Host Site Overview

A Solidify/Practice Understanding Task

Purpose: To locate the 4th corner monument to confirm the property lines surrounding a residential home, so that the homeowner's know where to build their fence. Then determine if there is any overlap between properties that occurred during the creation of the original subdivisions within that neighborhood.

Career Field:

Surveying
Canoy Surveying

WTCC Associate Program of Study and Contact Person:

Geomatics Technology (Surveying)
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NC Math 4 Standards:

AF.2 Apply properties of trigonometry to solve problems
- **AF.2.2** Implement the Law of Sines and Law of Cosines to solve problems

Precalculus Standards:

PC.F.3 Apply properties of trigonometry to solve problems involving all types of triangles
- **PC.F.3.2** Implement the Law of Sines and Law of Cosines to solve problems

PC.N.3 Understand properties and operations with vectors
- **PC.N.3.1** Represent a vector indicating magnitude and direction (bearing angle)

Unit Alignment:
NC Math 4 - Unit 4: Trigonometry
NC Precalculus - Unit 6: Analytic Trigonometry
WTCC Math 121 - Trigonometry

Common Core State Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.

Prerequisite Skills

These skills could be reviewed in a warm-up and are addressed in the Desmos Activity

- Using Law of Sines and Law of Cosines
- Understand Bearing Angles
- Reading a compass
- Triangle Sum Theorem
- Area of Triangles
- Conversions

Time Required

The time required to complete this activity is approximately **90** minutes.

Materials Needed

- Student Activity Sheet
- Calculator
- Ruler

Vocabulary

- Bearing Angle in Surveying - surveying rarely uses degrees. They usually use a system of bearings based on deviation from north or deviation from south. For example: N 70° E means 70° to the east of North. See some examples below.
- Surveying - or land surveying is the technique of determining two-dimensional or three-dimensional positions of points and the distances and angles between them.
- Monument - a physical structure which marks the location of a corner or other survey points.
- Robotic Total Station - can measure angles and distances electronically. It uses trigonometry to give us the position of coordinates in space or the viewing plane.

The Teaching Cycle:

Launch: Have students complete the DESMOS LAUNCH ACTIVITY (linked here), which will review the prerequisite skills. It also includes the launch video, which highlights Canoy Surveying, goes into detail about the work surveyors do, and assigns students the task for the day. It is super important that they go through the Desmos activity because it goes over how to use bearing angles to find the measure of internal angles within the property.

Possible questions to discuss before starting the task:

- What do surveyors do?
- Why are surveyors important?
- What math skills do you think you need to be a surveyor?

This activity will have students determine the 4th corner point on a residential property, so that the homeowner's can build a fence with confidence that they are not accidentally building it on their neighbors property. Once they find the 4th corner point, they will then investigate if there is any overlap between properties that may have occurred when they originally laid out the subdivision.

Have students read the introduction page. Then have them answer the first question (Why is it useful to have metal stakes monumenting the property?). I would suggest having them share their answers before moving on. Some possible answers:

- Can be found using a metal detector
- Will not degrade over time

Then have them finish reading the task. You may want to utilize the 3 Read's protocol. The FIRST read is to understand the context. The SECOND read is to understand the mathematics involved. The THIRD read is to generate a plan for solving the problem.

It may be beneficial to work with students FIRST to find the angles within the property lines FIRST if they seem to be struggling with bearing angles to help them get started. Finding angle Z is the hardest part of this activity.

Explore #1: Have students work in small groups (2-3) to work through the first task, which is locating the 4th corner point of the property. As they are working, students may struggle with finding the measurement of angle Z. This angle measurement can be found using the bearing angles in the diagram as well as the Law of Cosines. Be prepared to help them and guide them to the helpful image found in the student activity sheet. When finding side X and angle Y, students will need to find side X first before they can find Y. First, they will use the Law of Cosines to find X, since we have a SAS triangle. Then, once they have X, they can either use Law of Cosines or Law of Sines to find Y. **Note: Students may be tempted to assume angle Y is 60, but the diagonal is not a straight line. Might be interesting to see if they assume it's 60, how far off the other angle measures would be.*

POSSIBLE Extension for Precalculus and MATH 171 (WTCC)
After the students find the value for X and start to find the value of angle Y, most students will probably use the Law of Sines. You can then have them determine if there is the potential for two triangles, aka the ambiguous case in law of Sines, in this case and then talk about whether the second triangle would actually make sense in the context of this problem.

Discuss #1: Bring students back together to discuss how they found the 4th corner point. Have students share how they determined the missing values, angle Z, angle Y, and side X. Have different groups share their work for each unknown. Make sure students understand how each measurement is found. Also, have a discussion on the order and why there is a specific order. If possible, see if there were groups who only used Law of Cosines vs. a mix of Law of Cosines and Law of Sines.

POSSIBLE Extension for Precalculus and MATH 171 (WTCC)
Discuss with students the possibility of a second triangle. Have groups share their work and how they used the law of sines to determine whether a second triangle was possible. Then discuss whether it would even make sense in the context of the problem and the image of the property shown.

Explore #2: This is for if you decide to do the extension activity. In the second task, students are asked to find the area and acreage of the land based on the measurements that have been calculated. They will use the area of a triangle, given a SAS triangle or the area of a triangle, given a SSS triangle. Once students have calculated the area for all 4 triangles, then they should sum them up and get the total square footage. They are then

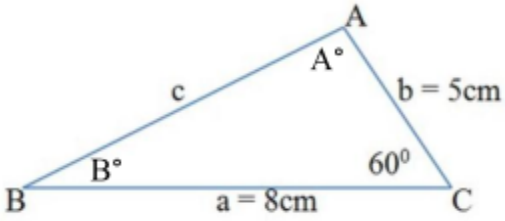
asked to determine the acreage and compare that to the total acreage given in the original survey document. They should find the square footage is off just slightly, but the acreage comes out to be the same.

Possible Extension Opportunity: Have students derive the area formula for a SAS triangle using right triangle trig. Could also be used as an exit ticket problem and launch the discussion for the next day. OR have them derive the formula first BEFORE moving into task 3.

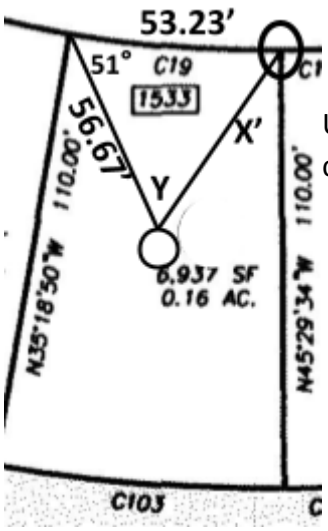
Discuss #2: Have several groups share how they determined the area of the individual triangles. Look for some groups to use the SSS formula vs. the SAS formula. Have groups share out their response to the final question, about how well the land was surveyed based on the original plot document. Based on the original document, the new land survey does a good job and the results calculated gave the same acreage.

Possible Extension: Have the students write a letter to the homeowner, writing up the findings in the form of a report. Bring it down to a level that a non math person would be able to understand and comprehend.

Exit Ticket:
Question #1: Define a bearing angle and draw an example.
Question #2: Using the image below, use Law of Cosines and Law of Sines to find the missing values in the triangle.



Two example assessments for testing:
Question #1



Using the diagram, determine the angle Y we need and the distance X to locate the corner point circled in the diagram.

Question #2

If we are told that we have a bearing angle: N 62°W, show what this would look like and then determine what the standard position angle would be.

Student Activity Sheet

Answer Key