



The Write Time in Math

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Davidson K8

This curriculum unit is recommended for Students in Third Grade Mathematics

Keywords: writing, talk frames, conversation, vocabulary, area, square units, length, width, dimensions,

Teaching Standards: See [Appendix 1](#) for teaching standards addressed in this unit.

Synopsis: How does a teacher gauge how deeply a student has comprehended a math concept? Did the student truly understand and make a connection to the concept they explored or did they learn a few tricks for computation and “buzz words” they could identify on a multiple-choice test? There is research and evidence that if a student can actively participate in group discussion, fluently, use the associated vocabulary, and write accurately about the application of a skill, then they probably have made true connections and mastered the concept. The goal of this unit is to provide a variety of student-led talk and writing opportunities for elementary students to explore the concept of Area. In these integrated writing and math lessons students will write for a variety of purposes, all focused on standards of Area. Students will demonstrate their understanding of the vocabulary, computation and, knowledge of Area and how they can apply it in realistic word problems.

I plan to teach this unit during the coming year to 22 students in third grade

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By Karyn Hays

Introduction

Rationale

I wrote this unit for several reasons: First, writing is a passion of mine. I enjoy creative writing as a hobby and educators must use their passions to help reach their students. Math was not easy for me as a child. I think this is why I have a deep empathy for children who struggle in math. I am always looking for creative ways to help children comprehend, connect to, and interpret math. I find the challenge to infuse an intentional and purposeful writing component to my daily math instruction a valuable and exciting idea. Adding intentional writing to my math instruction would not be that much of a shift in my instruction. I already use a little bit of writing regularly in my math instruction. My students use math journals from day one in my math class and they are often tasked with copying math vocabulary or concepts, copying word problems and solutions after I have modeled the writing on my whiteboard. We start each lesson with a problem and discuss ideas together about what key terms, numbers, connections, and patterns we notice in the problem. This math talk, which my students are trained to engage in, is essential to the next step of writing about the math. My students are often asked to “explain” their thinking in their math workbooks and provided with a small box to write out an idea in a short sentence. My challenge is to evolve the math talks during this problem solving into a deeper writing experience and grow their knowledge of how to write for other purposes besides just “explaining” a math concept or idea.

Second, there is a recent shift in education recognizing that students must be able to communicate their mathematical reasoning in speaking and writing. The NCTM 2000 Standards state that colleges are reporting students are not able to effectively communicate and many careers in STEM depend on this essential skill. Our third-grade standards reflect this need and expectation. The standards state that students should learn how to give opinions with evidence as support, construct arguments, and demonstrate understanding of a topic in a real or imagined experiences. Students learn that a key purpose of writing is to communicate clearly and coherently. The NC ELA Writing Standards emphasize the importance of writing routinely in order to build knowledge and demonstrate understanding; “SL.3.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others’ ideas and expressing their own clearly”. However; there are few resources available to elementary teachers that focus on how to instruct this type of writing in mathematics. There is the occasional math worksheet sandwiched between multiple skill sheets in a math textbook.

Third, students stumble and freeze when they come across the word “explain” in their math word problems. They have very limited ideas of what is a conjecture, or a generalization is, or how to even begin to answer this type of question. Wouldn’t it be helpful to give students

the tools to feel comfortable with these terms and have a strategy when they encounter these math tasks?

My final reason that I am interested in the idea of infusing writing into my math class is that it relates to a topic I explored several years ago about journaling in science. Teachers who implemented the inquiry method when teaching Science and had students write about their observations, made greater gains in science and reading. The writing helped students make deeper and more solid connections to the science content. Students were more likely to remember the vocabulary, the processes, and the content material, if they were given opportunities to write about the Science they discussed in class. If this happened in Science, why not in Math? As educators we have researched and concluded that students who can write about a concept with correct vocabulary are making deeper connections to the subject matter. After all, you can't fake it when writing because you can't guess and choose A, B, or C on a multiple-choice task. It's also likely that if a student cannot speak or write about a topic, a student does not truly understand it.

Demographics

My school is located north of Charlotte in North Carolina. We are part of the Charlotte Mecklenburg School system in the Northwest Learning Community. We are a suburban school serving grades K-5 and have just recently added a Sixth Grade with the intention of adding one grade level per year to become a K-8 school. I teach a regular education Third Grade class consisting of 22 English speaking students with diverse abilities and backgrounds including African American, Indian student, Latin American, and one child of mixed race and several Caucasian. I have 4 students with reading disabilities including two students who are dyslexic. These students leave class during the day to receive small group instruction with a resource teacher during either reading, or math, or both.

My students' progress is monitored throughout the year by using the NWEA MAP test (Measures of Academic Progress) for reading and math. We also measure their reading progress by using a Beginning of Grade Reading Test and comparing it to an End of Grade Reading Test. We administer an End of Grade Math Test, but we do not have a test at the beginning of the year for Math. I use the data from the MAP Reading and Math tests to inform my instruction, as well as, formal and informal classroom assessments to monitor mastery of the standards by my students. Students who do not pass Third Grade Reading standards by the end of the year are considered for possible retention as required by NC Read-To-Achieve legislature. There is no formal requirement for mastery in math.

Students often encounter questions with writing tasks in our math curriculum, however, many students skip the writing work and just give computation or drawings as their answer or they wait for guided practice on these tasks. With the exception of a few, most students are daunted by writing in math and will avoid it when possible. This is a change from how I typically approach math writing. I usually make it a quick "model and copy" in most lessons, and later in the semester, we discuss how to write simple explanations to a question posed by me or in a workbook task.

Content Research

The pedagogy I use in my classroom for teaching math is well supported by research in the math community and by the mathematics and science standards. The National Council of the Teachers of Mathematics *Principles and Standards for School Mathematics* (2000) states: “Students who have opportunities, encouragement, and support for speaking, writing, reading, and listening in mathematics classes reap dual benefits: they communicate to learn mathematics, and they learn to communicate mathematically” (p. 60). In my classroom, I rely heavily on the use of conversation and questioning in all subject areas to introduce the standards we are exploring. I use the discussion and related texts as a springboard for student to write in some form about the concept in their journals. Research discussed in numerous publications such as Williams’s “Connecting class talk with individual student writing”² all emphasize the necessity of conversation and writing by students in all subject areas. This is the way I prefer to teach and interact with my students. My classroom is rarely silent and surfaces are rarely bare. Students often have a notebook, a graphic organizer, and a text with the content spread out before them. We use these materials daily as we explore the standards of all our curriculum, including math. Research in science supports that daily writing in notebooks allows students to make deeper connections about the topics they are learning and they are more likely to remember what they learned³. Therefore, it makes sense that educators are exploring this valuable learning strategy in math⁴.

