Lesson Title	Geometric Direction
Length of Lesson	50 minutes
Created By	Shane Irvin
Subject	Geometry
Grade Level	9^{th}-12^{th}
State Standards	4b. Solve real-world applications and mathematical problems to find missing measurements in right triangles by applying special right triangle relationships, geometric means, or trigonometric functions.
DOK Level	DOK 2
DOK Application	Tabulate, Recognize, Repeat, Calculate
National Standards	Measurements: Apply appropriate techniques, tools, and formulas to determine measurements, understand and use formulas for the area
Graduate Research Element	Determining angles and lengths through the Pythagorean theorem is a well-used mathematical tool in GIS.

Student Learning Goal:
The learning goal for this lesson is for the students to grasp a full understanding on linear measurements and the applications of those measurements in the study of the Pythagorean Theorem. While most students learn this theorem through practice problems and explanation in the classroom, it is the goal of the lesson to push the students to learn the lesson in an abnormal setting. The students will be required to find set points in numerical order around campus. As they pace between the points the students will draw what they feel that they have done (one straight line at a time). Over the period of about 15 minutes, the students will then have to complete the missing measurements using the Pythagorean Theorem. This learning goal allows the students to cover the expected subject and state standards while allowing them to have fun pacing outdoors.

Materials Needed (supplies, hand-outs, resources):
Cones, Worksheets, Writing Utensil, Aerial Imagery

Lesson Performance Task/Assessment:
The worksheets, which will be handed out in class will go along with what the students paced out. It will ask for missing measurements that the students could potentially pace out but due to time are "required" to use the Pythagorean Theorem. This assessment will be accompanied by questions from the teacher throughout the students' independent practice:

Why is it important to find distance on a map?
Mapping is all about distance. Without it, an idea of projection on the map would cease to exist.

What parameters are required by the Pythagorean Theorem to be considered?
It must be a right triangle and one side of three must be missing.

Is it possible to use the Pythagorean Theorem on arcs?
No, the distance while a rough estimate does not consider the circumference.

Lesson Relevance to Performance Task and Students:
The students are beginning their study on the Pythagorean Theorem. The opportunity for this lesson to establish a connection with the Theorem will allow the students a full understanding of how to apply it to specific area in the field of science, geography, and mathematics. The students will eventually be required to use the Pythagorean Theorem to create a balloon car. This practice will allow the students to become comfortable with the subject area.

Anticipatory Set/Capture Interest:
The students will complete this exercise outside. This anticipation will be used as the anticipatory set. While this will be used, it will be clear to the students that a completed worksheet must be signed by the time the class goes back to the room.

Guided Practice:
The students will be given a hand out and will review the basics of the Pythagorean Theorem, as well as understand what pacing is. The students will follow along in the handouts. See below for handout. The students will then be lead outside to a set up course with cones and will be allowed to begin answering the questions.

Independent Practice:
The students will be required to go through the worksheet see below.

Directionally Challenged
In this exercise you are finding your way using the Pythagorean Theorem. Answer the questions below by pacing out to each cone. Each cone is numbered one (1) through (6). The order doesn't matter as long as you can find the missing components. Your goal is to prevent extra pacing work by only getting two out of the three triangle lengths and use the Pythagorean Theorem to solve the missing hypotenuse.

THE PYTHAGOREAN THEOREM

$$\boxed{a^2 + b^2 = c^2}$$

Where a and b are the sides and c is the hypotenuse

WHAT IS A PACE?

The pace is the distance from the heel print of one foot to the heel print of the other foot. This is the distance traveled forward by a single leg. An average that you will see listed in many places is 2.2 feet (0.67 meters) for women and 2.5 feet (0.762 meters) for men, but it depends very much on height. **To make it easier, everyone will use 3 feet today so if you go 20 paces it will be 60 feet.**

2.2 FEET

Throughout this exercise maps will be used that correspond to questions. For questions 1-3 refer to MAP 1.

