The Language of Math Opens Windows

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This curriculum unit is recommended for: 5th Grade High Ability Math Students

Keywords: Mathematical vocabulary, language, gifted, inquiry-based learning, base systems, history of mathematicians, math fairs

Teaching Standards: See Appendix 1 for teaching standards addressed in this unit.

Synopsis: This unit focuses on developing problem solving skills, expanding students' mathematical vocabulary, studying current and past mathematicians and engaging high ability math students in mathematical explorations and challenges. Students will expand their understanding of mathematics by looking at math through different lenses which include creating their own mathematical dictionary, researching and 'becoming' a past or current mathematician, learning how to work in different number base systems and participating in a Math Fair. This interdisciplinary, inquiry-based unit includes a variety of mathematical experiences that incorporate multiple intelligences such critical and creative writing, visual spatial arts, research and dramatic interpretation. The foundation of the unit is built upon looking at mathematics as a language and comparing it to English, foreign languages and other symbolic representations. In developing students' sense of the *language of math*, the depth and complexity of their mathematical understanding will grow Multiple entry points will allow students to identify areas of focus. Differentiation will occur based on the students' mathematical skills, understanding and interest. The Math Fair and Wax Museum of Historical and Present Day Mathematicians will culminate and celebrate the students' mathematical learning and discoveries.

I plan to teach this unit during the coming year in to 25 students in a 5th grade class with high ability math students.

The Language of Math Opens Doors

by Mindy Passe

Introduction

How can we ignite a passion for exploring mathematical concepts rather than the current approach of accelerating students through the mathematical curriculum? Many of my students come from homes that focus on the acceleration of learning often at the expense of the development of a strong foundational understanding that often occurs when students are given the opportunity to engage in the inquiry based learning which allows students to explore and challenge themselves based on their own interests and skills. So, the question is how do we do this within the framework of our current mathematical teaching based on Common Core Standards? First, we make a conscious decision that for our 5th graders, our goal is not to master middle school math concepts but to broaden their foundation of mathematical concepts in general. Then you ask, but how can we accomplish this? My answer is through the study of the 'language of math'. With the help of Dr. Harold Reiter, the idea to look at math through the lens of language was born. He helped me to quickly make connections between math and language and to start to explore, in my mind, about the similarities such as the use of letters, symbols, punctuation and expressions. I started thinking about the commonalities of language and math such as synonyms and antonyms. In thinking about my own study of languages, I quickly realized how learning French had helped me to better understand grammar in English and that my knowledge of Hebrew helped me to recognize the variation in the structure of language including symbols such as reading directionality and vowels. My premise, then, is that in developing students' sense of the language of math, the depth and complexity of their mathematical understanding will grow. Lastly, I noticed that as a linguistic person/teacher, my class is rich in vocabulary development. My students are required to have a dictionary at hand for all discussions and I often use unfamiliar vocabulary in simple classroom directions, such as, "As your peruse the unit..." or "Our recess is imminent. " Since I have not done this in math, I include in this unit/approach to learning an intentional focus on expanding and using more mathematical language and formal study in our classroom and discussions.

Why, you may be thinking does "The Language of Math Opens Doors"? As stated above, it is my belief that through learning the language of middle and high school math vocabulary, elementary students will have a view into that world and be better prepared to understand the concepts through some of the new vocabulary introduced into their thinking and understanding. In addition, according to Julian Stanley[1], author of The Study of Mathematically Precious Youth and an advocate for gifted math students, students from non-English speaking backgrounds and homes are often more comfortable and successful in math classes since it is the only non-English laden subject in school and

therefore, more easily accessible. Likewise, students from low income families often come to school with stronger skills in math than language since math skills are often more likely to be a part of their early life experiences. Thus, the language of math is a window into their intellectual ability for teachers and a lens for some students to see their own academic potential more clearly.

Background

I teach fifth grade in a large urban partial magnet elementary school in the city of Charlotte, North Carolina. My school is part of Charlotte Mecklenburg Schools and is unique in that it has three distinct programs: neighborhood students, who are almost all African American and low income, a gifted magnet program with a very diverse group of students working above grade level and bused in from middle to upper class suburbs and a very selective program for highly gifted students from the entire county. On my grade level, for example, there is one highly gifted class, 2 gifted classrooms and 3 classrooms of neighborhood students. Although we are 3 distinct programs, we continuously work to develop our school-wide program through integration of curriculum, special activities, field trips, etc. My class has 23 students that remain in a self-contained classroom. I teach my 23 students all subjects except math. For math, my colleague and I are using flexible grouping based on pretests for each standard. I am working with the students who have already mastered or almost mastered the skills and my colleague works with those students who need work on the standards. Even though all of our students are identified as gifted, there is a wide range of knowledge and skills.