Talk Together

To engage students in the writing process, conversation and talk about the math must take place first. Having students talk about their ideas can help their written communication as they move to journal writing. The use of academic conversation has been well documented as an essential skill that students need to be practicing daily in the classroom⁵. The use of student “talk” was also captured and discussed at length in an article written by Casa titled “Connecting class talk with individual student writing”⁶. In the study by Casa, she described a strategy to help students move from academic conversations to writing. She described a first-grade class that was discussing attributes of triangles and using a graphic organizer, the talk frame, to capture their discussion points. Casa also highlighted the numerous benefits of using a “talk frame.” The use of a talk frame graphic organizer written on the board, in front of the students, allowed her to create an interactive graphic organizer that tracked the development of ideas for all the students to see. As students reasoned through a mathematical question she recorded the discussion on the board. This record allowed students and the teacher to refer back to earlier thoughts in the conversation that may have helped further their thinking. Casa was able to get a sense of the class’s depth of understanding as she used the talk frame.⁷ While talking about symmetry with her students she was able to document the student’s conversation, which allowed the students to “see their thinking develop over time, it encouraged them to rely on their own reasoning. The recorded Talk Frame conveyed that their ideas are important, and let them realize that solving problems can result in multiple perspectives”⁸

“Teachers who use the talk frame in the manner described in this article will find that it helps focus the discussion on a significant mathematical topic; encourages concentration on and making sense of students’ ideas; gives time to decide how to navigate the discussion; allows formative assessment of the class and individual students’ depth of understanding; and assists in facilitating the process for the class to come to valid mathematical conclusions”.⁹

Why include conversation when we are talking about math and writing? Because talk is essential to writing at the elementary level. Elementary students are still learning the basics of sentence structure, spelling, and handwriting. They can talk faster than they can write. Most students enjoy talking to their peers so the math becomes collaborative and social. Conversation is key to a classroom experience as it can help students express their knowledge of a math topic and then support them in translating their thinking to writing. Conversation can assist students in thinking more deeply about the “why” of their math. This is a tough skill for students of many ages, and something that I have noticed as a challenge for my third graders. Students are usually looking to each other to provide the correct answer quickly rather than think about why the answer makes sense and is reasonable. This is proof, and not all students understand how to provide evidence of their thinking. Or want to take the time to do this. “Showing your work” is often a skipped step in math as students feel overly confident in knowing the answer and feeling that is sufficient enough. Providing conversation allows students to talk through their ideas, provide proof, and supports creative thinking. This is important to encourage students to feel small steps of success in their problem solving to increase their confidence. They may not have all the steps, or mastered a standard completely, but, after all, there is more than one way to arrive at an answer. If a student has a partial understanding of a concept, conversation can give them the validation that yes, you can do this, and you are almost there, let’s keep going.

Conversation can allow your quieter, timid math students a chance to participate without feeling the pressure to “produce” on the spot. Listening to other students’ conversations, or reading another student’s written explanation to a problem, may validate what the first student was thinking, therefore, helping them make the connection to mastery of a standard. There is great merit in hearing another perspective beyond just the teacher in a math activity. Students can often explain key ideas, concepts, and vocabulary in more “kid friendly” language. For example, in my math class I listened to a conversation where one student was explaining, in his terms, the commutative property to his peer. He described his strategy to his work partner by stating “I flip-flopped it because it doesn’t matter how I write it” This “third-grade-ese” made a lot of sense to the student he was peer coaching through the assignment because his partner then applied the same “flip-flop” approach to the very next problem unassisted.

Turn and talk is another valuable strategy that should be used often in a class math activity. It gives students the opportunity to communicate their thinking, or just talk through an idea. When a problem is first presented to the class, or a new vocabulary word is introduced, I often have my students “turn and talk” and ask them to share what they know about the math problem or what they know about the vocabulary word. This gives them a chance to process the content and share with each other how they connect it. They may recognize something in a word problem they have experienced before or they may notice a math vocabulary term sounds familiar and they encountered in another subject. For example, when discussing arrays in a multiplication lesson, a student shared that the checker board they played earlier at recess that

day was an array. Talking with other students provides a bit of a safety when it comes to math. Some students feel very confident about their math skills because they have mastered the vocabulary and the strategy or skill being discussed. Other students may often feel scared to share with the adult in the room that they don't "really know" the answer. They are afraid of being wrong or being graded. Whereas, after a turn and talk conversation, more often than not, students often have an idea of what to write. They may have picked up more accurate vocabulary, an additional step to their computation, or an idea of how to dissect a word problem.

In the book *Classroom Discussions* by Chapin, O'Connor, & Anderson¹¹, there are multiple examples of different classrooms math conversations going on that are facilitated by the teacher using a variety of "talk moves" to engage the students in rigorous discourse about the math they are exploring that day. The teacher uses strategies such as the use of "reasoning" which encourages students to keep adding their own ideas to the conjectures their classmate's state to see if their reasoning is correct. "Repeating and re-voicing" are also discussed in the article to highlight the effectiveness of a teacher echoing what a student states and being intentional to not interject their own opinions or correcting a student's statements.¹²

For the past ten years, the National Council of Teachers of Mathematics Standards has called for listening, speaking, and writing, in all subject areas of elementary K-5 education.¹³ Teachers are expected to plan for and provide discourse in all subject areas, including math. Curriculum guides and materials include questions for "number talks" and "solve and shares", etc. In my district we use Envisions Curriculum for Third Grade by Pearson. The regular use of academic conversation is key to their lesson component of "solve and share."¹⁴ In class, we also open lessons with number talks where teachers are leading the students in math strategy or number sense discovery conversations. To facilitate this type of conversation, it is beneficial to provide sentence frames and model the use of these statements so students can use this type of talk accurately and more naturally in the classroom.

Once you have established norms and routines for positively sharing ideas through conversation, the next step is to have students write about their math ideas. There are several ways to accomplish this. When planning writing tasks in math it is important to think about what types of writing will actually help strengthen a student's understanding of math concepts. Writing in math will help students communicate their learning as they make sense of the math through words. If they write about their math ideas it can help them remember and connect to the content¹⁵. Students may begin to see patterns or pathways to other math topics. Writing can allow students to reason out their thoughts and see the accuracy of their solutions. It may also help students find connections to a new concept. For example, the use of journaling is a great way to establish a routine for quick exploratory writing in the beginning of a lesson.¹⁶

Organize Their Thinking

Graphic organizers

The use of graphic organizers in writing is not a new strategy in a reading class. However; in a search for graphic organizers for mathematics I found very few or couldn't find any. This suggested to me that graphic organizers are used less in mathematics class. I did find a few examples of the use of graphic organizers in math which I will describe.

There was a study conducted with middle grades students using a graphic organizer (4 Corners and a Diamond) that was adapted for problem solving.¹⁷ The results were very positive in that all teachers reported dramatic improvements in students' mathematics scores on open-response items after implementing the four corners and a diamond graphic organizer. The percentage of students (N=186) who scored at the "meets" or "exceeds" levels on each of the open-response item categories on the pre-test was 4% for math knowledge, 19% for strategic knowledge, and 8% for explanation. After instructing students to use the graphic organizer in mathematical problem solving, the percentage of students scoring "meets" or "exceeds" on the post-test improved to 75% for math knowledge, 68% for strategic knowledge, and 68% for explanation.¹⁸

A talk frame graphic organizer¹⁹ is one tool that teachers and students can use talk as a springboard for their writing. A Talk frame is a type of graphic organizer that allows the teacher to record the discussion taking place so students have a reference to draw ideas from as they write. In her article, Madelyn Williams uses a talk frame in a first-grade classroom to help students make connections and use appropriate vocabulary related to symmetry. The example lesson showcased the class using leaves to study symmetry and the author was capturing the student's statements on a talk frame. Williams took the conversation and the graphic organizer to the next level by tasking students to then write about the class activity on symmetry. The students could use the talk frames as a reference. However; what she found post-lesson is that most of the students added in their own original thoughts and personal experience as a participant in the lesson about symmetry. This showed that the students internalized the content learned and synthesized the ideas as they put it in their own terms. They did not just copy the statements provided in the talk frame.²⁰

