

## Finding the math in “Holes”

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### **Overview**

This unit aims to integrate mathematics into the sixth grade Pittsburgh Public Schools (PPS) core curriculum. The unit will provide 3 mini- lessons that any teacher can explore with students who are reading or who have read *Holes*. During the 6<sup>th</sup> grade year, PPS students read and analyze *Holes*, by Louis Sachar. These lessons could also be used for seventh or eighth grade students who have already read the novel. In the sixth grade communications’ classroom students explore the key concepts of irony, how the setting affects the character, how the characters can change over the course of the plot and how characters grow and mature as they interpret life situations. The mini- lessons in this unit will make a connection to mathematics and communications using content from the novel *Holes*.

Communication skills are naturally integrated into the mathematics classroom through accountable talk, explaining math work in written form and responding to word problems. Unfortunately, mathematics does not often cross over to the communications classroom. Students leave the mathematics classroom and leave the mathematics at the classroom door. One of the goals of this unit is to bring mathematics out of the classroom and integrate mathematics into other areas of life. As students open their eyes to the mathematics around them, hopefully they will begin to see the natural overlap of mathematics into everyday life.

To begin to expose students to the mathematics around them, this unit will explore the mathematics in the popular novel *Holes*. Students will be exposed to ideas that they may not label as mathematic. They will also be provided with connections from the novel to sixth grade eligible content. Exposing students to mathematics imbedded in literature will foster their imaginations and creativity and hopefully guide them to the belief that math is everywhere.

## **Rationale**

Engaging, hands on lessons leave a lasting impression on our students. Think back to a memorable lesson from your schooling. What do you remember most? Most likely, there was a connection, something that drew you in, and an activity that tied everything together. In today's classroom teachers are often pressed for time with pacing guides and high stakes testing it can be difficult to create lessons that leave lasting impressions. This unit aims to provide lessons that will engage students in the connection between literature and mathematics. These lessons were created to be used in conjunction with the novel "Holes", but could easily be used with a student who has read the book in the past. All of the lessons are based on Pennsylvania State Eligible Content and can be easily adapted to meet the needs of students who require additional supports or students who require added academic rigor.

Mathematics and literature provide many opportunities for cross- curricular activities. Exposing students to the overlap of subjects makes each lesson that much more concrete and meaningful in their everyday lives. In mathematics we often ask students to classify information, solve problems, discover relationships and identify patterns. (Khemakhem) These same skills are used in middle school literature classes where we ask students to classify information ( fact/opinion, bias/propaganda), solve problems ( develop responses to literature), discover relationships ( infer meaning from the authors text) and identify patterns ( poetry, story time lines).

Marilyn Burns, a leading mathematics educator and children's author, stated a number of reasons for connecting literature to mathematics:

-connecting literature to math concepts provides a meaningful context for the mathematics concepts

-literature can explain how math develops through the human experience

-literature can explore mathematics as its own language

-literature easily integrates math into other content area

-concepts presented through literature can assist in the development of number sense

-well written literature can support problem solving and of course exposing students to the mathematics in literature reinforces the idea that math is everywhere!

My plan for this unit is to integrate communications and mathematics concepts. As a Therapeutic Support Teacher, my classroom is self- contained. One of the positive aspects of being a self- contained teacher is that I can observe my students' abilities across all subjects. I can easily make reference to the current communications lesson, or bring up the math lesson during science. As our district works to develop our core curriculum, I believe that it is imperative that we make cross curricular connections. Students need to explore content outside of the traditional environment and see how the topics are applied to the world outside of the classroom. Cross curricular connections help students see the connections.

In developing this curriculum unit, I kept in mind the developmental stages of middle school children. According to Erickson, students' social emotional development at this stage centers around competence. This stage is often referred to as Industry Vs. Inferior. Children are working on mastery of their basic skills. During this time period it is essential that students learn to relate to peers, participate in collaborative group work and improve their self discipline. This unit provides opportunity for group work and independent practice to work on both of these important skills.

The National Council of Teachers of Mathematics offers curriculum focal points for each grade level. These focal points should be addressed in the appropriate grade level to promote mathematical growth, problem solving and reasoning. In the sixth grade, the NCTM recommends the following focal points

-Number and Operations: Developing an understanding of and fluency with multiplication and division of fractions and decimals.

-Number and Operations: Connecting ratio and rate to multiplication and division.

