What is a "math trail?"

The math trail was first conceived as a way to help students become active learners by finding the math that exists in their communities.

Many teachers have since used and expanded on the math trail concept. One of them is Presidential Award winner Kay Toliver, from East Harlem, New York. Ms. Toliver and her students can be seen doing a math trail activity in the "Math Trail" episode of the series *Teacher Talk*, a 20-minute video that is included in this kit.

There is no one "right way" to conduct a math trail. The basic activity is simple: students observe the environment outside the classroom, to discover examples of math concepts that they are studying. They then create problems for others to solve based on their observations.

A series of observations and problems can be put together to create a "trail" that others can follow. The trail can lead participants into the community, or trace a route through the school grounds. The choice will depend on the circumstances and resources that exist at your own school.

Done well, a math trail can help students discover new things about their community at the same time that it sharpens their mathematical thinking. One of the things that initially attracted Ms. Toliver to the math trail was her desire for students to have a greater understanding of and respect for the rich history of East Harlem.

"To give a context for the activity, I start by having my students read a short book about the history of East Harlem, where our school is," she says. "They are usually surprised to discover how East Harlem has changed over the years, and are excited to learn about famous people who graduated from our school. We discuss what they have learned. I have also had good results from bringing in neighborhood 'old-timers' to talk about how things have changed, or special aspects of the community."

The math trail activity has these objectives:

- To help students value mathematics by giving them an opportunity to discover its applications in the real world.
- To improve students' problem-solving ability by giving them an opportunity to create and solve their own problems.
- To improve students' ability to communicate mathematical ideas.
- To improve students' ability to work together on mathematical problems.
- To develop students' interest in and respect for the community in which they live.

How to do a math trail

(Note: These instructions are based on the approach that Kay Toliver has found to be successful with her students at East Harlem Tech/P.S. 72. They are offered as a template to be used as-is, or adapted to fit local needs.)

PRE-PLANNING

- Watch the video, "The Math Trail," included in this kit.
- Evaluate your local circumstances. What are possible locations for your math trail activity? Are there locations nearby that have any historical significance? Is there anything that is unique or noteworthy about your local area (or community) that could provide a context or theme for a math trail? Are you convinced that you will have to remain on your school grounds for this activity?
- Decide where you want to take your students. Once you have done this, determine what special arrangements will need to be made (if any). If you have chosen a location that has historical or other significance, ensure that you have reference materials available.
- Review the examples on pages 8–11 of this guide. (You can find additional examples at www.nationalmathtrail.org.) Satisfy yourself that you understand how the activity works.
- Go to your intended sites, and spend some time looking for potential math problems. Make notes of several, for use with your students.
- If technology tools such as digital cameras, calculators, etc. are available at your school, and you would like to incorporate them, ensure that they will be available on the day that you intend to use them.

ORIENTATION

- Tell students that you will be taking them out of the classroom to do an activity called a "math trail." It is strongly recommended that you also show them the sections of the documentary *"Good Morning Miss Toliver"* (included in this kit) that show Kay Toliver and her students on the math trail.
- Ask the students for examples of math problems that could be created by observing locations and activities in their environment.
- Tell them where the math trail is going to take place. If you have chosen a site with historical or cultural interest, introduce this element of the project. Let the students know how they can obtain additional information.
- Tell the students that their assignment will be to find examples of math problems along the route that you have chosen. (If possible, you could also offer them the option of creating a route themselves.) They will create a book that presents both the trail and the problems they have created. They will be expected to provide solutions for each problem in the book.
- Answer any questions.

TRIAL RUN

- Take the class to the math trail location. Show them where the math trail will start.
- Walk through the area, and point out a few examples of math problems. Begin by presenting examples yourself. As student interest and understanding develops, ask the students to suggest examples.

FINAL PREPARATIONS

- Arrange the students into working groups. Each group should have a manager, a recorder, a photographer and other members. Each person must know his job. (Ms. Toliver notes, *"Sometimes I let students choose their own groups, but more often I assign them myself, perhaps with some mathematical scheme. In life, they won't always be able to choose who they work with, and I want them to develop the ability to work well with many different people."*)

- Tell the students that their book must have an introduction, a map of the community, and instructions as to exactly how to follow their trail.