In my math class, many of my students are working well above grade level based on their End of Grade tests, Khan Academy levels and teacher input. Typically, parents believe it is best to accelerate the students who are working well above grade level. Regarding mathematically gifted students, Rotigel[2] asserts,

"Since these children often prefer to learn all they can about a particular mathematical idea before leaving it for new concepts, a more expansive approach to mathematics based upon student interest may avoid the frustration that occurs when the regular classroom schedule demands that it is time to move on to another topic."

Additionally, Dana T. Johnson[3] asserts that mathematically gifted students have needs that differ in nature from those of other students. She advises that teachers use inquiry based, discovery learning approaches that emphasize open-ended problems with multiple solutions and encourages them to allow students to design their own way, to find the answer to complex questions. I agree whole heartedly and have experienced often first-hand that,

"Gifted students may discover more than you thought was possible. "

With this philosophy in mind, I believe that it is imperative to work to build a strong foundation of the key concepts that will prepare students for the middle and high school and keep them engaged, challenged and excited by giving them hands-on, minds-on mathematical experiences. I firmly believe that as a teacher of gifted 5th grade students, my job is NOT to teach middle school math but to prepare my students for their future courses in math by developing problem solving skills, expanding their mathematical lexicon, studying current and past mathematicians and engaging students in mathematical explorations and challenges that will help them learn to ***tolerate confusion***, an experience that Dr. Harold Reiter[4] asserts is necessary for mathematical growth and exploration.

Objectives

This interdisciplinary thematic unit is designed to be taught over a 6-week period but will become an overarching theme that will continue throughout the year. This language of mathematics unit, will, of course, focus on mathematics but will be interdisciplinary in nature in that it will include English Language Arts, science and the arts. This unit is inquiry based, student centered and reflects the Common Core structure of incorporating the reading skills needed to understand informational text as the foundation of the curriculum. The mathematical objectives will include 5th grade math objectives in Numbers and Base Ten such as recognizing that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents to its left. Writing will be imbedded throughout the unit because according to current research,

"Writing in math class supports learning because it requires students to organize, clarify, and reflect on their ideas--all useful processes for making sense of mathematics. In addition, when students write, their papers provide a window into their understandings, their misconceptions, and their feelings about the content." [5]

Fifth grade students are expected to interpret information presented visually, orally and quantitatively and explain how the information contributes to an understanding of the text in which it appears. My students will be expected to draw on information from multiple print or digital sources, demonstrate the ability to locate an answer to a question or to solve a problem efficiently and communicate effectively what they have learned. Students will use the scientific method to explore mathematical concepts and ideas and will use research skills to learn the historical context and process of mathematical discovery.

An understanding of the base ten system is "The Most Important Thing for your Child to Learn About Arithmetic"[6] according to Dr. Roger Howe. He explains that,

"Cultural variation is one of the most prominent features of modern global life: people do things differently in different places. Language is perhaps the most obvious example of this variability, but differences can be found in almost all spheres of activity. However, there is a cultural artifact that transcends language and is almost universally used in the civilized world: the decimal system, or base ten place value system, based on the Hindu-Arabic derived symbols for the digits: 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9."

And thus the cornerstone of this unit will be an understanding of how the decimal system works. The basics of the base ten system will be explored thoroughly with a focus on place value representation. According to Dr. Harold Reiter[7],

"Since decimal representation is an important starting point in learning the arithmetic of integers and decimals, it is also important to explore alternate methods of representation, using bases other than ten. This is roughly akin to the idea that one does not really understand one's own language until we learn a second language."

An underlying guide to the unit are "The Standards of Mathematical Practice" that describe varieties of expertise that mathematics educators at all levels should seek to develop in their students. These practices rest on important 'processes and proficiencies' with longstanding importance in mathematics education. These processes include: make sense of problems and persevere in solving them, reason abstractly and quantitatively, construct viable arguments and critique the reasoning of others, model with mathematics, use appropriate tools strategically, attend to precision, look for and make use of structure and look for and express regularity in repeated reasoning.

This interdisciplinary unit will incorporate communications skills, mathematical reasoning/data interpretation skills and analysis and synthesis of research. As students read non-fiction and fiction books related to the language of math, they will be expected to be able to explore the meaning of texts and make connections to themselves and the world. Students will use their creativity and 21st century communication skills, including technological tools such as Power Points, blogs, animation and develop their creativity, abstract thinking and ability to evaluate and synthesize complex information as they transform their knowledge and skills into meaningful presentations and projects, creating real products for real audiences.

Strategies

KWL

At the completion of the introductory activity, the Language of Math posters, students will analyze and discuss their work. This will help direct their learning with K/W/L (What I **K**now, **W**ant to Know, What I **L**earned). This approach is a teaching model used to encourage student-centered, inquiry based learning by activating students' prior

knowledge (K), developing questions of personal interest to encourage purposeful reading and research (W) and summing up and reflecting on what was learned and if and how questions were answered (L). Ideas, questions and results are recorded collectively on a chart for the whole class to serve as a guide to further study of the overarching question: How can the study of the language of math increase our understanding of mathematical concepts? Students will be given the opportunity to select a topic/concept to explore and then create a product to share what they have learned. Using the idea that students will create real products for real audiences, which may include a picture book for younger students, a lesson for their peers or a video or multi-media presentation about mathematicians.

