-quality response to this might be; "I knew it was a cool outside so I could not wear shorts. I choose my black legging because they are comfortable and not too hot/not too cold. My favorite long sleeve shirt was dirty so I choose my light pink t-shirt because it is a little snug so it would not bulge when I put on a lightweight sweater". The reason a writing prompt like this pertains to mathematical journaling because we want students to "think" about their thinking. If this type of metacognition is unfamiliar, transitioning to mathematical journaling might come easier if the students have practice using the thought process while journaling. Once students have become familiarized with the proper metacognition used in high-quality mathematical journaling, forms such as the one in Appendix D may offer opportunities

for students to comment on their performance during daily mathematics lessons. This is a great way for children to monitor their own progress of their mathematical skills.

Teaching Modeling? Argumentative Mathematical Journaling.

- Argumentative mathematical journaling (Making Your Mathematical Case) is a style of writing that requires the student to make claims, supporting the claims with evidence, evaluations, and recognizing the validity of others reasoning, and to help make sense and clarification of mathematical ideas through writing (Fox, 2017). When utilizing the argumentative style of mathematical journaling, students are engaging in higher-order thinking that promotes them into a deeper understanding of the mathematics content. Argumentative journaling is a writing style that needs to be explicitly taught through teacher modeling. As a teacher, model how one engages in argumentative mathematical journaling by thinking aloud as you (the teacher) engages in the prompt. Proper modeling of this writing style should carefully isolate each component of how one might solve a mathematics problem, write down the thought process of each step, demonstrate through the "evidence" how one could make a mathematical case. After a substantial amount of the teacher modeling the argumentative journaling thought process, guide the students to learn how to interact with the text/problems in such a way that when approaching a mathematics problem, students use evidence which is the thought process of solving the algorithm.

What does Mathematical Journaling look like?

- Students should be in a place that promotes writing, such as their desk. Access students' prior knowledge to introduce the lesson. Help ignite the thought process and recall

background knowledge through prompts such as, “What do you know and how do you feel about…?”. Teachers should model their writing through their own journaling. When the teacher provides a mathematical prompt to the students, the teacher should write their thoughts during the journaling time then share those thoughts with students. Deconstructing the prompts on the board, revising writings, and changing/improving wording are all helpful in teaching and utilizing mathematical journaling (Burns, 1995). Cunningham and Allington (2011), discovered that when teachers use whole-group, small-group, and individualized instruction, teachers are more effective in reaching all their students. Utilizing cooperative learning during mathematical journaling allows students to learn from one another and verbalize thinking. Additionally, cooperative learning creates the opportunity for students to gain new perspectives regarding the content (Burns, 1995). “Having students work cooperatively reduces the isolation of working alone and gives individuals support for taking intellectual risks…working in small groups can encourage otherwise shy or hesitant students to talk, which helps them clarify their ideas and prepare for writing” (Burns, 1995 p. 147). Towards the end of a mathematics class, the ending journal entries should show reflection of the content and understanding, as well as personal feelings. Appendix F demonstrates some ways to engage students in that final content related and reflective entry.

How to Provide Feedback.

- Providing feedback that is authentic guides the student and informs them of they are correctly engaging in mathematical journaling. Avoid general comments such as, “Good job” or “Nice thought” as this type of feedback provides no authentic insight into the

teacher thinking and is not helpful to the student (Burns & Silbey, 2001). The best method of feedback for mathematical journaling is to speak directly with the student (Burns, 1995). By speaking with a student about their journal entries, the teaching and facilitation helps the student defend their thinking while gauging a deeper understanding of their reasonings.

Measuring Mathematical Journaling Success.

- A progressing students' mathematical journal will show evidence that they are engaging in the mathematical thought process, illustrates they verbally defending and explaining their reasoning, developing and growing in their mathematical vocabulary, and strengthening mathematical communication skills. Additionally, by asking students to revisit old entries and then rewrite the entry allows them to engage in the content and journaling at a deeper level (Math Journals, n.d.). This revisitation allows them to reflect on how far they have grown as writers and mathematicians.