-Algebra: Writing, interpreting, and using mathematical expressions and equations.

This unit does not address all of the focal points; however it provides a variety of practice in algebra. Students are asked to use a formula to find the volume of a cylinder, and then compare that volume as the circumference increases or decreases. Students who require enrichment could then turn these measurements into ratio statements. All students should be able to notice patterns and make statements about these patterns.

The pattern work continues when students work with palindromes. They will get to explore patterns and make predictions; these skills will be useful as the students continue to explore algebraic concepts.

While completing the eligible content story, students will explore concepts they find difficult. Students should be permitted to choose any piece of eligible content they have not mastered.

The eligible content story provides opportunity for cross-curricular planning between communications and mathematics teachers. The mathematics teacher can work with student on any misconceptions. The communications teacher can review the basic elements of a story and figurative language.

## **Objectives**

In this instructional unit students will work on skills that are directly tied to the Pennsylvania State System of Assessment. Students will have the opportunity to build their eligible content skills and develop an understanding of the connection between mathematics and communications. In the volume of a cylinder lesson, students will be asked to find the volume of a cylinder and compare the changes in the volume as one measurement changes (diameter). In the palindrome lesson students will be asked to use basic calculation skills to find palindromic numbers. They will also be asked to identify patterns in their answers. The eligible content story activity will vary from student to student. Students will be asked to identify the piece of eligible content that they have the most difficulty with they will then develop a story explaining the content and skill.

## Strategies

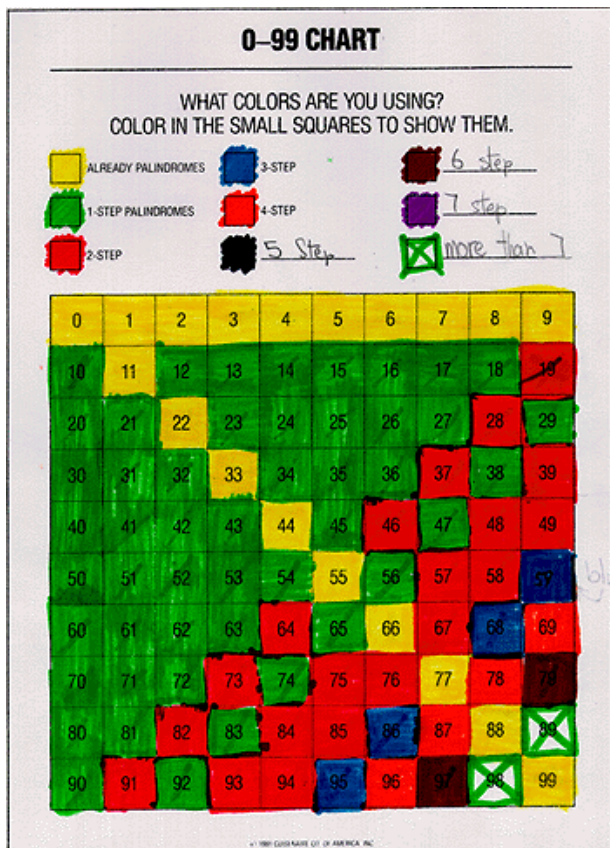
The lessons in the unit were developed for an Accelerated Learning Academy (ALA). As an ALA we follow the America's Choice workshop model. The workshop model begins with a teacher directed mini- lesson, which is focused on a grade level standard. Next, the students move into work time. This is the longest part of the lesson. Students are asked to apply the standard. Students may work independently or in small groups. During work time, teachers work with small groups to reinforce ideas, address misconceptions or provide enrichment activities. Teachers also use this time to conference with students 1:1, discuss work products and progress. The America's Choice workshop model is research based and provides easily understandable expectations and predictable classroom routines.

When developing specific strategies for this curriculum unit, I kept in mind the National Council of Teachers of Mathematics belief that proficiency in math comes from a combination of conceptual knowledge and flexibility to apply the conceptual knowledge in a variety of settings. Sixth grade students who participate in this unit will require an introduction to the idea of volume, however with the support of a formula sheet and an explanation from their teacher they will have the knowledge to work on the problem. The idea of numeric palindromes may be new to the majority of students; however they should have the ability to complete the task. They will need to be flexible in their thinking to find patterns in the palindromes. The eligible content story will require a thorough understanding of the content and the ability to think outside of a box and develop a story from the math concept.