Using Writing to Assess Mathematical Understanding

Four types of writing were presented in the article "Write On" by Janine Firmender, Tutita M. Casa, and Madelyn W. Colonnese²¹. Descriptions and purposes for these four types of elementary mathematical writing are explored in depth and provide great reinforcement to the idea that math and writing should be integrated regularly in the elementary classroom²². The suggested purposes for writing discussed are: Exploratory, Informative, Argumentative and Mathematically Creative Writing²³. Exploratory writing can be used to help students connect to a problem, a situation or his or her own thoughts and ideas. Informative writing is helpful for students to engage in as they can use this to explain or describe a concept. Argumentative writing would be used for persuasive writing as they construct or critique an argument. And finally, Creative mathematical writing should be encouraged to allow students the opportunity to expand upon their own ideas, or to demonstrate their mathematical fluency.²⁴ Writing provides another

informal and formal assessment to judge a student's mastery of a math concept.²⁴ I have found that if a student can write an explanation to a question and accurately describe the process by which they arrived at their conclusion they have mastered a concept.

This made me wonder—how I could I incorporate more intentional writing into my math program as an assessment piece? My students tend to write so little when “forced” to give written evidence to a question, (no matter what the topic) would they give me concise responses to an argumentative question or exploratory writing? What could I do to help them feel more comfortable to produce this type of writing? I decided to rely on my background as a reading teacher and find graphic organizers for these writing tasks. Upon my research I have found out this would be a bit of a challenge. So, this is my rationale for this curriculum unit. I plan to use the “talk moves” and “Talk Frame” from Casa/Williams. I have also created a few of my own graphic organizers to help my students organize their thoughts and practice writing the 4 types/purposes for writing. The goal of this unit is for my students to create a mini-portfolio with an examples the types of writing in math: one exploratory piece, one argumentative, one creative, and one explanatory.

Unit Goals

Goals for my students:

1. Students will be able to effectively communicate their knowledge of math concepts using accurate vocabulary and detailed statements in a variety of writing activities
2. Students will identify different purposes for writing in math, how they contrast, and who the audience may be for each type of writing. We will focus on 4 main purposes - exploring, explaining/defining, argumentation (constructing viable arguments), and thinking creatively through writing
3. Students will practice writing for different purposes of mathematical writing within the unit. Students will practice several experiences writing an explanatory entry, a creative entry, an argumentative entry, and an exploratory entry throughout the unit.
4. Students will use graphic organizers that are modeled in class to help them organize their ideas, aid them in including key vocabulary, and guide them through adding elaboration to their mathematical writing.
5. Students will use class discussion and class group notes to generate ideas for writing responses to questions posed in math activities.
6. Students will demonstrate a broader depth of knowledge and comprehension of Area through the use of writing assignments.

My goal for this unit is for all of my students to engage and participate in speaking, listening, and writing for each of the 4 purposes of writing in math. Each student will complete a writing task that contains a graphic organizer related to each of 4 purposes of writing. Each student will write a response to a math problem that addresses the variety of writing purposes: Exploratory, informative, argumentative, and mathematically creative. Each writing task will focus on the topic we are exploring: “Finding the Area of Rectangles”. I plan to pretest

my students on word problems for this topic, then administer a similar word problem post-test on this topic to see if the writing helped increase my student's mastery of solving word problems involving Area.

Students often encounter questions with writing tasks in our math curriculum already, however, many students skip the writing work and just give computation or drawings as their answer - or they wait for guided practice on these tasks. With the exception of a few, most students are daunted by writing in math and will avoid it when possible. This is a change from how I typically approach math writing. I usually make it a quick "model and copy" in most lessons, and later in the semester, we discuss how to write simple explanations to a question posed by me or in a workbook task.

General Teaching Strategies

My instruction for this unit would include introducing each of the four types of mathematical writing used, have the students write a sample problem, (if it was for Exploratory writing for example) in their journal. A graphic organizer will be introduced along with the type of writing we are practicing that day. Each type of question and writing will be discussed whole group, and responses discussed with teacher facilitating the conversation. Then the students will complete the corresponding graphic organizer for the specific purpose of the writing. As students become more proficient in their writing, the graphic organizers could change into something simpler or just an acronym. Writing tasks included in the unit will be creative writing and exploring the concept of area. Students will also engage in persuasive writing by constructing an argument that helps them to solidify their ideas with sound reasons about why a concept works and informative writing where they will define a word or concept from a math lesson.

After we spend time practicing each of the 4 types of mathematical writing - Exploratory, Explanation, Argumentative, and Creative together, my plan is for the students to continue to use these graphic organizers as they respond to each type of writing in future math units.

Instructional Implementation

Third Grade Curriculum Unit Area

Third Grade Math Standards Addressed in this Unit Lessons 1 - 4:

.3.MD.C.5

Recognize area as an attribute of plane figures and understand concepts of area measurement.

.3.MD.C.5.A

a square with side length 1 unit, called "a unit square," is said to have "one square unit" of area, and can be used to measure area.

.3.MD.C.5.B

a plane figure which can be covered without gaps or overlaps by n unit squares is said to have an area of n square units.

.3.MD.C.6

Measure areas by counting unit squares (square cm, square m, square in, square ft., and improvised units).

3. MD.C.7

Relate area to the operations of multiplication and addition

Lesson 1 – Explore! – Introduction to Area with Exploratory Writing

Lesson Objective: Students will cover a flat shape using equally sized squares to visually explore the idea of Area and write about their experience.

Purpose of Lesson: This lesson is designed to have students explore the concept of that a plane figure can be covered by individual square units without gaps and overlaps. This would be used at the beginning of the unit on Area so it should be open-ended and the writing may be non-specific in vocabulary and wording. The writing should include ideas such as covered space, number of squares covering, the “floor” of their designed indoor or outdoor space.

Lesson Materials:

Printed shapes- one for each student Appendix 2

Centimeter grid paper

Inch grid paper

Explore! Graphic organizer Appendix 5

Plastic square tiles from a math kit, any size

Optional – Explore Assessment Rubric

Opening:

1. Hold up a cut shape (see Figure 1). Ask students to pretend that the shape is actually a place that has just been created. It is a new space, but it is unfinished. Give the student's time to think of what this space could be. They should imagine that their space can be any place and can be anywhere, but that they are looking down at it from the perspective of the sky as if they were a bird. The area may be a pool, a park, a room in a house, a favorite place to play a sport, or a favorite place they look to go.
2. Explain the "place" they are looking down at will need a covering – for example if it's outside: maybe grass or pavement. If it's a place inside – it needs wood, tile or floor. Have students turn and talk to neighbors or table group to share ideas about what place they would turn this shape into.
3. Next, ask students to share ideas. Then, ask them how they would cover the "floor" of their shape? Students can share out ideas (ex – wood, carpet, tile, grass, concrete, mulch, etc.)
4. Finally, invite each group to come to the work station and choose 1 cut shape and invite them to give this shape a name and cover the "ground" of this shape using square units.