Appendices

Appendix A: Mathematics Survey for Elementary Students. This survey is an excellent resource to gain an authentic understanding of how a student approaches and feels about mathematics.

Name: _____ Date:_____

Mathematics Anxiety Survey for Elementary Students

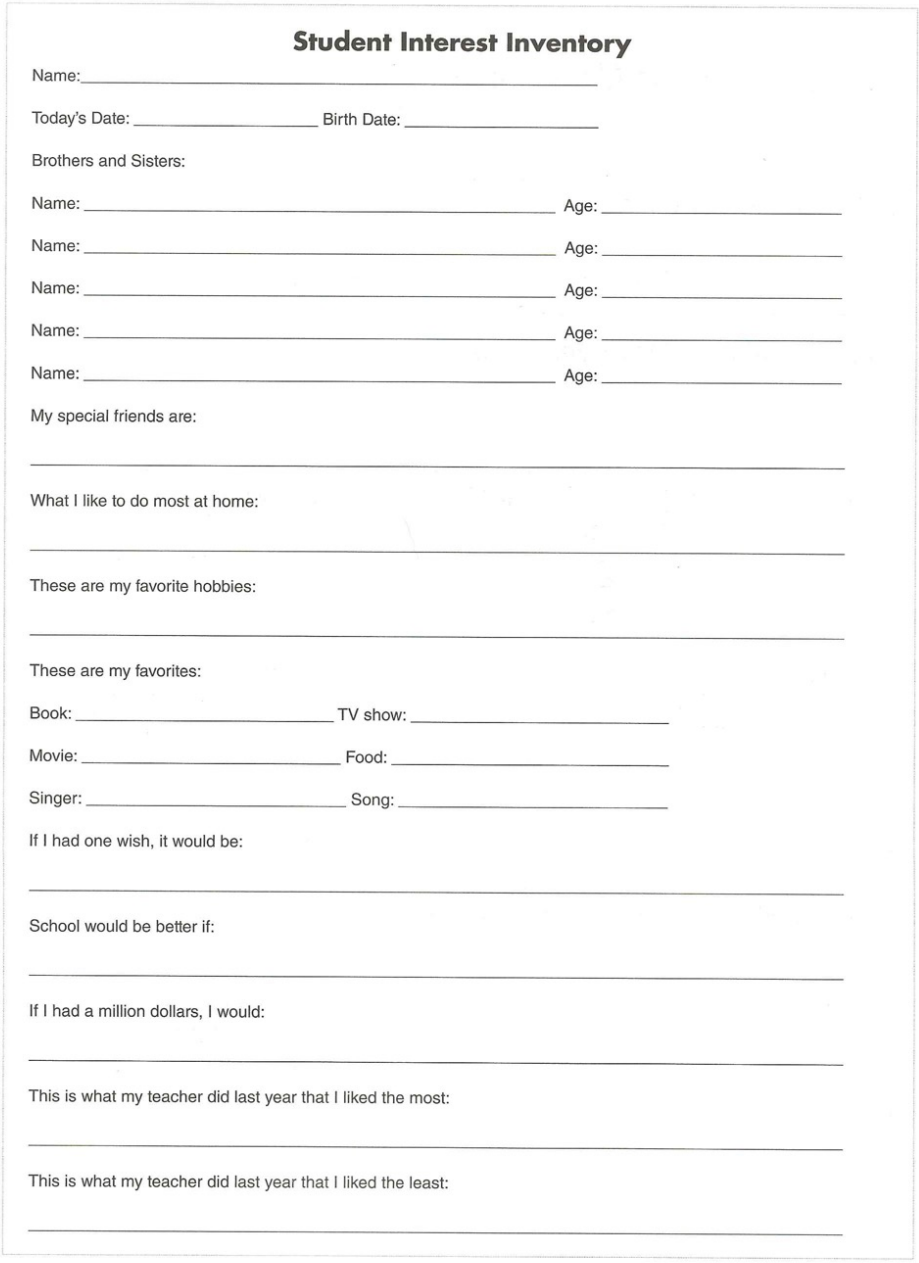
Do You Have Math Anxiety?