Depth and Complexity

The framework for this unit will be based on Sandra Kaplan's[8] concepts that incorporate depth and complexity into any unit of study. Sandra Kaplan's model uses simple icons to engage students in complex thinking while adding rigor and critical thinking to instruction. Using these icons is a strategy often used with gifted students but equally effective with all types of learners. To develop in depth lessons, students use icons that represent strategies to build understanding such as learning the language of the *discipline, looking for big ideas, essential details, rules, patterns, trends, unanswered questions and ethics*. Complexity is created as students look at the subject/issue over time, from multiple points of view and across disciplines. Initially, early on in the year, I introduce the students to this very complex approach to learning using popcorn as the theme. By initially using the concrete, fun and tasty topic of popcorn, students get to explore all aspects and use all of the icons/ways of thinking, which we incorporate into a bulletin board, popcorn and all. Focusing on a few aspects of this model at a time, in a variety of subjects enables students to get a grasp of this new vocabulary and provides an excellent way to differentiate for the varied thinking capacities and styles of my students. The complex nature of this unit with many varied perspectives, possibilities and entry points lends itself readily to this model. Students will be encouraged to look at mathematical concepts and language from different points of view; though the eyes of an architect, an astronomer or a dentist as well as look at math changes over time, trends in math and even questions about the ethics of how math is often used deceptively in advertising and marketing.

Multiple Intelligences

Howard Gardner's Theory of Multiple Intelligences[9] suggest that there are at least seven ways that people have of perceiving and understanding the world. Gardner's intelligences include logical-mathematical, verbal-linguistic, visual-spatial, bodily-kinesthetic, musical-rhythmic, interpersonal and intrapersonal. Gardner suggests that educators strive to incorporate more of the intelligences into instruction that has traditionally been focused on the verbal-linguistic and logical-mathematical intelligences. (Reading,

Writing and Arithmetic) By incorporating the other intelligences into the curriculum, teaching strategies and student project/product choices, students will be more engaged. Instructional methods that appeal to all the intelligences include role playing, model building, storytelling, musical performance, reflection and the visual arts. This unit is an example of how instruction in math, when broadened to include multiple intelligences, will engage students who are both strong mathematically as well as those who are strong verbally-linguistically, visually-spatially and bodily-kinesthetically. An example of this in the unit is when students research mathematicians, write about them and become one of them as we create a Wax Museum of Historical and Present Day Mathematicians.

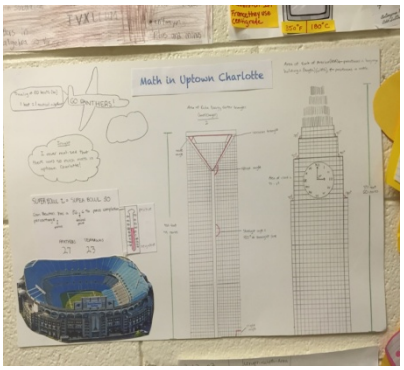
Vocabulary Development through a Word Wall and the Frayer Model

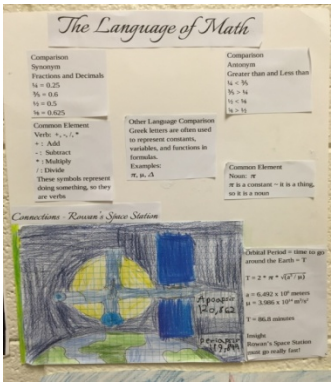
Traditionally used to build vocabulary in language arts and the primary grades, a word wall will be developed throughout the unit with students adding concepts accompanied by diagrams. Students will develop their own personal illustrated Mathematical Dictionaries on an ongoing bases. The Frayer Model[10] is a graphical organizer used for word analysis and vocabulary building. This four-square model prompts students to think about and describe the meaning of a word or concept by defining the term, describing its essential characteristics, providing examples of the idea, and offering non-examples of the idea. This strategy is typically used to stresses understanding words within the larger context of a reading selections but I think that it will be equally helpful in math by requiring students, first, to analyze the mathematical concepts/constructs (definition and characteristics) and, second, to synthesize/apply this information by thinking of examples and non-examples.