Guided Practice – Since this is exploratory, do not give too much instruction- let the students create this idea of Area on their own.

Create a work station table and let students choose:

A right angle cut shape

Scissors

Plastic square tiles (or anything similar you may have that you use for hands-on math)

or

Centimeter grid paper - students can cut the squares they need

Inch grid paper- students can cut the squares they need

Guided Practice

1. Teacher circulates and facilitates with directions only
2. Students should name their shape/their “place” a name – is it a room, a park, a sports area such as a basketball court, a pool, etc. This will help them to visualize that they are looking down at the “floor” of their area.
3. Optional – If students choose blank grid paper for squares to cut, they may wish to add decoration to make their cut shape look more realistic. They may want to color, shape or draw on their grid paper BEFORE cutting it into squares
4. Students cut their squares (skip if using plastic tiles) and lay them over their shape until their shape is covered. Teacher circulates to watch if students overlap squares or leave gaps. Teacher may notice - Is the entire shape covered?
5. When students finish- discuss the covered shapes briefly. Teacher may ask: what do you notice about your finished space?
6. Teacher asks the following questions:
Did you overlap or have gaps with your squares? Does this matter when you are covering the area of a space?
Does it matter what size squares you use?
7. Hand out *Explore!* Worksheet to students. Explain to the students that they are going to now describe what they created at their seats. Direct students to look at the topic of their Explore sheet.

For: My Topic, write a sentence starter for the students on the board such as

“My shape was a (*give the name of the place*) and I covered it with _____.) Direct the students to complete their writing by describing how they covered and filled their space. Students should write 3 or 4 details describing the activity and used their space.

Closing

Invite students to create a “gallery walk” by displaying their covered shape and their writing at their seat. All the students can walk around and see what space everyone created with their shape and how they all chose to cover their area. You may want to hand out sticky notes for students to leave comments about what they notice on each student’s “space” or what they wrote.

Lesson 2 Explain – Writing to Explain Area

Lesson Objective: Explain, in writing, to a second grader, how you would know how much carpet to put on the floor of a bedroom with the length of 10 ft. and the width of 12 ft.

Purpose of Lesson: This lesson is designed to be used in the middle of a unit on Area. The idea of this lesson is for students to demonstrate their knowledge of Area and communicate their thinking through written expression. Students would need to have prior knowledge of multiplication by tens, arrays, and introductory lessons about Area.

Lesson Materials:

Graph paper or flat square tiles

Explain! Graphic Organizer – Appendix 6

Large Whiteboard for all students to see

Optional - Explain! Assessment Rubric

Prior to lesson: Draw on chart paper or on whiteboard talk frame bubbles, and other portions of graphic organizer (see Figure 2)

Opening:

1. Prior to the lesson the teacher will write on the whiteboard the following question for students to model and discuss.
2. Gather students together to read and discuss the following problem written on the whiteboard:
“Explain to a second-grader how you would find out how many feet of carpet you would need for the floor of a bedroom that has a length of 10ft. and the width of 12ft.”
3. After wait time, ask the students to turn and talk to their classmates close by to share what their notice about this problem.
4. Teacher can lean in, listen to conversations and can ask additional questions.
5. Call on students to share out what they heard from their conversation. The teacher may want to re-voice what they heard to be sure the group hears the statements being made.
6. Next, Teacher gets the students to visualize what their room looks like. Teacher poses question to the group: Think about your own bedroom. What does it look like? What does the floor look like? Give wait time. Ask for students to give their answers to this question.
7. Teacher poses next question: how big do you think your room might be? Share with your group, or neighbors how you would measure this?
8. Teachers poses next question. Ask the students, if they had to lay down new carpet in their room, what possible ways could they figure out how much carpet they would need? Instruct students to turn and talk with groups/partners to discuss these questions.

Guided Practice:

1. Bring group attention back together. Teacher asks students how could they solve this word problem posed on the board.
2. Teacher asks next question: How could they model this problem using mathematical tools?
3. Show the students flat tile squares and invite the students to pair up and try using the tiles to model the solution to this problem.

Work Time:

1. Provide student pairs with flat tiles so they can model the problem at their seat. (Teacher circulates to see if students know how to create a rectangular 10 by 12 array)
2. Have students label the measurement of the length of the sides of their array. Students can either use graph paper to shade in their array and label their array on the sides with sticky notes, or pencil on pieces of paper, etc.
3. Teacher asks the students: Can you calculate how large a carpet that covers this Area would be, using the labels on the sides of the shape?
Teacher may pose questions that draw out discussion to review vocabulary terms: dimensions, length, and width
4. Direct students to turn and talk about their ideas with students near them
5. Bring group back together and direct their attention to the Talk Frames on the board/ chart paper. Ask the students “How do you know how much carpet you need” Teacher listens as student share out ideas. Facilitate the conversation for students and revoice appropriate vocabulary such as “length, width, dimensions, total number of square units, look for students to explain that area is equal to the number of square units by counting them or by multiplying the length by the width of the square units
6. As students share out- capture student responses in Talk Frames – responses may vary but possible response may include “I know 10 rows of 12 tiles would make an array, a carpet would be an array with sides that are 10 feet long and 12 feet long”
7. Students should be able to explain related multiplication equations that show the computation of area using length multiplied by width.
8. Ask the students “If a Second Grader had to put carpet in their bedroom, how you would direct them to solve this problem? Can you explain the steps? Direct the students back to the original word problem written on the whiteboard. Instruct the students to their task – Explain the directions step by step to a second grader on how to calculate the carpet needed for a 10 by 12 room.
9. Distribute the graphic organizer to the students and have them complete the steps for solving for Area using the discussion notes captured on the talk frames.

Independent Practice:

Students complete the graphic organizer for their writing about Area using the discussion and talk frames completed from the class.

Closing:

Have students share what they wrote. Use the Gallery walk style or simply discuss as students read from their writing.

*****Extension/ Challenge - Use the Distributive property to break apart a larger size bedroom area such as 16 ft. by 12 ft. Or have students calculate the area of a room with a small closet that is adjacent to a room that is 8ft by 8 ft.

Lesson 3 – Persuade! Argumentative writing about Area

Lesson objective: Write accurately about a strategy of how to find Area to persuade someone to use it.

Purpose of lesson: This lesson is designed to give students practice in how to discuss and defend different strategies for solving a problem using the measurement of Area. Students will discuss the problem and construct an argument using the properties of Area to defend why their solution is reasonable. This lesson would be introduced after the basic introductory lessons of Area has been taught. Students should know: length, width, area, square units, how to solve for area using the formula length multiplied by width.

Lesson Materials:

Large whiteboard for all students to see – Talk Frame written on board prior to lesson to record student thinking

Persuade! Graphic Organizer – Appendix 7

Journals, paper, or small whiteboards for students to draw and write out the word problem

Sticky notes

Optional – Persuade Assessment Rubric

Guided Practice:

Opening:

1. Students gathered in a group to read and discuss the question written on the board :

“Is the total area of a rectangular room larger or smaller when the rectangle is separated into two parts? Why or Why not?”