- Allow students to take one or two periods to go out and determine the sites and problems of their trails. They should work out how they will divide up the work of putting their book together, and do so in the next two periods.

- Emphasize that students should be very proud of the final product before they turn in their books.

COMPLETING THE ASSIGNMENT

- Before turning in its book, each group should present its results to the class.

EVALUATION

- Ms. Toliver offers the following guidelines for assessing performance on the math trail:

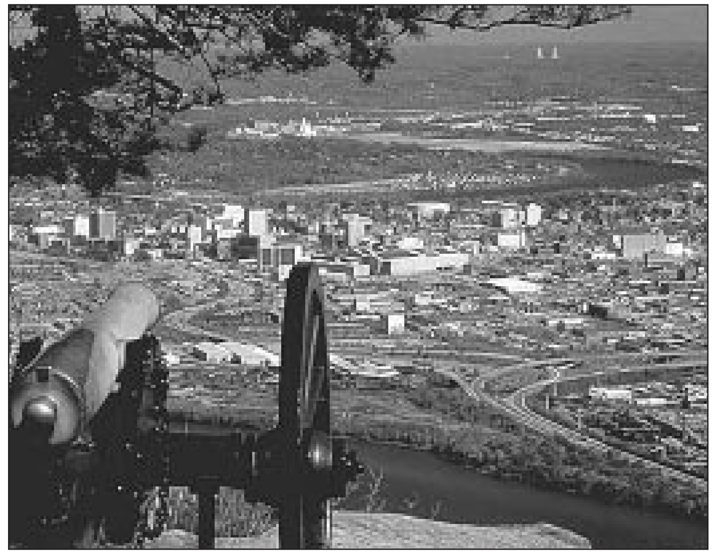
  "When I evaluate the books, the main thing I'm looking for is the math problems and their solutions. But I also look for the quality and effectiveness of the presentation, and good language skills.

  "It's surprising what can happen when you take mathematics out of the classroom and onto the sidewalks. For example, I had one young student who didn't do very well in geometry during the regular class. But as we were doing a trial run of the math trail, she looked at the top of a building and saw one very large triangle and a smaller one on the edge of the roof. She looked up at me and said, 'Miss Toliver, those are two similar triangles!' I had thought that this student hadn't listened to anything through the whole section on geometry! She went on to explain to me just why they were similar, using the concept of proportionality.

  "Not only can the math trail give students a new view of mathematics and of their community, it can give a teacher a new view of his or her students' understanding."

Sample Math Trail Problems

LOOKOUT MOUNTAIN, CHATTANOOGA, TENNESSEE



Background: Chattanooga is a Native American expression meaning, "rock that comes to a point." It is located on the "Moccasin Bend" of the Tennessee River, near the state of Georgia. It was originally started as a trading post and held a lucrative river port.

John Ross settled the city of Chattanooga in 1815. Ross was later named a Cherokee Indian chief and established a lucrative trading post on the Tennessee River called Ross' Landing.

The small town was incorporated in 1839. It soon became a railroad hub, being so close to Atlanta.

Lookout Mountain, the mountain which hovers over Chattanooga, is steeped in history—specifically, Civil War history. Its most famous battle happened near September 19, 1863, when the North launched a crucial campaign against the South.

Earlier at the Battle of Chickamauga, General Bragg's troops routed General Rosecran's. Rosecran retreated to Chattanooga. Nearby, Bragg controlled Lookout Mountain and Missionary Ridge. Soon, General Grant and Hooker came with troops. Hooker, at General Grant's orders, attacked Bragg's Lookout Mountain position. Hooker had around 9,000 men while Bragg had a defending force of about 2,000. However, Hooker's troops had to storm the steep, thickly vegetated mountainside to reach Bragg. Because of the tremendous fog present that day, the ensuing battle was called the "Battle Above the Clouds."