Math Activities

Introductory Activity - Language of Math Posters

To introduce students to the Language of Mathematics, students will brainstorm their current ideas and words that they know about math. Following the individual brainstorming, students will discuss and add to their lists, making connections, additions and developing questions. Students will each create a poster about The Language of Math that will include examples/connections, comparisons to both English and other languages, real world connections and their personal insights and ideas. Sandra Kaplan's [11] Depth and Complexity icons can help students explore ideas as they look at math from another point of view, focus on details, find trends, look at changes over time and so on. The posters will be shared via a Gallery Crawl where students can offer comments and questions about their response to the posters. Students will develop their own personal KWL chart, recording what they already **k**now, **w**ant to know and eventually, what they **l**earned. These posters will be on display and serve as source for generating ideas for Math Fair projects. Use the attached rubric and student samples below to guide and assess students. See Appendix 2.





Place Value, Base Systems and Martian Math

Understanding place value is critical in developing mathematical thinking. The decimal system is annually taught at the beginning of the year, typically with place value charts, number blocks and expanded notation; all of which help students to understand *decimal representation*, the basic method we use to represent numbers. According to Dr. Harold Reiter[12],

"Because the method of representation is an important starting point in learning the arithmetic of integers and decimals, we shall explore alternate methods of representation, that is, representation using bases other than our usual base ten 10. This is roughly akin to the idea that one does not really understand one's own language until we learn a second language."

Through exploration of different base systems, teachers can determine to what degree students understand the decimal system. The study of place value is often seen as boring by most students (and some teachers). By introducing the concept of Martian Math, we build intrigue and excitement. First, we ask the students why our system is based on the number ten and allow for discussion of various ideas. Our ten fingers are bound to come up and once that does, it is time to jump in and tell the students about Martian Math, explaining that Martians have only 3 fingers on each hand and then ask what the students think that their number system is based on. This leads us to an exploration of Base 6, Martian Math. We begin with counting: 1, 2, 3, 4, 5, and then the fun begins, as does the understanding of place value. Collectively, we create a place value chart modeled after our decimal system, that looks like this:

	1296	216	36	6	1 (6)

As we build the chart, comparisons are made to the decimal system and exponents that help students to see the connections between the two 'languages'. Once the students

have written Martian numbers on their own chart, we can give them the Martian Numbering Place Value Chart (See Appendix 3) and challenge them to count to 60 and beyond and look for patterns. As students complete it, they are challenged to note and discuss patterns and identify similarities and differences between the decimal system and Base 6. (For example, 100 in each system is the base squared.) Then it is time to systematically explore each operation in Base 6. I will model an example of this in addition.

To begin, we start with a Martian number and add it to itself. First, we convert the Martian number to a decimal, then add and check:

Martian 123_6 = $100_6 + 20_6 + 3_6$
= $(1 \times 6^2) + (2 \times 6^1) + (3 \times 6^{0)}$
= 36 + 12 + 3
= 51

Addition in Base Six	**Addition in Base Ten**
1 (3 +3 =10 so carry 1) 123_6 $+123_6$ --------- 250_6	51 + 51 --------- 102
To check*: Martian 250_6 = $200_6 + 50_6 + 0_6$ = $(2 \times 6^2) + (5 \times 6^1) + (0 \times 6^0)$ = 72 + 30 + 0 = 102	**To check:** 250_6 = 102

* Note: Other methods of checking and converting to decimals include repeated subtraction and division and can be found in Dr. Reiter's place value work.

Continue to work problems as a class and as students learn to do this on their own, ask them to do a problem in each of the four operations, comparing base ten and base 6. Questions and confusion along the way will lead to a better understanding, identification of misconceptions and greater facility in both systems. Once students are comfortable working problems in all operations with Base 6, then challenge the students to create an origin story for a different base system and then follow the process that we did: count, create and fill in a place value chart, look for patterns, then add, subtract, multiply and divide with that system. Differentiation will occur naturally as students work independently, with partners or in small groups with scaffolding from the teacher,

as needed. Ask students to make posters with the key elements of their base system and story. Model how to do this with Martian Math, including some green three-fingered Martians and references to the Red Planet. Students can eventually create a picture book about their language with their origin story and mathematics in their base imbedded in the story.

Comparison of English Language and Mathematical Language

Now that students have been introduced to the concept of the language of math and explored some of their own ideas through the posters, we will begin a more structured process to challenge students to identify the common elements of math and the English language. First, in groups and then as a class, we will create a table to help students see the common elements and concepts of each. Using a teacher led inquiry model, I will help students to identify the key components of English, beginning with letters and punctuation, rules of grammar and how we analyze formal text, including sentences, paragraphs and types of writing (prose, poetry, informational, etc.) Students will then add in the mathematical counterparts, comparing *letters* and *punctuation* to *digits* and *mathematical symbols*, *numbers* and *equations* to *words* and *grammar* and *problems* and *solutions* to *paragraphs* and *narratives*. Students will be challenged to add examples of each comparison. This will be modeled strategically with a focus on punctuation, which many 5th grade students have had little instruction. As we look at each punctuation mark such as periods, exclamation points, parenthesis, we will identify commonalities and differences in usage and meaning. On large paper, a class chart will be created:

Symbol/name	Usage in English	Usage in Math	Similarities/Differences
, comma	In a series: Apples, oranges, kiwi	In a series: 1,2,3,4,5	Same function
. period . decimal point	To end a sentence and for abbreviations I love Mr. Ed.	To separate whole numbers from decimals 10.123	Totally different function
( ) parentheses	Patriotic colors (red, white and blue) are popular on the 4th of July	(x + y) + (x - y)	Similarities - used to set apart expressions and ideas

The book, "Eats, Shoots and Leaves: The Zero Tolerance Approach to Punctuation"[13] by Lynne Truss will serve as a fun way to explore how minor changes in punctuation affect meaning in English while encouraging students to compare this to the order of operations and how other symbols such as decimal points and division slashes affect math meaning. First, I will introduce the book to the children by telling them that

the title comes from the story of a panda that walks into a cafe, orders a sandwich, eats it and then fires two shots in the air.

"Why?" asks the confused waiter as the panda makes for the exit. The panda produces a badly punctuated wildlife manual and tosses it over his shoulder.

"I'm a panda", he says at the door. "Look it up."

The waiter turns to the relevant entry and sure enough, finds an explanation.

"PANDA . Large, black-and-white bear-like mammal, native to China. Eats, shoots and leaves."

So, we are told that punctuation does matter, if only occasionally it is a matter of life and death."

As students understand the subtlety of the story, share a few pictures from the children's version that further illustrate how a comma or apostrophe make a difference (available on Amazon) For example, what is the difference between, "Slow, children crossing." vs. "Slow children crossing." or "Those things are my brother's." vs. "Those things are my brothers." Discuss how each could be illustrated. Then ask the students to think about math and how one small change could make a difference in a number sentence or expression. Have students brainstorm possibilities and they will easily come up with decimal points, parentheses, division slash. Then have them work on this idea, asking the question, "What's the difference? What difference does it make?" (See Appendix 4.) Continue to help students see the parallels between the language of math and the English language; how the rules of each language help us to understand and be precise.

Additional topics will include word structure, sentence structure, analogies, classifications. Cryptarithms and cryptagrams will also provide a fun route to analysis of math and the English language and will help students identify patterns, commonalities and differences.

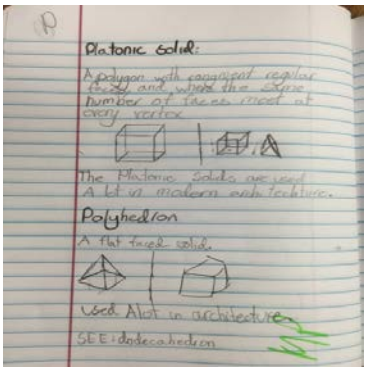
Historical Connections in Math

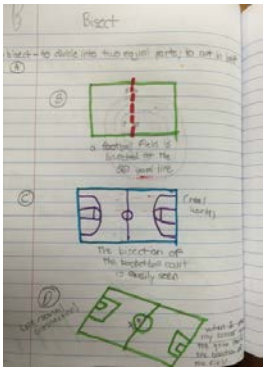
Students will be given a list of mathematicians and told that it will be their job to research a mathematician, both historically and mathematically and create a presentation. Several children's picture books such as Sir Cumference and the Round Table[14] and other books from the Charlesbridge Math Adventures can be read and discussed using interactive read aloud strategies as well as biographical sketches from Historical Connections in Math by Wilbert Reimer[15]. As a class, we will take a selection from the latter and work together to re-create the mathematician's biography in autobiographical form, including a mathematical challenge for the readers to try. Then each student will select a mathematician and write an autobiographical narrative of that person with a mathematical challenge. Students will work together to create a Wax Museum of Historical and Present Day Mathematicians as they dress, pose and speak as the mathematician in a

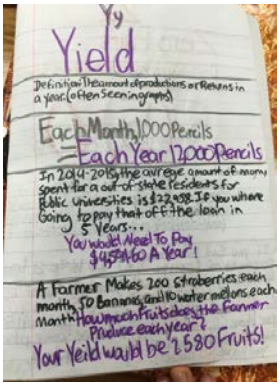
three minute presentation. Visitors to the museum will respond to a challenge made by each mathematician in a game-like format. Students may also create a picture book featuring their mathematician with a narrative that simplifies and illustrates an important mathematical concept. These books will be shared with younger siblings and/or our second grade class buddies. Students will decide the medium that they will use for the story including multi-media, video options and glogs/blogs. Videos of the Wax Museum will be on our class website and/or a student made math website.