In the volume of a cylinder activity students will be asked to estimate how much dirt they would remove with their shovel. Some students may require a review of fractions of an inch. Teachers may find it necessary to have precut paper strips to represent the different size shovels. It is important that students see the small difference in the shovel sizes and the amount dirt removed by students with different size shovels. Students will work in small cooperative groups to investigate how much dirt will be removed by their shovel for 1-10 days. After finding this information students will be asked to continue and find out how much dirt will be removed after 30 days, which is how long Stanley Yelnats was in Camp Green Lake. Students will also be asked to construct a graph with their information and present it to their peers.

The palindromes lesson will be a new idea for many students. Introducing palindromic words first and then having students explore both palindromes as words and

as sentences is the best way for students to see the connections. Words as palindromes are an interesting topic and some students may want more information. In the reading lists section you will find books to suggest to these students. The palindrome number lesson requires students to add numbers. They should not be permitted to use a calculator, so that they can set up and check each step. Some students may want to complete this on an individual basis or with a partner. You may want to warn students that 89 solves in 24 steps. The attached worksheet is marked. In order to avoid frustration, I would suggest that you allow students to skip 89. Students who complete the task quickly should be challenged to go on to the number 200. This time inform students that 187 solves in 23 steps. The number 196 will provide a particular challenge as there is no known palindrome for 196. Many people have created computer programs in an effort to find a palindrome for the number 196. They are still trying. Curious students can be directed to a number of websites from the reading lists to explore palindromic numbers. After students have completed their explorations, they should engage in a group conversation about the patterns they observe. Special education students may need more help seeing the patterns. I found an example of a wonderful adaptation on the website <http://www.geocities.com/~harveyh/palindromes.htm>. This chart or one similar could be easily made; it would allow students to join in the conversation.



During the conversation about palindromes it is very important that the classroom teacher take a step back and allow the students to guide the conversation. Accountable talk should be encouraged through modeling and rephrasing, the following examples of accountable talk placed on the board will guide the students in the right direction.

I would like to build on what \_\_\_\_\_ said.

I would like to disagree with\_\_\_\_\_.

I have different ideas about that.

Do you think that will always work?

It is important to not only guide how students speak in a classroom but also to guide the content of the conversation. A number of mathematically rich conversations can build from the idea of palindromic numbers, prime numbers, even, odd, square and square root, proving an idea, and counter examples.

The eligible content story is independent of the novel *Holes* .It could be pulled out separately and taught at any time. Students, much like the rest of us, don't know what they don't know. An important part of data driven instruction is sharing with students their weaknesses and strengths. This information is easily accessible to any Pittsburgh Public School employee through the Real Time Information System ( RTI). Students' 4 Sight exam scores can be printed so that the anchor, descriptors, eligible content and points earned over a number of different tests can be easily viewed. This data can then be shared with the student so that he/ she can see their progress. Students should be permitted to choose a piece of eligible content that they have not yet shown to have mastered to date. These stories can foster a great deal of understanding not just for the author but for other students in the class who read the story.

A number of the activities in this unit require or give the option of group work. Group work requires planning and organization on the part of the teacher. Expectation must be clearly defined and each student must have a job and understand the responsibilities of their given job. Another roadblock to group work is deciding how to grade the work produced. A number of different approaches can be applied; each has its advantages and disadvantages. As with any assignment it is important that students understand the expectations and have seen a sample of work that meets the standard. Ideally, students can review work from previous years and see work that is below the standard, at the standard and exceeding the standard. As a teacher, I find it helpful to save samples of student work (with the names removed). For the first time you may want to develop your own work sample. Once students understand what is being asked of them it is important that they understand their role in the group. Work assignments with a list of job responsibilities should be given to each student. Prior to assigning the work it is important that students understand how they will be graded, individually or as a group some teachers find it helpfully to allow group members to have input in their partners grades.

## Classroom Activities

### Volume of a Cylinder

Students will begin the lesson by rereading the following passage for mathematical significance.