Grade: 10

Math topic: Trigonometry

Math problems:

1. If the distance between Chattanooga and Lookout Mountain is 5.75 miles, the angle of elevation is 7 degrees, and the height of the deck we stood on to get these measurements is 41.5 feet tall, how tall is Lookout Mountain in miles? In feet?

2. If Lookout Mountain's shadow is 10,669.85 feet long, how long is the shadow of the deck we stood on in the same sun? (Hint: use calculations from problem #1.)

3. If you were to hold up a meter stick in the same sun, how long would its shadow be?

4. Why is it important to have precise measurements when measuring the angle of elevation of an object so far away? If the angle of elevation was 7.5 degrees, how tall would Lookout Mountain be?

Standards *(source—The Futures Channel)*:

- Can solve real-world problems involving trigonometric ratios.

Submission created by Mark Yates and his students at McCallie School, Chattanooga, TN.

POTTSBORO HIGH SCHOOL, POTTSBORO, TEXAS

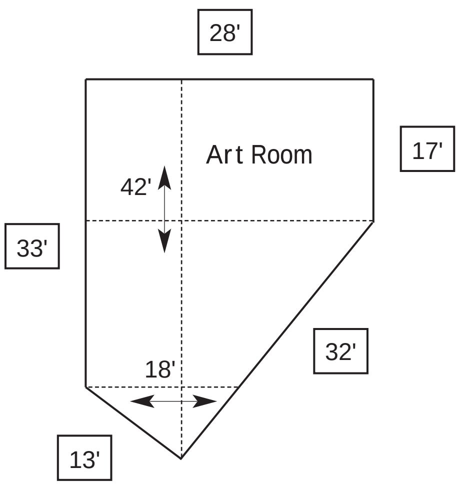
Background: Pottsboro I.S.D. began building the new high school in April 1999, and the construction is to be finished May 2000. The high school is located on Highway 120. This is a very exciting occasion for the town of Pottsboro.

Grade: 6

Math topic: Geometry

Math problems:

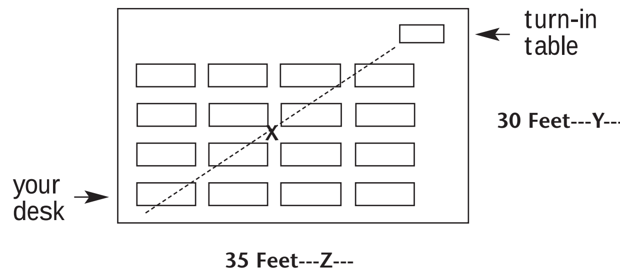
1. For a math project, you are assigned the problem of finding the carpet area of the school's Art Room. This room is a little unusual because it has 5 walls. The table has already divided the sections for you. Find the area of the new high school's art room.



2. If the approximate area of the new Pottsboro High School is 125,000 square feet, and the cost is approximately $11 million, then what is the cost per square foot?

3. The teacher makes a new seating chart and places you in the very back corner. This is a disadvantage because the turn-in table is in the opposite corner and you can't walk that far because of your broken ankle. Find how far you would have to walk to turn in your assignment by using diagram A, making line X your path.

   Also, find how much easier the X path is than the YZ path. (Hint: the Pythagorean Theorem A≤ + B≤ = C≤.)



Standards *(source—The Futures Channel):*

- Can determine the area of a rectangle by computation.
- Understands the concept "square unit."
- Understands the Pythagorean Theorem and can apply it to solving problems related to right triangles.

Submission created by Martee O'Mary's eighth grade students at Pottsboro Middle School, Pottsboro, Texas.