The Lexicon of Math

Students will explore the lexicon of math in a variety of ways to create their own personal math dictionary and reference guide. Students will begin by using The Frayer Model[16] of vocabulary development to understand the glossary of terms used in Math Olympiad. In years past, I have had my students use this glossary as a reference in developing their problem solving strategies but I think that by being more intentional about trying to understand these concepts, it will help students to see how developing their mathematical vocabulary will improve their problem solving skills. In addition, students will each be assigned a letter of the alphabet and challenged to identify and define both in words and mathematically a term or concept that is new to them. Students will use the site Math Dictionary for Kids[17] and others to help them find their words and then work cooperatively to create our own version of a math dictionary either 2-D, 3-D or on line, which will be a part of our student made Math Website. (2-D and 3-D work will be photographed and/or scanned to be included.) In addition, students will work cooperatively to explore and expand their usage of numeric prefixes such as bi (binary, bifocal, bicycle, bicuspid) , tri (tripod, triangle, triplets), etc. as we create a floor to ceiling chart of the prefixes and examples to be on display in our hallway. Knowledge of these words will increase students' vocabulary in not only math but in a wide array of subject areas. Students will create their own smaller, personal version of this chart and dictionary to as a part of their personal math reference guide. This reference guide will become handy throughout their mathematical journey into middle and high school math. Sample Student Dictionary Pages:







Math Fair

Dr. Ted Lewis and Dr. Andy Liu[18] of the Mathematics Department, University of Alberta started Math Fairs. We are basing the first Math Fair at our school on their model which states that a Math Fair is a *problem-solving* fair. Unlike a Science Fair, a Math Fair is noncompetitive. The projects are student-centered and problem-based. Students will follow the guidelines and timeline traditionally followed for our Science Fair, in that they will identify a topic, conduct research, identify a problem and develop a hypothesis. The basic difference is that student's focus will be on manipulating concepts and numbers rather than physically experimenting to test their hypotheses (although this may be done). Students may conduct tests, surveys and investigations that they have designed or they can try replicate the work of other mathematicians. Areas of study include economics, architecture, engineering, cooking, interior design, sports and probability as well as traditional math investigations. For example, a student may want work on understanding The Birthday Paradox and then use a data base of birthdays from a school population to test it out. Another example is a student who is exploring the how the slope of an incline affects the speed of a toy car, with a focus on identifying common ratios. Another student may be comparing the prices of specific items at a variety of stores throughout the holiday season. Students will create tri-folds to display their findings and report their conclusions with a written paper and oral presentation that includes their research, data, and real world connections. If possible, we will combine the Math Fair with our Wax Museum of Historical and Present Day Mathematicians and have it take place on or near March 14th aka Pi Day! This will create a true celebration of mathematical history, exploration and learning!

Appendix 1

Implementation of Common Core Standards

CCSS.Math.Content.5.OA.A.2

Write simple expressions that record calculations with numbers, and interpret numerical expressions without evaluating them. *Additionally, students will write and read expressions in at least 2 other base systems other than the decimal system.*

CCSS.Math.Content.5.NBT.A.2

Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10. *This concept will be explored as students develop a better understanding of place value in multiple base systems.*

CCSS.ELA-Literacy.RI.5.9

Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. *Students will research and mathematical concepts and use this information in their poster, dictionary and other products.*

CCSS.ELA-Literacy.RI.5.10

Read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4-5 text complexity band independently and proficiently. *Students will research mathematicians and create informational and narrative interpretations of their life and mathematical exploration and insights.*

CCSS.ELA-Literacy.RI.5.3

Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text. *Students will compare and contrast their mathematicians and the context of their contributions as they create a chronological order for their Wax Museum of Mathematicians.*

CCSS.ELA-Literacy.W.5.2

Write informative/explanatory texts to examine a topic and convey ideas and information clearly. *Students will simplify and explain mathematical concept*

Appendix 2

Challenge: You will create a poster that focuses on **The Language of Math**.

	Points	Student Assessment	Teacher Assessment
TWO Comparisons ex. Synonyms, antonyms, etc.	20		
TWO Common Elements (Symbols, punctuation)	20		
Foreign/Other Language Comparison/Connection	10		
Connections (Usage, real world, expressions)	10		
Your Insight/Epiphany (Aha!)	10		
Accuracy	10		
Creativity/Originality	10		
Neatness/Legibility	10		
Total	100		

Before you begin, brainstorm possible ideas for each section below:

Comparisons ex. Synonyms, antonyms, etc.	Ex. Antonyms - positive and negative numbers; Synonyms - equivalent fractions
Common Elements (Symbols, punctuation, parts of speech)	Parentheses, commas, variables as pronouns
Foreign/Other Language Comparison	Hebrew Aleph = 1, Bet = 2, Martian Math
Connections (Usage, real world, sports, new vocabulary)	Miles per gallon, force = mass/distance, 1 cup = 2 pints, RBIs
Insights	
Creative Ideas	

Appendix 3

How good are you at Martian Numbering? Complete the chart to see!

