



Writing Breaks in Mathematics

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This curriculum unit is recommended for:
North Carolina High School Math Teachers

Keywords: writing breaks, quadratics, mathematics, exit slips

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

Synopsis: Writing has great implications for the student and for one who teaches mathematics. I have noticed that students in high school need development of their writing skills in mathematics. When high school students are assigned real world questions their answers to the questions are sometimes left blank or answered with very few words that do not include an explanation. The purpose of this unit is to provide the students in my freshman and sophomore classes with opportunities to increase their understanding of concepts, and help them to make connections, by using “Writing Breaks and “Reflection Writing” to increase active engagement in mathematics. Written communication is an important skill for all students, when creativity and written discourse unites in mathematically creative writing, students are challenged to engage in higher-level mathematical reasoning and communication.

I plan to teach this unit during the coming year to (132) students in NC Mathematics 1 and Mathematics 2.

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Introduction

Demographics at Northwest School of Arts is a B+ magnet public school located in Charlotte, North Carolina. Northwest School of Arts is, according to “Niche” an online site, known for being the second best High School of Arts in North Carolina. The demographics at Northwest School of the Arts has about 1138 students. The school serves grades six through 12th grade. The student body consist of a diverse population that include 12.80% Hispanic/ Latino, 30% Native Hawaiian, Pacific, .10% American Indian/ 35.7 % Caucasian or White, 1.0% Asian, 4.5 two or more races, 45.7 Black or African American. Only 6% of students receive free or reduced lunch.

The students who attend NWSA combine academics and a concentration in the study of visual or performing arts. Students choose to major in Band, Chorus, Costume Design, Dance, Musical Theatre, Orchestra, Piano, Theatre, Technical Theatre, or Visual Arts. High School students in grades nine to twelve can have more than one major.

NWSA students attend classes using an “A” day “B” day schedule, which means that my students attend class every other day. Students attend class for 90 minutes block scheduling. This school year I am teaching four NC Math 2 classes, one is Honors Math 2. I also teach two NC Math 1 classes. Class periods 1A has 14 students, class period 2A has 16 students, class period 3A has 28 students, class period 1B has 23 students, class period 2B has 21 students and class 3B has 30 students.

Demographics

I have been teaching for 20 years, I have noticed that my students have struggled interpreting and annotating questions, which led to their inability to solve and explain the questions. The district provides online resources for the teachers and students. We are encouraged to use our district materials to incorporate concept skills and guided practice. These resources also provide application problems to help contextualize the mathematics and to enhance the rigor for all NC Math 2 instruction. During instruction, my students want to write almost every sentence that is present to them from the Canvas online resource. I have tried to encourage students to pre-read, summarize the text, and pre-write the “Introduction and Key Concepts” and “Guided Examples”. Students continued to write during instruction. So, finally, I decided to assign the examples to my students so that they are prepared when they attend class. This would require that they write and review examples, answers and calculations already copied into their workbooks.

Rationale and Content Objectives

Mathematics teachers are being encouraged to implement various writing activities into their instruction; however, there is insufficient research to provide a basis or rationale for such practices. Improving a student's writing skills can improve their ability to learn Mathematics. Writing can help build a community in the classroom; it is a way for students to learn about themselves and their classmates. Writing challenges students to problem solve and think critically. Writing can improve the students' active engagement in the content taught, understanding in depth information given, make connections and allows time for students to formulate questions. Student will need to take lecture notes in college and because high school should prepare students for the future, students need to start putting their thoughts into words by writing.

Encouraging all students to share mathematically creative ideas through writing addresses twenty-first century goals to prepare students to become potential leaders and problem solvers. Promoting mathematical creativity and mathematically creative writing allows students to extend their understanding, seek new solutions, strategies and applications in mathematical discourse.

Creating a learning environment to encourage students to write in mathematics requires strategies to enforce a positive classroom for mathematically creativity. The following strategies are from the article "Beyond Doing Mathematics: Engaging Talented Students in Mathematically Creative Writing" (Firmender, Dilley, & Amspaugh, 2017). Teachers should promote the belief that all students can be creative. This would require a respect for all students' ideas, encouraging questions and risk taking. Embracing errors as a necessary part of the writing process. The use of failures and feedback to inform growth throughout the creative process and provide enough time for the process. Engaging students in depth, complexity, with challenging high-level mathematical tasks. Use of multiple approaches and strategies to solve problems. Engaging all students in oral and written discourse. Establishing rules and expectations for class discussions. Provide timely, risk free opportunities for constructive criticism and positive feedback.