2. Teacher gives wait time as students think about this question.
3. After wait time, direct students to turn and talk to their neighbor about what they know about this question.
4. Teacher calls on students to share ideas. As students share, teacher records ideas on the Talk Frame on the whiteboard
5. Teacher explains that they are recording “student thinking” on the graphic organizer to help capture thinking “out loud” and help back up ideas with facts
6. Teacher calls out each subheading on the graphic organizer to model how to complete each section.
 - a) Teacher models filling in the topic question
 - b) Teacher models filling in the “Don’t Hold In My Head” Teacher poses question “What facts do we know about area” – writes down the facts the students know about area
 - c) Teacher models filling in the as Talk Frames portion of graphic organizer. Teacher poses question “what do you think about this question?” Teacher records student ideas in each of the three bubbles. -Teacher models “thinking out loud” after thinking about the conversation, rereads the Facts I Know.
 - d) Teacher circles I agree/I disagree
 - e) Teacher calls on students. What should we draw/write in proof/evidence of ideas
 - f) Teacher models using the drawings and notes to complete bottom writing section “I agree or I disagree because....

Independent Practice:

1. Teacher poses this question to the class – written on board, or on paper

“If you take a 9×8 rectangle and cut it into two smaller rectangles, will the sum of the two smaller rectangles equal the area of the original rectangle. “

2. Group students in groups of 3 or 4. Let students talk through the problem presented with their groups. When students feel “ready” – students can take a graphic organizer to complete back at their seat.
3. Students complete graphic organizer independently.

Closing:

1. When all students have finished writing, display all written responses. Have a Gallery walk with responses written on the graphic organizer.

2. Give each student a sticky note. Direct students to walk to the next desk away from their own and find a response sheet. They need to read the argument and respond on their post-it. Do they agree or disagree with the strategy written and presented on the graphic organizer? Students should write a response and stick it to the response sheet to show if they were “persuaded, or not”

Lesson 4 – Describe! Mid- Unit Writing Project

Materials:

Explore! Graphic Organizer, Appendix 5

Gridded Graph Anchor Chart paper (buy a pad for several teacher to share or create your own) – you could also use a grid drawn on your whiteboard or projected on Smartboard

Grid paper for students

Lesson objective: Students can write an accurate description of a space using the concept of area

End of Lesson Assessment: This lesson is designed to be used as an extension or assessment at the mid or end of a unit on Area. Students will write an exploratory piece describing an outdoor space for their school that uses rectangles to show the areas of their designed space.

Opening:

1. Using a Smartboard or just several large photographs - display a picture of a bird’s eye view of a playground similar to this example.
2. Ask the students to observe the objects they recognize in the picture. What is planned out for this school outdoor space for kids play?
3. Have students share out what they notice in the picture. Record their observations on the board as this will create a word bank for students to use later when they write their own plans.
4. Explain how designers plan their space and they create blueprints and drawings to plan out how to use a space. They use accurate measurements to mark off the play spaces.



Guided Practice:

1. Teacher modeling- Using the classroom, explain that if the students were designers how would they explain the plan for the classroom they are sitting in right now? Ask the students to imagine if you “peeled the roof off” of your school and looked down in your classroom, what would you see? Have the students share out examples of what they see in the room as they are pretending to look down.
2. As they share – (desk, teacher desk, bookcase, carpet, door, tables, etc.) teacher can model drawing these items on gridded anchor chart paper using simple small rectangles or squares. Label the objects on the chart paper and use the same size/shape for objects that repeat – 4 squares will be desks, etc.
3. Square units – Discuss with the students the use of grid squares as your unit of measure. A square is one unit. (You will not focus on units equal to inches or centimeters as this is an exploratory unit just to have students feel comfortable with the idea of squares covering a space- but this is optional.)
4. Discuss- why rectangles or squares? If an object is round – why not use a circle? Explain that for today, we are just showing the area used for this furniture so it does not have to be an exact picture. For example: a desk may equal 4 squares, a bookcase may equal two equal rows of 6 or 8 squares. A round table can be shown with a circle to show the amount of floor space needed for the table. This will lead to more in depth conversation about the Area of irregular shapes.
5. When the class drawing is completed, discuss the design and use of space. Describe the objects in the room in terms of area. How many *squares on the grid* did you need for a student desk? How many squares was the *area* for the carpet? The door has a large area from the ground view, but when looking down at the door, you only see the top area which is thin – (maybe 6 squares across?) Discuss how objects use space when they are in use, such as the door.
6. Writing. Teacher models writing what you see from the drawing.

Independent Practice:

1. Explain that the students will design and write about their own space. They will become designers and create a playground for their school on grid paper. They can be creative and put anything they think would be fun to have in their playground. The students will draw the shapes on the grid paper as space from a bird's eye view and have to describe it in their writing in terms of the shapes (rectangles, squares, etc.) and explain the area they used.
2. Suggestion: To help students finish in a reasonable amount of time, limit the initial plan of the playground to 5 or 6 items but the students can include fun ideas that may not normally be found at school (a skating rink, maybe a pool, a garden, a sandbox, a fountain, tennis court, etc.) .
3. Distribute Explore planning sheet graphic organizer
4. Give students time to plan and sketch out their ideas for their playground on the plan sheet.
5. Teacher approves rough draft
6. Distribute the grid paper students will draw their playground in pencil
7. Writing – students will write about their design explaining how much area was used by each part of their playground. They will need to include how long and wide each playground space is.

Closing:

Students can share their plans and writing creating an “Area Art Gallery” for other students in the class to tour and see their work.

Lesson 5 – Create! Creative Writing

Materials:

Create a work “station” table in your classroom that includes the following materials

Graph paper

Plastic 1inch square tiles for creating ideas

Explore! Graphic Organizer, Appendix 5

Optional – Assessment Rubric Creative Writing

Lesson Objective: Connect and extend learning of the standards related to Area

Purpose of Lesson: This lesson is designed for students to write creatively about a space designed using the concept of Area

Independent Practice:

In this “Create” station, have the math tools available on a work surface or tub for students to use to model and write about Area.

Prompt:

Imagine you are a designer for the Treehouse Company, “Treetop Homes” Create two or three treehouse floorplans for people to choose from that your company will build for them. Create a pamphlet that has a description of the area for each floorplan.

Student directions:

To create the pamphlet – fold centimeter grid paper into thirds to create 3 long rectangular panels. Use the top portion of each panel to draw out your design. Use the bottom half of each panel to write about your plan.

Helpful Hints:

Use the materials such as the tiles to plan out your designs. Then draw them on the pamphlet grid paper.

Treehouse platforms can be any shape and may have a tree growing through them so the area may be a shape other than a rectangle.

Treehouses can have multiple floors.

Closing:

Share your Treehouse Pamphlet with the class.

Appendix 1: Teaching Standards

The standards in the unit are from the North Carolina Department of Instruction. They are from the new course of study effective in all North Carolina schools starting in the 2018-19 school year.

Third Grade Math Curriculum Alignment

.3.MD.C.5

Recognize area as an attribute of plane figures and understand concepts of area measurement.

Students will practice covering a shape with squares

.3.MD.C.5.A

a square with side length 1 unit, called "a unit square," is said to have "one square unit" of area, and can be used to measure area.