Choose from the scale of 1 to 5 to the right of each question, where 5 corresponds to strong agreement with the statement and 1 corresponds to little or no agreement with the statement.

1. I become physically agitated when I have to go to math class. 1 2 3 4 5
2. I am fearful about being asked go to the board in a math class. 1 2 3 4 5
3. I am afraid to ask questions in math class. 1 2 3 4 5
4. I am always worried about being called on in math class. 1 2 3 4 5
5. I understand math now, but I worry that it's going to get really difficult soon. 1 2 3 4 5
6. I tend to lose my concentration in math class. 1 2 3 4 5
7. I fear math tests more than any other kind. 1 2 3 4 5
8. I'm afraid I won't be able to keep up with the rest of the class. 1 2 3 4 5
9. I don't know how to study for mathtests. 1 2 3 4 5
10. It's clear to me in math class, but when I go home it's like I was never there. 1 2 3 4 5

If you score in the 40–50 range it is likely that you have math anxiety to some extent. You should use the results of this survey to help you to understand your current attitude toward math. Do not consider a high total to mean that you are hopeless and will always feel this way. Mathematics anxiety can be reduced and/or prevented.

Appendix B: Student Interest Inventory.
Teachers need to understand their students interest and personal lives to better tailor instruction. Tools like the Student Interest Survey, are an excellent resource for understanding students.



Student Interest Inventory

Name:_____

Today's Date: _____ Birth Date: _____

Brothers and Sisters:

Name: _____ Age: _____

Name: _____ Age: _____

Name: _____ Age: _____

Name: _____ Age: _____

Name: _____ Age: _____

My special friends are:

_____

What I like to do most at home:

_____

These are my favorite hobbies:

_____

These are my favorites:

Book: _____ TV show: _____

Movie: _____ Food: _____

Singer: _____ Song: _____

If I had one wish, it would be:

_____

School would be better if:

_____

If I had a million dollars, I would:

_____

This is what my teacher did last year that I liked the most:

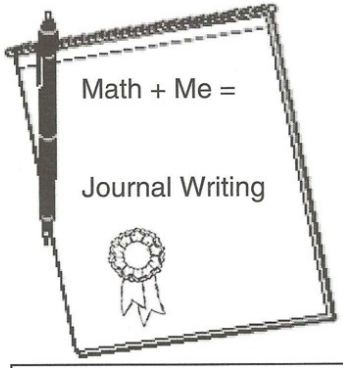
_____

This is what my teacher did last year that I liked the least:

_____

Appendix C: Mathematic Journal, first page.
Starting the mathematical journal can be intimidation, this worksheet helps student engage in the thought process of reflecting on mathematics.