*The shovels were kept in a shed near the showers. They all looked the same to Stanley, although X-Ray has his own special shovel, which no one else was allowed to use. X-Ray claimed that it was shorter than the others, but if it was, it was only by a fraction of an inch.*

*The shovels were five feet long, from the tip of the steel blade to the end of the wooden shaft. Stanley's hole would have to be as deep as his shovel and he'd have to be able to lay the shovel flat across the bottom in any direction. That is why X-Ray wanted the shortest shovel. Page 27*

After the students have reread the passage, they will engage in a guided discussion about the math ideas imbedded in this idea. Lower level students or English language learners may need to discuss the idea of a "Fraction of an inch" this would be a great time to review the idea of labeling fraction on a ruler. As students discuss the concept, the classroom teacher will provide guiding questions, "What shape would the hole resemble?"(circle)"What geometric measurement would be "five feet across in any direction"? (Diameter)

Students will use the formulas for area of a circle and volume of a cylinder (they will be given formula sheets), using the measurement for their "Shovel". Students will be given shovel sizes ranging from 4 ½ feet- 5 ½ feet, they will be asked to find the area of a circle and a volume of a cylinder using this measure as the diameter. After students have their initial measurements they will be asked to find out how much dirt will be removed each day for 10 days, students will then add each day to the last and graph the information. As a challenge students will be asked to find the amount of dirt removed for 30 days.

The closing of the lesson will consist of the students explaining their graphs and leading a discussion based on the differences they observe.

### Palindromes

Stanley Yelnats the main character in *Holes*, has a name with a unique quality. It is a palindrome. Have students reread the following passage

*Stanley's father was also named Stanley Yelnats. Stanley's father's full name was Stanley Yelnats III. Our Stanley is named Stanley Yelnats IV. Everyone in the family had always liked the fact that "Stanley Yelnats" was spelled the same forward and backward.*

Students will begin this lesson by exploring basic palindromes. Students will then create a list of palindromic numbers. After students have exhausted a list of numbers, the teacher will explain that almost every number can become a palindrome. The classroom teacher will explain that all numbers can be turned into palindromes by adding the reverse. For example,  $40+04=44$ , the number 40 can become a palindrome in 1 step. The students will be given a worksheet asking them to find palindromes for a variety of numbers. The activity will help students with their computation skills, problem solving and give them an opportunity to discuss patterns. After students have completed the palindrome worksheets, a discussion in class will uncover the patterns students have discovered.

### Eligible Content Story

This lesson does not relate directly to *Holes*. However it gives students an opportunity to bring literature and mathematics together. Students will be asked to review their grade level eligible content list and identify the one idea that they find difficult. Students should be allowed to review their 4- Sight exam scores. Once they have identified their "problem content", they will need to write a short story using the concept as the theme.

In writing the story students will have an opportunity to explore the concept and correct any misconceptions. This activity will also give students an opportunity to work with the elements that make a good story, characters, plot and setting. Students will be able to share their completed stories with peers and create a classroom collection for other students.

## Annotated Bibliography/ Resources

### ***Book for Teachers***

Bay- Williams, Jennifer M., and Sherri L. Martinic. *Math and Literature*. 1st ed . Sausalito, Ca: Math Solutions Publications, 2004. Print.

This book offers a number of different mathematical activities for popular children's literature.

Bergerson, Howard W.. *Palindromes and Anagrams*. New York: Dover Publications, 1973. Print.

Palindromes and Anagrams offers expanded explanations on both topics.

Gardner, Martin. *The New Ambidextrous Universe*. 5. Mineola, New York: Dover Publications, 2005. Print.

If you find mathematical tricks interesting you will enjoy this novel and many of the others written by Martin Gardner.

Sachar, Louis. *Holes*. 10. New York: Random House, 2000. Print.

Stanley Yelnats explores his families past as he faces his own difficulties at Camp Green Lake.

### ***Websites for Teachers***

[http://sci.tamucc.edu/~eyoung/middle\\_school\\_literature.html](http://sci.tamucc.edu/~eyoung/middle_school_literature.html)

This website offers an extensive list of children's novels and the mathematical concepts that can be connected to each book.

<http://qapmath.qataracademy.wikispaces.net/file/view/Integrating+Math+and+Literature.pdf>

This power point presentation is a great jumping off point for anyone interested in the math and literature connection.

<http://www.pde.state.pa.us/>

The Pennsylvania Department of Education website offers information on state standards, samples from the state assessments and a wealth of other information.

[www.nctm.org](http://www.nctm.org)

National council for teachers of mathematics offers guidelines of each grade level, offers support on a variety of topics and keeps you updated on best practice.