Content

The content in this unit is from the North Carolina State Standards. The focus is that students will understand quadratics is a second-degree polynomial that are represented as Parabolic. Students should recognize the relationship that exist between a polynomials' factors, zeros, roots and x-intercepts. It is important that students are able to interpret, compare, and analyze quadratics in different representations such as tables, graphs, algebraic expressions, and verbal descriptions.

Content Research

The following questions were posed in the article “Beyond Doing Mathematics: Engaging Talented Students in Mathematically Creative Writing” (Firmender, Dilley, & Amspauagh, 2017) What is mathematical creativity? What are the characteristics of a learning environment that fosters mathematical creativity and written communication? Mathematical creativity is one way to advance mathematical reasoning, which requires creative thinking. Creative thinking can be defined as a combination of logical thinking and divergent thinking.

Creative mathematical thinking is important because the essence of mathematics is thinking creativity, not simply arriving at the right answers (Mann, 2006). Mathematically creative writing is one way to encourage creative mathematical thinking. The National Council of Teachers has made recommendations about how important written communication in mathematics is for students to explore and share ideas (NCTM, 1991 & 2000). The Common Core Standards also made recommendations that students should be engaged in “constructing viable arguments and critiquing the reasoning of others” (CCSSI, 2010, p. 6).

An unpublished doctoral dissertation, conducted a study at Louisiana State University and Agricultural and Mechanical College. The reason of this study was to address whether metacognitive skills were influenced by expressive writing in introductory algebra classes. Twenty students were selected randomly from a high school student body of 1,150 students. This study found that the form to employ, the engagement of students in a communitive process of writing is language and mathematics. This task involves students describing situations in which they are a part of and understanding their relation to the things that they describe and learning to signify by attaching linguistic and symbolic forms to experience.

Several of the authors from this study concluded that writing sustains the development of reasoning, communication, and connections. Although, there are considerable descriptions of the use of writing in mathematics, there has been very little analysis of the text themselves. If writing is to become an integral part of the mathematics curriculum, the analysis of the students writing, should be addressed. Therefore, the research would provide an exploratory investigation of writing in mathematics through focusing on the metacognitive aspects found in student texts generated to describe their problem-solving processes.

Background on Writing and Metacognition

It has been widely documented the importance of writing as a constructive process (Vygotsky 2006). Writing involves deliberate analytical actions on the part of the writer. Written words require that the writer maximally compacts inner speech so that it is fully understandable, making deliberate structuring of meaning and forming associations between current and new knowledge. These ideas of writing are part of a generative act in the process of constructing meaning that is largely accepted (Applebee, 1984).

Instructional Implementation

To infuse writing in the classroom, just add a writing activity to engage students in the content.

Researcher “Graham and Perin” (2007) (2) identified eleven elements of writing instruction to help students to write well and to use writing as a vehicle for learning. Learning to write well requires instruction and

Tools for Learning to Write

1. Teach students strategies for planning, revising, and editing.
2. Explicitly and systematically, teach students how to summarize texts.
3. Use instructional arrangements in which students learn how to summarize texts.
4. Assign students specific, reachable goals for their writing tasks.
5. Use computers and word processors as a way together on writing.
6. Teach sentence combining as a way to construct more complex, sophisticated sentences
7. Engage students in prewriting activities to generate ideas for composing.
8. Use inquiry activities where students analyze immediate, concrete data to develop ideas and content for a particular writing task.
9. Use the writing process to provide to provide extended writing opportunities.
10. Provide opportunities to read, analyze, and emulate models of good writing.
11. Use writing as a tool for learning content material.

“Joan Countryman” (1992)(3) explored the relationship between mathematics and writing. She offer the following four benefits in mathematic classes.

1. Students should write to keep ongoing, records about what they are doing and learning. During the phase students write, to restate new information in their own words, or write about content they found confusing.

2. Students should write in order to solve math problems.

During this, phrase students write about their computations and compare these to their writings about the process.

3. Students should write to explain mathematical ideas.

When students write explanations about their work and provide examples, allows the teachers to assess students understanding.

4. Students should write to describe learning processes

Strategies and Classroom Activities

As a starting point to writing breaks, would require the teacher to stop a few minutes (suggestion about two minutes) to allow students time to write down what their thoughts are about the content, this could be in the form of phrases, questions, misconceptions or connections. Students tend to recall between 10 to 30 percent of what they see, hear and read. Scheduling writing breaks every ten to twenty minutes, because this time is the attention span for most teenagers, will allow students time to reflect during the lesson being taught.