	1296	216	36	6	1		7776	1296	216	36	6	1
0						**32**						
1						**33**						
2						**34**						
3						**35**						
4						**36**						
5						**37**						
6						**38**						
7						**39**						
8						**40**						
9						**41**						
10						**42**						
11						**43**						
12						**44**						
13						**45**						
14						**46**						
15						**47**						
16						**48**						
17						**49**						
18						**50**						
19	**0**	**0**	**0**	**3**	**1**	**51**						
20						**52**						
21						**53**						
22						**54**						
23						**55**						
24						**56**						
25						**57**						
26						**58**						
27						**59**						
28						**60**						
29						**6000**						
30						**7000**						
31						**8000**						

From CTI 2015, Fundamentals of Mathematics by Dr. Harold Reiter

Appendix 4

What's the difference? What difference does it make?

Example 1	Example 2	What's the difference?	What difference does it make?
Let's eat, grandpa! Illustrate	Let's eat grandpa! Illustrate		
William brought an extra large pizza. Illustrate	William brought an extra-large pizza. Illustrate		
54.1 + 63.3= _____ Solve	5.41 + 63.3 = _____ Solve		
3 X 4 + 12 x 9 = Solve	3 x (4 +12) x 9 = Solve		
  Illustrate	 Illustrate		
  Solve	 Solve		

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Student Resources

- http://mathdelights.org/ Mathematical challenges, puzzles, activities, games and even magic tricks; includes an excellent cryptarithm guide
- http://www-groups.dcs.st-and.ac.uk/~history/BiogIndex.html - incredible website of biographies of mathematicians dating back to before 500 AD, including an extensive list of female mathematicians
- http://www.amathsdictionaryforkids.com/dictionary.html - animated, interactive online math dictionary for students which explains over 630 common mathematical terms
- www.mathisfun.com/definitions - fun, interactive resource of math vocabulary
- www.mathwords.com - fun, interactive resource of math vocabulary
- http://www.glogster.com/ - resource to create multi-media blogs

Teacher Resources

- http://mathdelights.org/resources/videos.html - wide array of resources for teachers and parents, including questioning strategies, suggestions for math videos, books, relevant research papers and many mathematical activities for students
- http://www.byrdseed.com/introducing-depth-and-complexity/ - Sandra Kaplan's Depth and Complexity introductory popcorn lesson, icons and additional resources
- http://mathforum.org/dr.math/ - wide range of topics in a Q and A format can be a guide for teaching and learning of math subjects from elementary to high school
- http://www.amathsdictionaryforkids.com/ - in addition to the interactive, animated dictionary for students, there are over 200 math charts and references of everything mathematical from place value to percentage, geometry to time and money
- Historical Connections in Mathematics, Volume 1: Resources for Using History in the Mathematics Classroom, Walter and Luetta Reimer, Aims Educational Foundation, Fresno, California, 1992

Notes

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[2] Rotigel, J. & Fello. "Mathematically Gifted Students: How Can We Meet Their Needs?" *Prufrock Press* Vol. 27, Issue 4, Pp. 46-51, no. 4 (2004): 46-51. Accessed October 16, 2015. http://www.davidsongifted.org/db/Articles_id_10514.aspx.[22]

[3] Johnson, Dana T. "Gifted Math Students.". Accessed October 31, 2015. http://www.educationoasis.com/resources/Articles/teaching_gifted_math.htm.

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[5] Urquhart, Vicki. "Using Writing in Math to Deepen Student Learning." Www.mcrel.org. 2009. Accessed November 1, 2015.

[6] Howe, Roger. "The Most Important Thing for Your Child to Learn about Arithmetic." 2010. Accessed October 31, 2015. http://math2.uncc.edu/~hbreiter/CTI2015/MostImportantrev2.pdf.

[7] See note 3.

[8] "Depth and Complexity Icons | Byrdseed." October 25, 2013. Accessed October 31, 2015. http://www.byrdseed.com/category/depth-and-complexity-icons/.

[9] "Multiple Intelligences By Dr. Thomas Armstrong." Multiple Intelligences By Dr. Thomas Armstrong. Accessed November 1, 2015. http://www.institute4learning.com/multiple_intelligences.php.

[10] "Reading Educator." Reading Educator. Accessed October 31, 2015. http://www.readingeducator.com/strategies/frayer.htm.

[11] See note 7

[12] See note 3

[13] Truss, Lynne. *Eats, Shoots & Leaves: The Zero Tolerance Approach to Punctuation*. New York: Gotham Books, 2004.

[14] Robb, Don, and Elena Dworkin Wright. *Round Table Geometry: Sir Cumference Classroom Activities*. Watertown, MA: Charlesbridge Pub., 2010.

[15] Reimer, Wilbert, and Luetta Reimer. *Historical Connections in Mathematics: Resources for Using History of Mathematics in the Classroom*. Fresno, CA.: AIMS Educational Foundation, 1992.

[16] See note 9.

