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| **Lesson Title** | GPS-ometry |
| **Length of Lesson** | 50 minutes |
| **Created By** | Shane A. Irvin |
| **Subject** | Accelerated Geometry; Regular 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** | Application, Measuring, Solving, Inquire |
| **National Standards** | Specify locations and describe spatial relationships using coordinate geometry and other representational systems. |
| **Graduate Research Element** | GPS is imperative in the graduate fellow's research. Using geometric ideas that the students already know, they will be able to learn and apply the ideas behind geographic positioning systems |

**Student Learning Goal:**
The learning goal for the students is to establish a basic geometric connection between geographical positioning systems (GPS), that they see every day (cellphones, car GPS systems), handheld GPS units, and the extensive geometry behind the way the systems find exact positions. The lesson is designed to get the students connected to both the knowledge of what the satellite constellations above the earth do as well as the trilateration and triangulation (geometric properties and equation behind providing accurate positioning through cellular towers.

While the students will not heavily focus on the usage of satellites and how they go about providing data to the individual units, there will be a basic discussion on how through projected angles the satellites can provide better or worse accuracy to the GPS user. The main focus will be involved in discussing how devices we use everyday track positions, since most devices rely on trilateration and triangulation, not satellite constellations.

**Materials Needed (supplies, hand-outs, resources):**
Cellphone with GPS, Car GPS, Work problem (see attached INSPIRE_LP_Irvin_12_01_11_WS), writing utensils

**Lesson Performance Task/Assessment:**
The task/assessment for the students will be an activity that will apply what was taught in the guided practices. The students will work on a problem using geometric principles

already learned to determine how to fix problems such as multipath error (blocking of a signal), by building a cell tower taller. The problem will utilize algebra, the Pythagorean Theorem, and basic geometry skills learned these 9 weeks.

**Lesson Relevance to Performance Task and Students:**
The students are on the verge of transitioning from coordinate geometry to area. This lesson will help them once again understand what they have learned in a real world application. By having the students work through the attached problem, they can see that through math and geometry, they can solve the real world problems that face engineers and scientist every day.

**Anticipatory Set/Capture Interest:**
The two GPS units. The students will be asked why one (satellite GPS unit) doesn't work indoors, versus the (GSM cell phone unit) works indoors. This will get them thinking about GPS.

**Guided Practice:**
The students will work with the teacher to give examples of GPS as well as answering the following questions:

What is GPS?

What do you know about cell phones versus GPS units?

What do you think is the difference?

Why do signals get blocked to GPS units?

The questions will be asked and then correctly answered to the students. Items like multipath error will be explained as a correlation to research.

**Independent Practice:**
The students will work as groups to establish the framework for a provided problem on the board. The problem will require the student to use algebra, the Pythagorean Theorem, and basic geometry skills learned these 9 weeks. The problem will require the student to analyze and use the correct geometric tools to solve for a specific portion of the problem. The unknown is the objective of the independent practice. Once the student has the unknown, the student can check the problem using the Pythagorean theorem to double check their work.

**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:

All of these extensions depend on the students' ability and knowledge of the subject matter. The student will have the opportunity to get more specific with triangulation considering their knowledge background. If the student is knowledgeable about trigonometry the lesson can be expanded to explain the law of sines. Individual IEP's will be supported.

**Check(s) for Understanding:**

What is GPS?

What do you know about cell phones versus GPS units?

What do you think is the difference?

Why do signals get blocked to GPS units?

**Closure:**

The closure of the lesson will be the integration in why they believe the mathematics made real life situation easier. The graduate student can then take this time to give the students specifics on how GPS is utilized in their research as well as how multipath error affects their research accuracy.

**Possible Alternate Subject Integrations:**

Geography, Algebra, Trigonometry

**Teacher Notes:**

The teacher must understand specifics about GPS and how it can have errors due to specific issues like multipath error. The teacher will have the ability to get the students thinking bigger if the students have mastered trigonometry.