In the article, “Using Writing in Mathematics to Deepen Students Learning” (4) described three different types of writing prompts. Content prompts that relate to mathematical

concepts and relationships. Process prompts that relates to algorithm and problem solving and Affective prompts that relates to students attitudes and feelings.

To start “Writing Breaks” use prompts such as; “What information seems important to you? What questions do you have? Is there anything that is confusing to you about the content? Rate your understanding from one to five (low to high) and explain why you choose this rating. What were the key points in today’s lesson? Answering these questions will require little to no planning from the instructor, but will allow students time to reflect, elaborate on their ideas and conjectures. Teaching can continue after this short writing break. To extend this process, students can share with a partner or they can compare their observations.

Exit slips for students to respond to essential questions from each unit, student will use an index card or half sheet of paper, to jot down their response to the question prompt. The Teacher is required to remember to stop for about five or ten minutes during the end of class, to allow students to answer the essential question have students use all of the time allowed to write about the writing prompt. These questions are used to encourage and support mathematical writing.

The goal is to use the student responses to help guide the teaching in the next class. Exit slips are a great diagnostic tool. Students will probably be more honest, writing comments on an exit slip, then if being asked in class, “do you have any questions”? When using that question in some of my classes, students tend not ask many questions, when I ask them in that way. Exit slips requires less pressure from the student to answer aloud.

According to the article, “Low Stakes Writing” which was a tool to help students build comfort through sharing and developing their thoughts through writing. This task is used every day at the University Park Campus School in Worcester, MA. Low stakes writing is used in every subject at the UPCS to help foster students voice, self-confidence and critical thinking skills. An example of a writing prompt for this task is as following.

Teacher: So, what I want you to do right now is in your notebook write down at least one thing you know, and one thing you do not, or one question you have.

This process avoids the pressure of students feeling, what would my teacher want me too write. The defining element is the way the writing is graded.

Strategy 1

As the teacher, you focus on the students’ thoughts, expressions and learning. The focus is not on grammar, punctuation, or getting the correct answer the first time. This process is used for students to write down their ideas. Allowing students to interact with others students about their ideas, allow students to change their ideas and revise them if not correct.

The following Strategies are used at UPCS:

1. Grade Low-Stakes writing simply. Because this process is used to help build students understanding around the concept. The task is not graded for right or wrong answers. Students were graded by completion of the assignment 100%. Late assignment 70%, if incomplete 0%. Students' writings are used to foster critical thinking skills, development of their voice, instead of a tool of judgement.
2. Have Students Share Their Low-Stakes Writings
Writing exercises should include students sharing with a partner, group or the class. Students are asked for their thoughts on paper, and then sharing with a partner, sharing aloud in class. The class is required to produce a student-generated answer. Students are more invested in answers that come from their peers instead of the teachers' answers.
3. Differentiate Learning Through Group Work
Sharing low-stakes writing through group work allows students to build collaboration and group work, which allows for differentiation within their groups. Students are able to discuss their answers and make corrections or add additional facts. Students who did not answer correctly would most likely have someone in their group with the right answers. Students with the correct answers would be able to annotate and add something new.
4. Use of Challenging Questions instead of Giving Traditional Feedback
Conversation starter prompts can be used instead of pointing out their errors.
Let me see if I understand you.....
Another way to look at this could be.....
So you are saying.....
What do we know so far.....
Can I ask you a challenge question about that? To invite students to take a challenge is offering them a chance to learn more, express themselves clearly, allowing them to move forward.
5. Create Open Questions
Open questions allow students to interact, because these questions are broad and non-threatening. University Park Campus writing prompts examples:
What do you notice?
What is one thing that you know and one question that you have?
Write a "Dear Confused Student/Absent Student" letter. UPCS uses this assignment after students have mastered the content. Student are allowed to explain in detail, what they know and how they know this content.

Math low-Stakes Writing Prompts. Teachers can show students examples and non-examples before teaching definitions. This process requires students to identify what makes something an example or a non-example. Suggestions from UPCS include an example about teaching polygons. UPCS suggests giving students a handout with two columns labeled “Polygon” and “Not a Polygon”. Students should not be given a definition, or allowed to look up the definition. The students should look at the two columns of examples and non-examples and describe what it requires to be an example or non-example of a polygon. Students should be able to define concepts by using a low-stakes writing task, share with a group, and then share with their classmates to develop a solid definition.