H.W. MOUNTZ ELEMENTARY, SPRING LAKE, NEW JERSEY

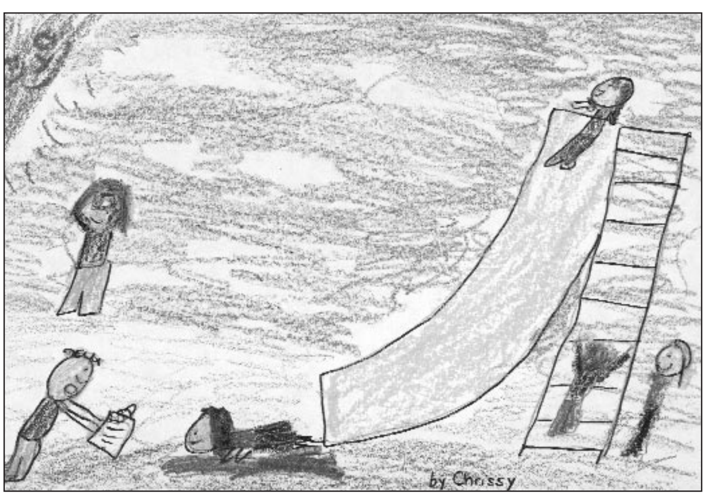
Background: Our K–8 school, located in the small seashore community of Spring Lake, New Jersey, has a wonderful playground with two structures for the primary grade students. During recess the first and second graders alternate use of this play area.

Recently, we had a discussion about the "fairness" of this arrangement. My first graders concluded that it was fair because of safety reasons.

Further discussion found the children outside, observing how they used the equipment and wondering how much safe space really was needed. One of the students identified that a builder or architect would need this kind of information when setting up the playground.

The children formed their math problem and solved it as a group.

We took pictures of the two play structures and later, students illustrated how they solved the problem.



Finally, we compared our findings with information located via the Internet and provided by the U.S. Consumer Product Safety Commission:

"Handbook for Public Playground Safety," publication #CPSC-325, Washington, DC: "Stationary climbing equipment and slides should have a use zone extending a minimum of 6' in all directions from the perimeter of the equipment."

Math topic: Measurement

Grade: 1

Math problem:

Your playground has a large connected play structure ("jungle gym"). It includes two slides, some climbing bars, poles, tunnels, and ramp (no swings). How much safe space is needed around the structure?

Hint: Children frequently fall forward when getting off the slide. Take the farthest measurement. Use standard or non-standard units of measure and convert later.

Solution:

We measured several children landing on their feet and then several who fell forward with their arms out in front (belly flop style). We used a stick that was 36 inches long to measure. We wrote down the measurements each time as "number of sticks long."

Here's how we solved the problem:

We measured with a stick that was 36 in. long. We changed 2 stick lengths to inches by using addition:

1 stick = 36 in.

2 sticks = 36 + 36 = 72 in.

72 inches = 6 rulers that are 1 foot, so 72 in = 6'

Measured from base of slide	Number of sticks long (stick = 36 in.)
8 children landed standing on feet	Less than 1 stick (24 in.)
8 children fell forward with arms outstretched	About 2 sticks

My students posed an additional problem. They wanted to know how much play space there was in between our two structures.

Here's how we did it: they measured 2 stick lengths out from each jungle gym and filled the space in between with themselves, standing together in a line.

Back in the classroom, they measured their 10-student line. It was 3 sticks long or 72" + 36" = 108."

Standards: *(Source—New Jersey Core Curriculum Content Standards)*

- 4.1 Students will develop ability to pose and solve mathematical problems in mathematics, other disciplines and every-day experiences.
- 4.2 Students will communicate mathematically through written, oral, symbolic and visual forms of expression.
- 4.8 Students will understand, select and apply various methods of performing numerical operations.
- 4.9 Students will develop an understanding of and will use measurement to describe and analyze phenomena.

Submission created by Marci McGowan and her first grade students at H.W. Mountz Elementary School, Spring Lake, New Jersey.

ABOUT the FUTURES channel

The materials in this guide are drawn from the archives of The Futures Channel, a producer and publisher of digital resources for math, science, technology and arts instruction. The Channel's emphasis is on helping teachers engage student interest by providing an extensive archive of microdocumentary video, lesson resources and other materials that connect curriculum topics to their real-world applications. Futures Channel offers online subscription licenses for individual teachers, schools, and school districts. For more information call 818-557-3300 # 2 or email info@thefutureschannel.com.