1. What do you think the measurements will be based off of what you know (HINT: What is the length of a football field in feet)

   A = D =

   B = E =

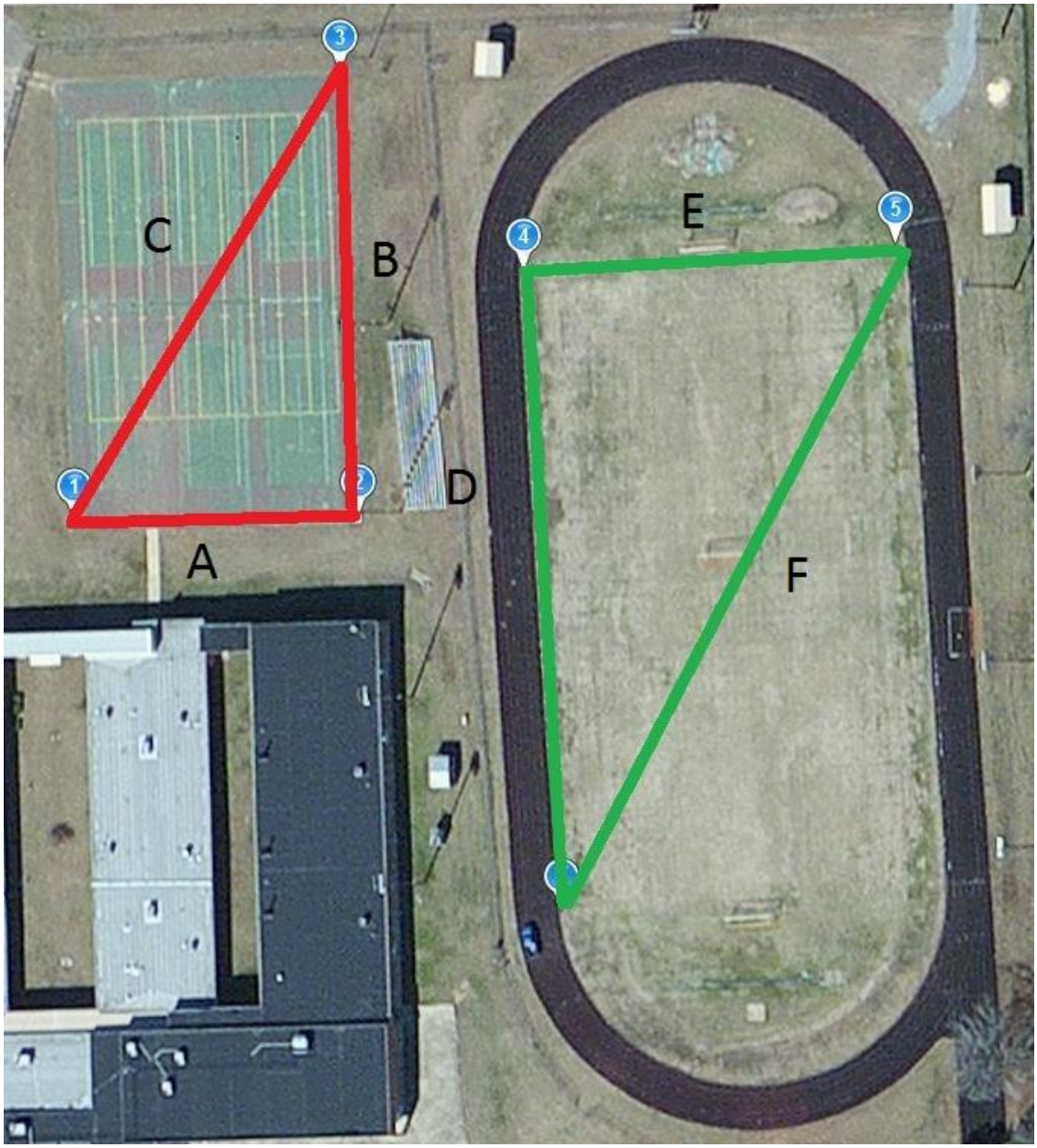
   C = F =

2. Pace out A and B and figure out C using the Pythagorean Theorem (ALL IN FEET)

   C =

3. Pace out D and BE and figure out F using the Pythagorean Theorem (ALL IN FEET)

   F =



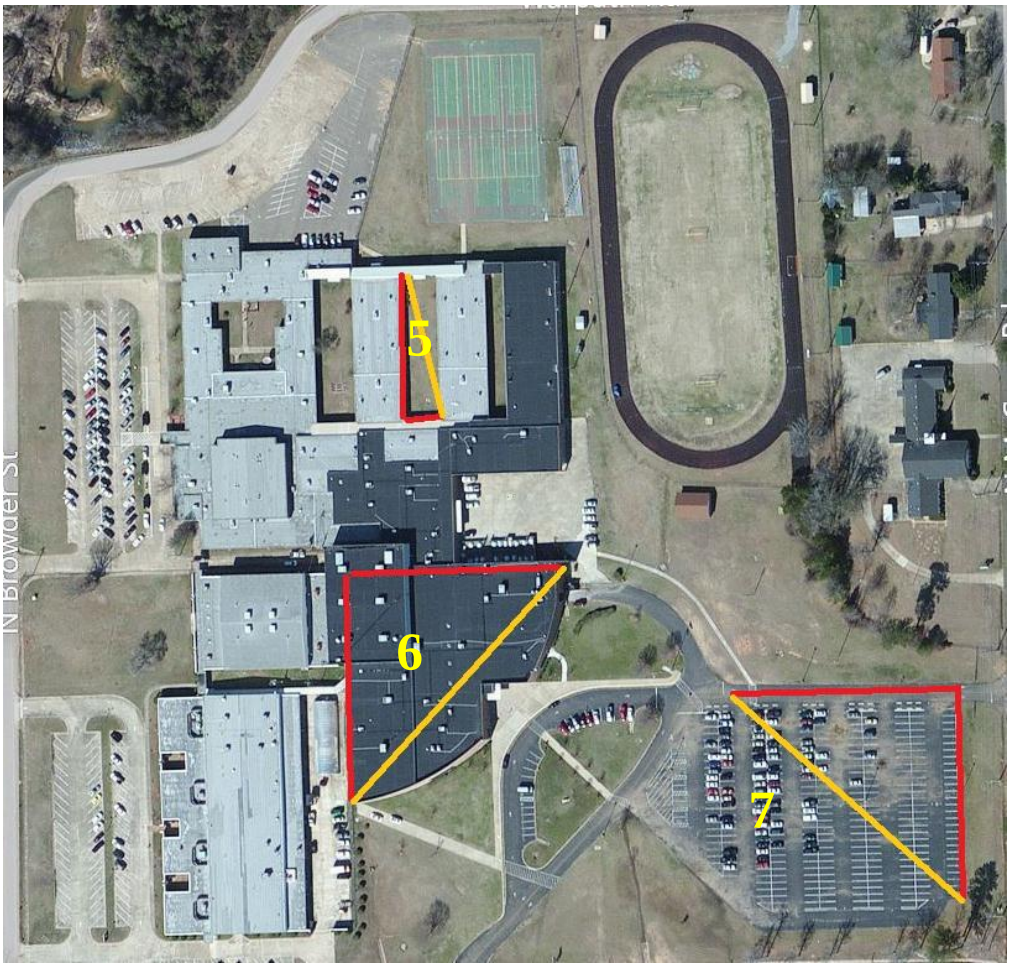
MAP 1

4. Using the distances collected from MAP 1, determine the distance in question 4 referencing MAP 2. While walking from point A to B then to C Mr. Dufours class got lost. Since the bell was about to ring the need to figure out how far of a straight line walk it was to the buidling. Find the distances between A and B, B and C, and using the Pythagorean Theorem, C and A. Once AC is found find the midpoint of that and that's how far the class has to walk to make it to the building before the bell.

MAP 2

IF TIME ALLOWS:

FIND OUT THE MISSING MEASUREMENTS OF 5-7 in MAP 3 using the distance collected over the past four problems.



MAP 3

Remediation and/or Enrichment:

Remediation:

In situations that remediation is needed the student can see the instructor for one on one tutoring. The student can also be paired with a high performing student with full understanding of the lesson.

Enrichment/Extension:

In situations where there is full understanding, the lesson can extended by letting the students find triangles on the maps. They will then be able to find the lengths of the missing triangles using the past questions and assumptions. All of these extensions depend on the students' ability and knowledge of the subject matter. Individual IEP's will be supported.

Check(s) for Understanding:
I will ask them to provide me with the answers to the questions in the **Lesson Performance Task/Assessment:**

Why is it important to find distance on a map?
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Closure:
In closure I will ask the students what they enjoyed about the lesson. This will be used for feedback for me but as well as to see if they cared about being outside over the actual content of the lesson.

Possible Alternate Subject Integrations:
Geography, Trigonometry, Calculus

Teacher Notes:
Pacing information: Health from About.com
Images: Provided by Google and Bing Maps
Editing of Images: Provided by the Author