<http://www.geocities.com/~harveyh/palindromes.htm>

This website will give you the full mathematical background on palindromes, a great place for adult learning.

### ***Book for Students***

Lederer, Richard. *The Circus of Words*. 1. Chicago: Chicago Review Press, 2001. Print.

An entertaining book full of word puzzles and games.

Terban, Marvin. *Too Hot to hoot*. 2. New York: Clarion Books, 2007. Print.

A book full of word and sentence palindromes, a challenge for every level.

Sachar, Louis. *Holes*. 10. New York: Random House, 2000. Print.

Stanley Yelnats explores his families past as he faces his own difficulties at Camp Green Lake.

Pennsylvania Academic Standards covered in unit.  
www.pde.edu

1.4.8.A Write short stories, poem and plays.

- Apply varying organizational methods.
- Use relevant illustrations.
- Utilize dialogue
- Apply literary conflict
- Include literary elements Standard 1.3.8.B)
- Use literary devices (Standard 1.3.8.C)

2.1.8.A Represent and use numbers in equivalent forms (e.g., integers, fractions, decimals, percents, exponents, scientific notation, square roots).

2.2.8.B Add, subtract, multiply and divide different kinds and forms of rational numbers including integers, decimals, fractions, percents, and proper and improper fractions

2.3.8.A Develop formulas and procedures for determining measurements ( e.g., area, volume, distance)

2.3.8.E Describe how a change in linear dimension of an object affects its perimeter, area and volume.

2.5.8.A Invent, select, use and justify the appropriate methods, materials, and strategies to solve problems

## Eligible Content Story

### Step 1

Review your 4 sight scores. Find one piece of eligible content, that you have difficulty with.

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(Example: M6. A.1.1.1 Represent common percents as fractions and/or decimals)

### Step 2

Time for research! Check with students in your class, Can you help anyone with their eligible content?

Meet with your Math teacher. Make sure you understand the topic

### Step 3

*Brainstorm*

Do you have a favorite story, TV show or movie? Write a parody.

Write a poem.

Write a play.

Write a transcript for a new interview.

Write a newspaper article.

Write an extended metaphor.

Meet with your communication teacher. Make sure your work meets expectations.

- Turn story into your Math teacher, revise mathematical ideas as needed.\*

### Step 4

Illustrate your story.

Step 5 Share your story with peers.

## Palindromes

Original Number	Number of Steps	Palindrome	Original Number	Number of Steps	Palindrome
1	0		44		
2	0		45		
3	0		46		
4	0		47		
5	0		48		
6	0		49		
7	0		50		
8	0		51		
9	0		52		
10			53		
11			54		
12			55		
13			56		
14			57		
15			58		
16			59		
17			60		
18			61		
19			62		
20			63		
21			64		
22			65		
23			66		
24			67		
25			68		
26			69		
27			70		
28			71		
29			72		
30			73		
31			74		



## Volume

*The shovels were kept in a shed near the showers. They all looked the same to Stanley, although X-Ray has his own special shovel, which no one else was allowed to use. X-Ray claimed that it was shorter than the others, but if it was, it was only by a fraction of an inch.*

*The shovels were five feet long, from the tip of the steel blade to the end of the wooden shaft. Stanley's hole would have to be as deep as his shovel, and he'd have to be able to lay the shovel flat across the bottom in any direction. That is why X-Ray wanted the shortest shovel.*

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Do you think X-Ray will be removing a lot less dirt? Will it make a difference?

In groups you will be assigned a shovel size 4  $\frac{1}{4}$  feet, 4  $\frac{1}{2}$  feet, 5  $\frac{1}{4}$  feet, 5  $\frac{1}{2}$  feet

1. If you had a shovel that was 5 feet long you would remove 98.13 cubic feet of dirt. Estimate how much dirt you think you would remove with your shovel \_\_\_\_\_
2. Using your shovel size and your formula sheet find out how much dirt will be removed after
  - 1 day
  - 2 days (day1 + day2)
  - 3 days (day1+day2+ day3)
  - 4 days
  - 5 days
  - 6 days
  - 7 days
  - 8 days
  - 9 days
  - 10 days

3. Graph your data

Challenge Question How much dirt would you remove after 6 months (the amount of time Stanley spent at Camp Green Lake) \_\_\_\_\_