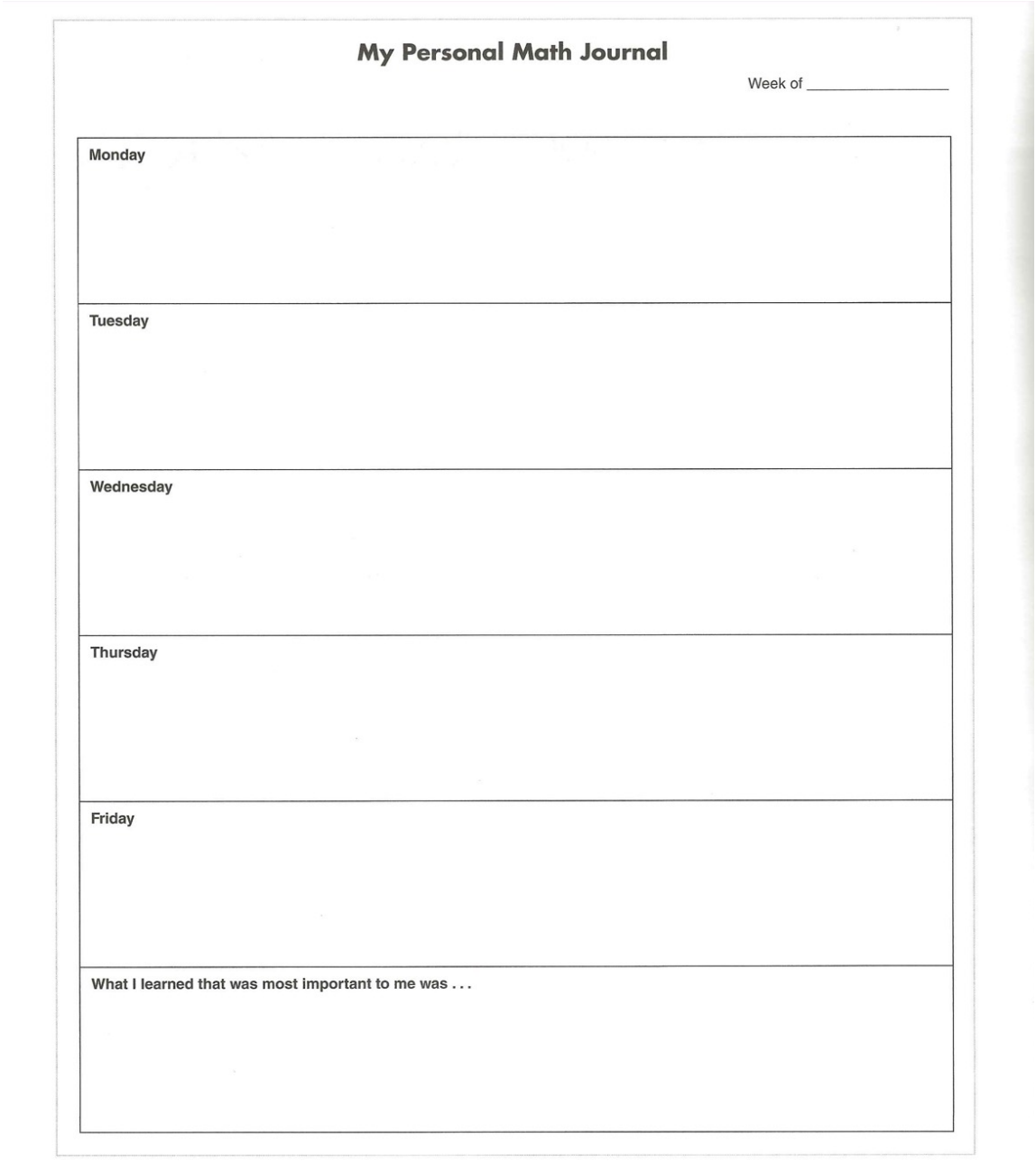
NAME_____DATE_____



Use this page as the first entry in your math journal…

One thing I like best about math is_____
_____
_____
_____
One thing I don't like about math is_____
_____
_____
_____
My favorite math materials are_____
_____
When it comes to math I am strongest at_____
_____
And weakest at_____
_____
A math idea I've heard of but don't know much about is____
_____
I would like to know more about_____
_____
_____

Appendix D: Weekly Journal Organizer.
If students are new to mathematical journaling, this resource is helpful with organizing their thoughts and setting the expectation that mathematical journaling needs to be a daily thought.