[17] Reimer, Wilbert, and Luetta Reimer. *Historical Connections in Mathematics: Resources for Using History of Mathematics in the Classroom*. Fresno, CA.: AIMS Educational Foundation, 1992.

[18] "SNAP Mathfairs." Who Are We? SNAP Mathematics Fairs. Accessed October 26, 2015. http://www.mathfair.com/.

Annotated Bibliography

"A Maths Dictionary for Kids 2015 by Jenny Eather." A Maths Dictionary for Kids 2015 by Jenny Eather. Accessed October 31, 2015.
Interactive website with an extensive students mathematical vocabulary list, teaching resources, charts and activities.

"Depth and Complexity Icons | Byrdseed." October 25, 2013. Accessed October 31, 2015. http://www.byrdseed.com/category/depth-and-complexity-icons/.
Introductory activities to help teachers and students understand the language and implementation of the Sandra Kaplan's Depth and Complexity icons/thinking.

Howe, Roger. "The Most Important Thing for Your Child to Learn about Arithmetic." 2010. Accessed October 31, 2015.
http://math2.uncc.edu/~hbreiter/CTI2015/MostImportantrev2.pdf.
A thorough and insightful discussion of how to teach place value to students with a focus on helping students to develop a sense of numbers and an deep understanding of the decimal system through multiple and varied activities and experiences.

Johnson, Dana T. "Gifted Math Students." Gifted Math Students. Accessed October 31, 2015. http://www.educationoasis.com/resources/Articles/teaching_gifted_math.htm.
Exploration of topics relevant to gifted education and mathematics including differentiation, pacing, process, technology and instructional strategies.

Li, Fuxia, and Wang Liidon. "The Study of Comparison between English Language and Mathematical Language." *Journal of Studies in Social Sciences*, 2013, 213-34.
Complex but instructive synthesis of the comparison of the English language and math with insightful connections and examples of sentence structure, punctuation and instructional techniques.

"Multiple Intelligences By Dr. Thomas Armstrong." Multiple Intelligences By Dr. Thomas Armstrong. Accessed November 1, 2015.
http://www.institute4learning.com/multiple_intelligences.php.

"Reading Educator." Reading Educator. Accessed October 31, 2015.
http://www.readingeducator.com/strategies/frayer.htm.
Explanation and example of The Frayer Model of vocabulary development that is useful in helping students understand concepts though definition, characteristics, examples and non-examples.

Reimer, Wilbert, and Luetta Reimer. *Historical Connections in Mathematics: Resources for Using History of Mathematics in the Classroom*. Fresno, CA.: AIMS

Educational Foundation, 1992.
A collection of resources that integrate the history of mathematics, problem solving experiences, biographical portraits and anecdotal stories that help students link human elements to mathematical concepts.

Reiter, Harold. "Understanding Fundamental Ideas in Mathematics at a Deep Level." Harold Reiter's Home Page. Accessed October 31, 2015. http://math2.uncc.edu/~hbreiter/.
Amalgamation of incredible resources, ideas, scholarly articles; go to Fundamentals of Math for this specific article.

Robb, Don, and Elena Dworkin Wright. *Round Table Geometry: Sir Cumference Classroom Activities*. Watertown, MA: Charlesbridge Pub., 2010.
One of many mathematical picture books that incorporate the study of math with a creative, often historical story. See Charlesbidge Publications for list of books.

Rotigel, J. & Fello. "Mathematically Gifted Students: How Can We Meet Their Needs?" *Prufrock Press* Vol. 27, Issue 4, Pp. 46-51, no. 4 (2004): 46-51. Accessed October 16, 2015. http://www.davidsongifted.org/db/Articles_id_10514.aspx.

"SNAP Mathfairs." Who Are We? SNAP Mathematics Fairs. Accessed October 26, 2015. http://www.mathfair.com/.
This webpage has everything you need to get started on your Math Fair. It has the philosophy, guidelines, resources, grading suggestions, student project ideas and two videos of successful fairs with narration by the leaders of the fair.

Stanley, Julian C. "Boys and Girls Who Reason Well Mathematically." *Ciba Foundation Symposium 178 - The Origins and Development of High Ability The Origins and Development of High Ability: Ciba Foundation Symposium 178 Novartis Foundation Symposia*, 2007, 119-38.
Review of Julian Stanley's life work of studying mathematically precocious youth and how to best meet their academic needs.

Truss, Lynne. *Eats, Shoots & Leaves: The Zero Tolerance Approach to Punctuation*. New York: Gotham Books, 2004.
An often humorous though serious examination about how the misuse of grammar impacts the meaning of everyday language, including symbols used both in English and math.

Urquhart, Vicki. "Using Writing in Math to Deepen Student Learning." Www.mcrel.org. 2009. Accessed November 1, 2015.
A synthesis of research and findings regarding writing in math with practical examples from classroom teachers imbedded.