**Pythagorean Theorem with Drones**

**Brief Description:**
Students will explore the different properties of right triangles and connect them with how the drone calculates the altitude and the distance from the pilot using the Pythagorean theorem.

| **Author(s):** | **Creative Commons License Type:** |
|---|---|
| Kyle Crawford | |

| **Grade Level(s):** | **Time Needed:** | **Math Class:** |
|---|---|---|
| 6th-8th | Day 1: 30 mins<br>Day 2: 50 mins | Middle School Math Levels |

**Context Key Words:**
Drone or Unmanned Aircraft System (UAS), Pilot in Command (PIC) Visual Observer (VO), altitude vs. distance from remote, Above Ground Level (AGL)

**Student Objective:** By the end of this lesson, students will be able to identify the length, height, and hypotenuse of right triangles and translate the right triangle into the real-life position of the pilot and the drone.

**Mathematical Practices**

| | | | |
|---|---|---|---|
| | Make sense of problem and perseverance | | Use appropriate tools strategically |
| | Reason abstractly and quantitatively | X | Attend to precision |
| | Construct viable arguments and critique reasoning | | Look for and make use of structure |
| X | Model with mathematics | | Look for and express repeated reasoning |

**Content Standards:**
CCSS.Math.Content.8.G.B.7
Apply the Pythagorean theorem to determine unknown side lengths in right triangles in real world and mathematical problems in two- and three-dimensions.
CCSS.Math.Content.HSG.SRT.D.11
If use with non-right triangles

**Background Information:**
In our world, we constantly need to calculate distances. Be it in construction, farming, engineering, or even using GPS location services, one of the best tools we use is the Pythagorean theorem. (A^2 +B^2 = C^2) Every right triangle contains three parts: the length, the height, and the longest side, the hypotenuse. If you know two of the sides, you can calculate the third side using the Pythagorean theorem.

**Vocabulary:**
Length, height, hypotenuse, right triangle

**Previous lesson connections:**
Parts of a right triangle, square and square roots

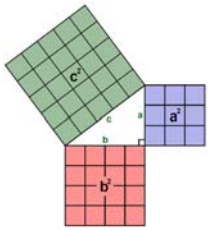
**Classroom Materials:**
Scientific calculators, string, scissors, large measuring tape, UAS

**Pythagorean Theorem with Drones**

**Procedure:**

**(In-Classroom Procedure) Day 1**

1. In what ways can we use the Pythagorean theorem, and how could it help make a job easier/better?
2. Think/pair/share in small groups followed by a KWL, etc.
3. Create multiple examples of right triangles on the whiteboard, some pointing "left" and identify the 3 sides of the triangle as A, B, and C, where C is always the hypotenuse or the longest side.
4. Work through a number of problems using the Pythagorean theorem to find the measurements of missing sides until students are firm on the concept.





(**Out of classroom Drone Procedure) Day 2**

1. Inform students that they will be calculating various measurements using the Pythagorean theorem and that they will be measuring the drone's height (the B side of our triangle), the altitude, the distance the drone is away from the remote (the C side and hypotenuse), and the length (the A side), the distance from the remote control to the launch pad.
2. Separate class into 4 or 5 groups and provide each group with a story problem concerning the drone's altitude or their distance. (Ex: "Please help! Our drone will be coming in for a landing, but the computer inside has experienced a malfunction. We know we're 30 feet from the launch pad and our distance from our drone diagonally is 50 feet. What is the drone's altitude?")

**Exit Task/Assessment:** 3.

1. To check their calculations, each group will be cutting string to the exact measurement of side C and side B of their triangles. Attach the strings to the drone and move the string to the ground axis points (the launch pad and the position of the PIC—use long measuring tape to find this exact measurement to show side A of your triangle.) Have students stand back from launch pad and take the drone up slowly to each groups' desired altitude. This should create a large right triangle for all to see.
2. Wrap things up back in the classroom by finishing up the KWL and reflecting through discussion.

| **Anticipated Student Solutions, Thoughts and Responses:** | **Suggested Teacher Responses, Questions and Guidance to Promote Student Thinking:** |
|---|---|
| • Students will make the connections from two-dimensional drawings on the board to how the triangles are used in the real world.<br>• Students will recognize the multitude of reasons this may be valuable. | • **(A^2+B^2=C^2)** When considering the Pythagorean theorem, A, B, and C refer to the three sides of a right triangle where C is the hypotenuse. Instruct students to plug in measurements with the corresponding sides. If you have two of the sides, you can solve the missing side with algebra. |

**Differentiation:**

Scaffold Supports

- Start small and use whole numbers. (3, 4, 5)
- A lot of visuals and manipulatives!
- Calculate some right triangles in the classroom or on the whiteboard

Extensions

- Creating pyramids with students and calculating SA and volume
- Connecting the hypotenuse with various angles and beyond