My Personal Math Journal

Week of _____

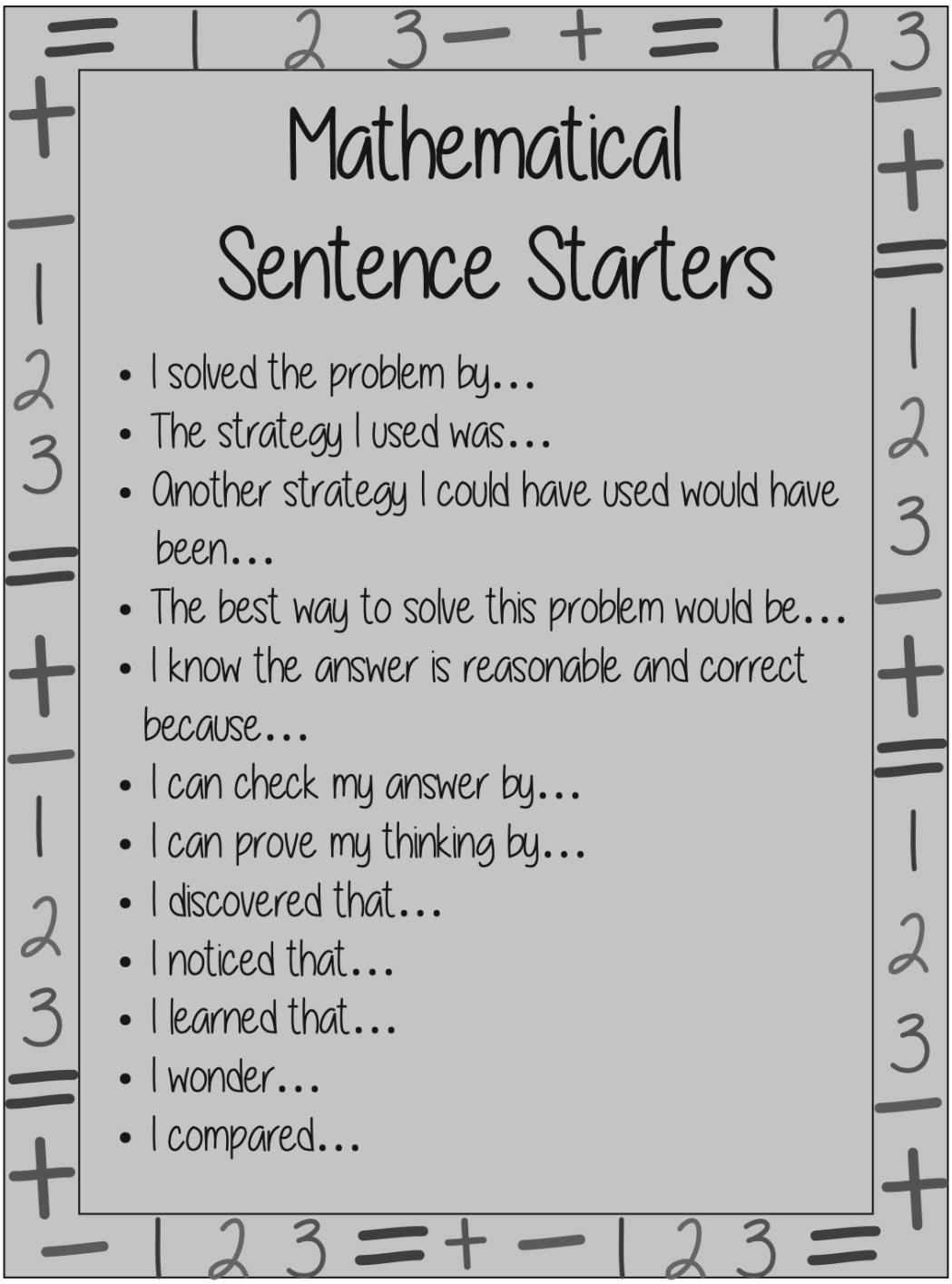
Monday
Tuesday
Wednesday
Thursday
Friday
What I learned that was most important to me was . . .

Appendix E: Mathematical Journal Prompts.

Here is a list of high-quality prompts to access the thought process, initiated through journaling, and to gauge a student's mathematical understanding. These prompts are all sourced from Thoughtco.com by Deb Russell, 2018.

- I knew I was right when.....
- If I missed_____ I would have to_____.
- The thing you have to remember with this kind of problem is.....
- Tips I would give a friend to solve this problem are.....
- I wish I knew more about.....
- How many times did you try to solve the problem? How did you finally solve it?
- Could you have found the answer by doing something different? What?
- What method did you use to solve this problem and why?
- Was this hard or easy? Why?
- Where else could you use this type of problem-solving?
- What would happen if you missed a step? Why?
- What other strategies could you use to solve this problem?
- Write 4 steps for somebody else that will be solving this problem.
- What would you like to do better next time?
- Were you frustrated with this problem? Why or why not?
- What decisions had to be made when solving this problem?
- What do you like about math? What do you not like about math?
- Is math your favorite subject? Why or why not?

Appendix F: Mathematical Sentence Starters.
Utilizing sentence starters will guide the students into mathematical journaling.



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