Sort by characteristics. Have students sort triangles into groups based on how they look. The students will sort the shapes into groups, of similar shapes and different sizes, next students will describe what each group has in common. Students should come up with congruent angles, Ratios of side lengths. Then students can develop a definition of similar triangles based on their observations.

Recognize patterns. Give students data from real world examples, such as the number of blocks, it takes to make a design, in figure one, two, three, and so forth. Have students identify patterns in the numbers by connecting the pattern they see in the design. Questions that can be used are: “Which parts of the design are always constant?” “Which parts changed based on the figure number?” Students should develop rules such as linear, quadratic, cubic and exponential equations. Another strategy is to apply word problems to abstract math and introducing new math concepts with word problems. The purpose of low stakes writing is to have students feel more comfortable with expressing their ideas in the educational climate. We want students to answer questions and have foundational knowledge. Low stakes writing allows students to use their voice when engaging in the concepts that are being taught in the classroom.

Appendix 1: Teaching Standards

North Carolina State Standards

Quadratics [Appendix 1](#)

Students will understand that a quadratic function is a second-degree polynomial represented graphically as a parabola. A relationship exists between a polynomial's factors, zeros, roots, and x-intercepts.

Cluster: Defining complex number N.CN.1

Interpret the structure of expression A.SSE.1a-b, ASSE.3

Analysis functions using difference representations F.IF.7, F.IF.8a, F.IF.9

Build new functions those models a relationship between two quantities F.BF.1

Solve equations and inequalities in one variable A.REI.4, A.REI.4a, and A.REI.14b

Solve systems of equations A.REI.7

Create equations that describe numbers or relationships ACED.1, ACED.2, ACED.3

Generalizations: My students will understand that it is important to interpret, compare, and analysis quadratics in different representations using tables, graphs, algebraic expressions, and verbal descriptions.

Students in Math 2 can demonstrate the ability to apply and comprehend critical language through the following statements

1. Create and interpret quadratic functions with multiple representation.
2. Use quadratic models to analyze and transform functions
3. Make and evaluate different representations of quadratic functions
4. Describe how changing a , h , and k affects the graph of a quadratic functions.

Appendix 2

Students can write in every class every day. Writing every day in mathematics class gives students the opportunity to write down their ideas about the content.

The teacher can write down what it is that they want students to learn from the lesson.

This could be used to assess the students writing. Giving students two minutes to write during introduction allows the students to think about what is being taught, sharing with a partner, allows students to discuss ideas that they come up with. Students can write and focus on notes that can be helpful later. Another strategy is to have students write for seven minutes and share out with partners, so that they can teach each other to become better writers.

The teacher can also use Exit Slips or Entrance Slips

Appendix 3: Teacher Resource

[Edutopia](http://www.edutopia.org/resource/university-park-low-stakes)-stw-universitypark-low-stakes-writing-prompts.pdf

Downloaded for <http://www.edutopic.org/resource/university-park-low-stakes>

-Writing-prompts-download that can be adapted to fit the needs of the Teacher.

These prompts are for any Subject included prompts for Mathematics, Science, History and English Language Arts

Appendix 4

Unit “Quadratics” Essential Questions

1. How are quadratic expressions and quadratic equations alike? How are they different?
2. How does changing the value of a coefficient, constant, or variable in an expression change the value of the expression?
3. How are the graphs of quadratic functions related to their equations?
4. How do you find the vertex of a quadratic function?
5. What types of real-world situations are modeled by quadratic equations?
6. How is a quadratic equation similar to a linear equation? How is it different?
7. How is a quadratic equation similar to an exponential equation? How is it different?
8. In what situations is it appropriate to use a quadratic model?
9. How can we solve a quadratic equation by factoring?
10. How can we solve a quadratic equation by completing the square?
11. How is the quadratic formula derived?
12. Why must a quadratic equation be set equal to 0 before it can be solved by factoring?
13. How do you know which factoring method to use when solving a quadratic equation?
14. How are radical expressions simplified?
15. How are complex numbers and real numbers related?
16. What types of numbers can be the sum or difference of complex numbers?
17. What information can be gathered by analyzing the key features of a quadratic function?
18. What properties must be true for a function to be identified as odd, even, or neither?
19. How are points of intersection related to the solution of a system of equations?
20. Is it possible for a quadratic-linear system to have no real solutions?

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