Throughout this unit, students will manipulate and count squares as they practice measuring spaces in Area.

.3.MD.C.5.B

a plane figure which can be covered without gaps or overlaps by n unit squares is said to have an area of n square units.

Students will practice counting and covering figures with squares and addressing the idea that each square should overlap or be spaced incorrectly as this not accurate when counting area.

.3.MD.C.6

Measure areas by counting unit squares (square cm, square m, square in, square ft., and improvised units).

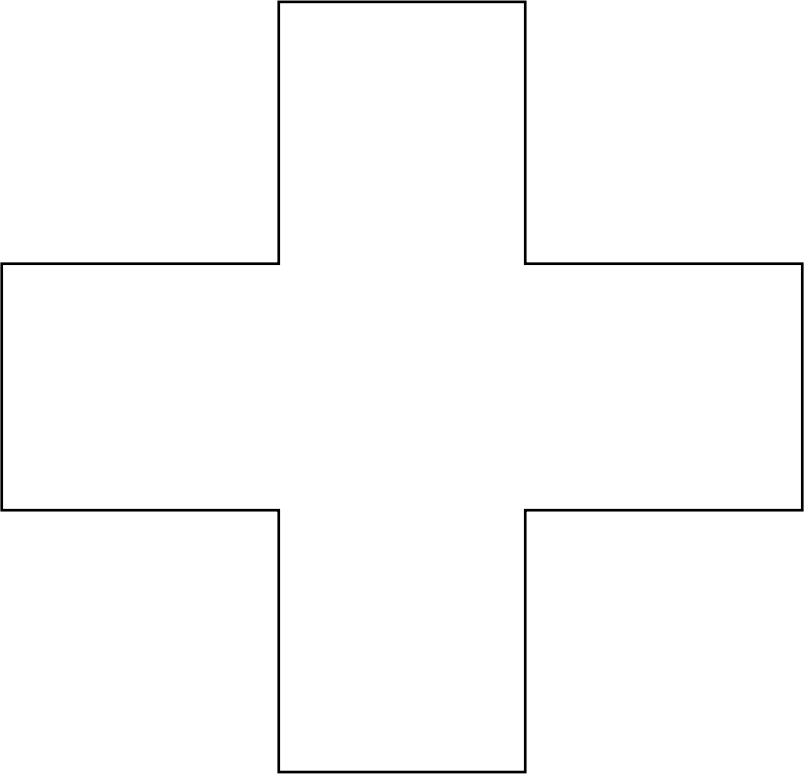
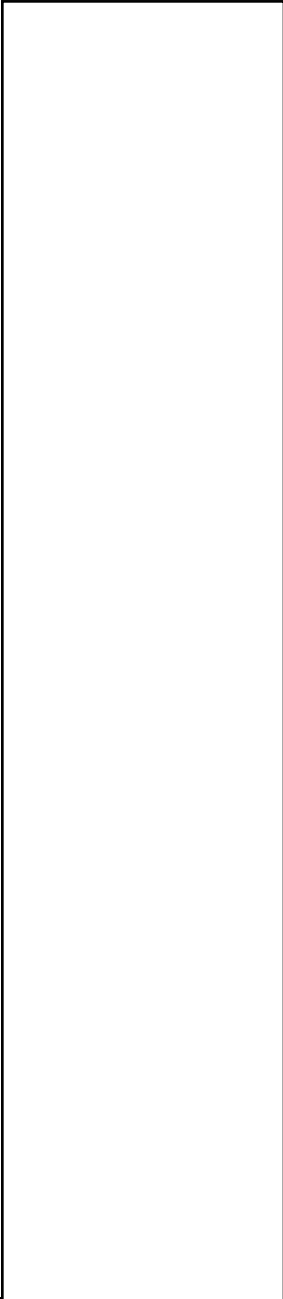
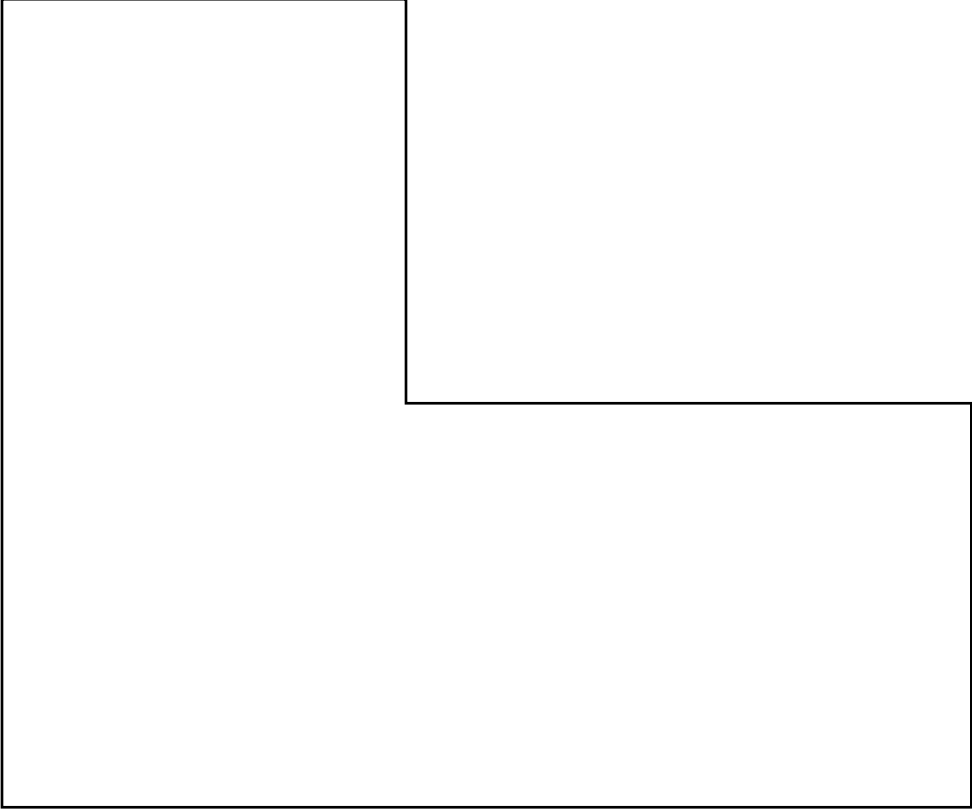
Students will use graph paper and manipulate square tiles to represent unit squares they can count to find the area of a given space.

3. MD.C.7

Relate area to the operations of multiplication and addition.

Students will model addition and multiplication using arrays to discover the correlation that Area can be calculated in a multiple ways...

Appendix 2 Lesson 1 Printed Shapes

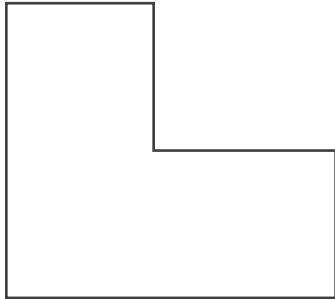



Appendix 3 –Assessment Pretest

Area Pretest

Name _____

Answer the question to each problem. If you need more space to draw or write your answer, use the notebook paper provided.

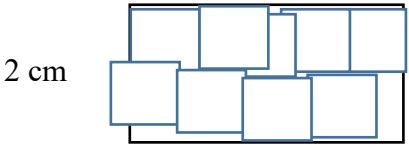
<p>1. Explain how many squares it would take to cover this shape.</p> 	<p>2. Explain to a first grader how you would find out how many feet of carpet you would need for the floor of a bedroom that has a length of 10ft. and the width of 15ft. (You may use this space to draw your idea)</p>
<p>Answer:</p> <hr/> <hr/> <hr/> <hr/>	<p>Answer:</p> <hr/> <hr/> <hr/> <hr/>
<p>3. A student only has 12-centimeter squares to cover the area of this rectangle. She says you can use less tiles to cover this rectangle if you just spread them apart a little so they mostly cover the rectangle. Is this true? Explain why you agree or disagree with this student.</p> <p style="text-align: center;">6cm</p>  <p>3 cm</p>	<p>4. If you take a rectangle that is 7ft by 9ft and separate it into two smaller rectangles, will the sum of the two smaller rectangles equal the area of the whole rectangle?</p>
<p>Answer:</p> <hr/> <hr/> <hr/> <hr/>	<p>Answer:</p> <hr/> <hr/> <hr/> <hr/>

Appendix 4

Area Post – Test

Name _____

Answer the question to each problem. If you need more space to draw or write your answer, use the notebook paper provided.

<p>1. Draw a shape with only rectangles. Explain how you can cover the area of this shape</p>	<p>2. Explain to a friend how you would find out how many feet of carpet you would need for the floor of a living room that has a length of 20ft. and the width of 12ft. (You may use this space to draw your idea)</p>
<p>Answer:</p> <hr/> <hr/> <hr/> <hr/>	<p>Answer:</p> <hr/> <hr/> <hr/> <hr/>
<p>3. A student says the area of this rectangle is 10 square cm. Is this true? Explain why you agree or disagree with this student.</p> <p style="text-align: center;">4cm</p>  <p>2 cm</p>	<p>4. If a rectangle that is 10ft by 8ft is separated into two smaller rectangles, will the sum of the two smaller rectangles equal the area of the whole rectangle?</p>
<p>Answer:</p> <hr/> <hr/> <hr/> <hr/>	<p>Answer:</p> <hr/> <hr/> <hr/> <hr/>

Appendix 5

Explore! Writing to Explore Graphic Organizer

My Topic:

Word Bank: What words must I include in my writing?

Draw out your idea. Label the parts of your drawing!

Appendix 6

Explain! Writing to Explain Graphic Organizer



Write the problem here:

Key Vocabulary

Talk Notes:

Three identical empty speech bubble shapes are arranged horizontally. Each bubble has a rounded top and a pointed bottom, with a small notch at the bottom center.

I took several steps to solve my problem.

First, _____

Second, _____

Next, _____

Finally, _____


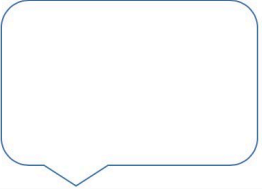
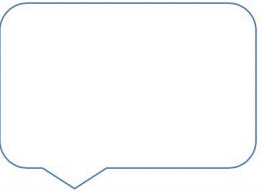
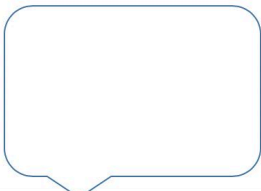
I think _____

because _____

Appendix 7

Persuade! I Agree/ I Disagree

Construct an Argument Graphic Organizer

The topic question: _____ _____		
Don't hold in your head! Tell the facts I know: Write or Draw what you know about the topic!		
	I heard : 	I heard : 
		I heard: 
Circle one – I agree / I disagree		
My argument: I agree/Is disagree that _____ because _____ _____		

Appendix 8

Explore! – Graphic Organizer Assessment rubric

Explore! Writing Guidelines	Student check	Teacher check
Student used a topic sentence My shape was a...		
Student included at least one detail that explains the idea of covering the “area” of the shape		
Student showed or told how many squares were used to cover the space accurately		
The shape was covered with unit squares with no gaps or overlaps		

Explain! Graphic Organizer Assessment Rubric

Writing Guidelines	Student Checklist	Teacher Checklist
Student wrote the problem stated		
Student wrote key vocabulary words for area		
Student included ideas from the Turn and Talk discussion		
Student completed the steps written accurately for each part of the solution		
Student completed I think and because section to show their explanation		

Appendix 9

Persuade! Construct an Argument! Assessment Rubric

	Student Checklist	Teacher Checklist
Student wrote topic question		
Student wrote or draw details about the topic		
Student wrote what they heard from the discussion		
Student explained whether they agree or disagree and gave facts for their opinion		

Creative Writing Assessment Rubric – Treehouse Pamphlet

	Student Checklist	Teacher Check
Student measured Area of treehouse platforms accurately with square units		
Student created 3 or more floor plans for treehouse pamphlet		
Student described the dimensions of each Treehouse platform accurately in the pamphlet		
Student included vocabulary from our unit study of Area		

Endnotes

- ¹ National Council of Teachers of Mathematics, ed. Principles and standards for school mathematics. Vol. 1. National Council of Teachers of, 2000.
- ² Williams, Madelyn M., and Tutita M. Casa. "Connecting class talk with individual student writing." *Teaching Children's Mathematics* 18, no. 5 (2012):
- ³ Butler, Malcolm B., and Catherine Nesbit. "Using science notebooks to improve writing skills and conceptual understanding." *Science Activities* 44, no. 4 (2008): 137-146.
- ⁴ Stewart, Carolyn, and Lucindia Chance. "Making Connections: Journal Writing and the" Professional Teaching Standards"." *The Mathematics Teacher* 88, no. 2 (1995): 92-95.
- ⁵ Chapin, Suzanne H., Catherine O'Connor, Mary Catherine O'Connor, and Nancy Canavan Anderson. Classroom discussions: Using math talk to help students learn, Grades K-6. Math Solutions, 2009.
- ⁶ Williams, Madelyn M., and Tutita M. Casa. "Connecting class talk with individual student writing." *Teaching Children's Mathematics* 18, no. 5 (2012): 315.
- ⁷ Ibid
- ⁸ Ibid
- ⁹ Ibid
- ¹⁰ Bossé, Michael J., and Johna Faulconer. "Learning and assessing mathematics through reading and writing." *School Science and Mathematics* 108, no. 1 (2008): 8-19.
- ¹¹ Chapin, Suzanne H., Classroom discussions: Using math talk
- ¹² Ibid
- ¹³ NC ELA Standard Course of study
<http://www.ncpublicschools.org/docs/curriculum/languagearts/scos/extended-k12.pdf>
- ¹⁴ Math Programs | Pearson | enVisionmath2.0 (K-5) | Grade 3 <https://www.pearsonschool.com>.
- ¹⁵ Cohen, Jeremy A., Tutita M. Casa, Heather C. Miller, and Janine M. Firmender. "Characteristics of Second Graders' Mathematical Writing
- ¹⁶ Burns, Marilyn, and Robyn Silbey. "Math journals boost real learning
- ¹⁷ Zollman, Alan. "Students use graphic organizers to improve mathematical problem-solving communications."
- ¹⁸ Firmender, Janine M., Tutita M. Casa, and Madelynn W. Colonnese. "Write on." *Teaching Children Mathematics* 24, no. 2 (2017): 84-92.
- ¹⁹ Williams, Madelyn M., and Tutita M. Casa. "Connecting class talk with individual student writing." *Teaching Children's Mathematics* 18, no. 5 (2012): 315.
- ²⁰ Ibid
- ²¹ Firmender, Janine M., Tutita M. Casa, and Madelynn W. Colonnese. "Write on." *Teaching Children Mathematics* 24, no. 2 (2017): 84-92.
- ²² Ibid
- ²³ Ibid
- ²⁴ Firmender, Janine M., Tutita M. Casa, and Madelynn W. Colonnese. "Write on." *Teaching Children Mathematics* 24, no. 2 (2017): 84-92.

Materials for Classroom Use

Resources for Teacher Use

Envision Math Curriculum - <https://www.pearsonschool.com/index.cfm?locator=PS2nU9>

Resources for Student Use

Graph Paper - <https://print-graph-paper.com/>

Plastic math tiles - <https://www.walmart.com/ip/Learning-Resources-Square-Color-Tiles-Sorting-Counting-Set-of-400-Ages-5/24886374>

Annotated Bibliography

- Adu-Gyamfi, K., Bosse, M. J., & Faulconer, J. (2010). Assessing understanding through reading and writing in mathematics. *International Journal for Mathematics Teaching & Learning*, paper 205
This resource reinforces the idea that student learning can be assessed more deeply beyond just multiple-choice testing.
- Bagley, Theresa, and Catarina Gallenberger. "Assessing Students' Disposition: Using Journal to Improve Students' Performance." *Mathematics Teacher* 85, no. 8 (1992): 660-63.
This article provides evidence that writing directly impacts student learning
- Bicer, Ali, Robert M. Capraro, and Mary M. Capraro. "Integrating Writing into Mathematics Classroom to Increase Students' Problem Solving Skills." *International Online Journal of Educational Sciences* 5, no. 2 (2013).
This resource highlights the benefits of giving students more writing opportunities to help them become more effective problem solvers
- Butler, Malcolm B., and Catherine Nesbit. "Using science notebooks to improve writing skills and conceptual understanding." *Science Activities* 44, no. 4 (2008): 137-146.
This resource explains the benefits of integrating writing into a subject area to help strengthen students' comprehension of a content area
- Burns, Marilyn. "Writing in math." *Educational Leadership* 62, no. 2 (2004): 30-33.
This resource highlights why writing in math is beneficial to students
- Burns, Marilyn, and Robyn Silbey. "Math journals boost real learning." *Instructor* 110, no. 7 (2001): 18-20.
This article provides evidence for the idea that math journaling is essential to student learning in mathematics.
- Casa, T. M., Firmender, J. M., Cahill, J., Cardetti, F., Choppin, J. M., Cohen, J., Zawodniak, R. (2016). Types of and purposes for elementary mathematical writing: Task force recommendations. Retrieved from <http://mathwriting.education.uconn.edu>.
This article explains the four types of writing teachers can implement in their math instruction
- Casa, Tutita M., Juliana R. MacSwan, Kara E. LaMonica, Madelyn W. Colonnese, and Janine M. Firmender. "An analysis of the amount and characteristics of writing prompts in Grade 3 mathematics student books." *School Science and Mathematics* 119, no. 4 (2019): 176-189.
This resource takes a closer look at the type of questioning in standard math textbook programs

Chapin, Suzanne H., Catherine O'Connor, Mary Catherine O'Connor, and Nancy Canavan Anderson. *Classroom discussions: Using math talk to help students learn, Grades K-6*. Math Solutions, 2009.

This article explains the “why” and “how” math talk can be used as an effective teaching strategy

Cohen, Jeremy A., Tutita M. Casa, Heather C. Miller, and Janine M. Firmender. "Characteristics of Second Graders' Mathematical Writing." *School Science and Mathematics* 115, no. 7 (2015): 344-355.

This resource highlights examples of writing in an elementary classroom and its effectiveness.

Common Core State Standards Initiative. *Common Core State Standards for Mathematics*. Washington, DC: NGA Center and ImCCSSO, 2010.

http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf

The website lists the Common Core State Standards, Mathematical Practices, and provides examples of mathematical situations relating to the standards. It explains each standard for each topic and grade level. It teaches the reader how to read and interpret each standard.

Firmender, Janine M., Tutita M. Casa, and Madelynn W. Colonnese. "Write on." *Teaching Children Mathematics* 24, no. 2 (2017): 84-92.

This article gives examples of how writing is an important part of mathematics instruction

Firmender, Janine M., Anna Dilley, Christina Amspaugh, Kathryn Field, Steven LeMay, and Tutita M. Casa. "Beyond doing mathematics: Engaging talented students in mathematically creative writing." *Gifted Child Today* 40, no. 4 (2017): 205-211.

This resource highlights the benefits of using creative writing to further the learning of high-level math learners

Franke, Megan L., Angela C. Turrou, Noreen M. Webb, Marsha Ing, Jacqueline Wong, Nami Shin, and Cecilia Fernandez. "Student engagement with others' mathematical ideas: The role of teacher invitation and support moves." *The Elementary School Journal* 116, no. 1 (2015): 126-148.

This article highlights the effectiveness of best teaching practices when it comes to increasing student engagement in math

National Council of Teachers of Mathematics, ed. *Principles and standards for school mathematics*. Vol. 1. National Council of Teachers of, 2000.

This resource explains best practices and expectations of math teaching.

Palmer, Kristy M. "Learning Mathematics the Write Way: How does Writing in Mathematics affect Mathematics Learning in Middle School?" (2018).

https://repository.uwyo.edu/smtc_plan_b/70/

This article highlights the use of writing in an intermediate grades math class and how it affects student outcomes

Pearson | enVisionmath2.0 (K-5) | Grade 3 <https://www.pearsonschool.com>

This is the website to the primary math resource our school system uses for math instruction in grade k-5

Pugalee, David K. "Writing, mathematics, and metacognition: Looking for connections through students' work in mathematical problem solving." *School science and mathematics* 101, no. 5 (2001): 236-245.

This resource highlights how writing reinforces student connections to math problem solving

Rossi, D. W. "Using elementary interactive science journals to encourage reflection, learning and positive attitudes toward science." Retrieved October 18 (2004): 2005.

https://www.utdallas.edu/sme/files/Using_Elementary_Interactive_Science_JournalsDRW.pdf

This article explains the many benefits of journaling in subject areas outside of English Language Arts, such as Science

Stewart, Carolyn, and Lucindia Chance. "Making Connections: Journal Writing and the Professional Teaching Standards." *The Mathematics Teacher* 88, no. 2 (1995): 92-95.

This resource explains how journal writing supports best teaching practices

Williams, Madelyn M., and Tutita M. Casa. "Connecting class talk with individual student writing." *Teaching Children's Mathematics* 18, no. 5 (2012): 314-321.

This article explains the effectiveness of rich class discussions

Zollman, Alan. "Students use graphic organizers to improve mathematical problem-solving communications." *Middle School Journal* 41, no. 2 (2009): 4-12.

This article provides further evidence and explains why graphic organizers are a worthwhile resource for students to use for communicating their ideas.