LESSON 2: DRONIE

Overview:

Students will use the DroneBlocks App to test-run, and take a "dronie" of themselves from the air! This lesson will introduce students to the fundamental concepts of DroneBlocks, while programming and launching their first mission. Extension lesson ideas are included to provide opportunities for students to add depth to their learning. **Always revisit the Pre-Flight Checklist before taking the drone to the field or selecting "Start Mission".**

Objective:

Students will:

- Discover the basic functions of the DroneBlocks App.
- Calculate and determine program blocks for altitude, distance, yaw, gimbal and camera.
- Learn how to determine the pitch (angle) of gimbal using simple math equations.
- Run a test-flight of the program through the Preview Mission feature.
- Launch a field mission that will result in a dronie for students to share!

Common Core State Standards:

Common Core Standards provided focus on grades 5 and 6, as a baseline. Educators should adjust standards based on the ability and/or experience of their students.

CCSS.ELA-LITERACY.RST.6-8.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

CCSS.MATH.CONTENT.5.OA.A: Using operations and algebraic thinking, write and interpret numerical expressions.

CCSS.MATH.CONTENT.6.G.A: Solve real-world and mathematical problems involving area, surface area, and volume.

CCSS.MATH.CONTENT.6.EE.A: Apply and extend previous understandings of arithmetic to algebraic expressions.

International Society for Technology in Education Standards:

ISTE 1.a Apply existing knowledge to generate new ideas, products, or processes

ISTE 1.c Use models and simulations to explore complex systems and issues

ISTE 2.a Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media

ISTE 2.b Communicate information and ideas effectively to multiple audiences using a variety of media and formats

ISTE 3.b Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media

ISTE 3.c Evaluate and select information sources and digital tools based on the appropriateness to specific tasks

ISTE 3.d Process data and report results

ISTE 4.b Plan and manage activities to develop a solution or complete a project

ISTE 4.c Collect and analyze data to identify solutions and/or make informed decisions

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Materials Needed:

- Pre-Flight Checklist
- DroneBlocks App downloaded on iOS devices for students
- Drone
- Propeller Guards
- iPad or iPad Mini

Part 1: Vocabulary

Vocabulary is important for understanding flight and photography with drones. Direct your students to research each of these words and collaborate to gain a deep knowledge of why these aspects of flight and photography are crucial to their final product. Allow your students to be creative with this section! Give them options to create commercials, poems, posters, or video clips to teach the definition and application of these words:

Yaw - Degree in which the drone twists or rotates about its vertical axis. A yaw rotation is a movement around the yaw axis of the drone that changes direction to the left or right of its direction of motion.

Pitch - The steepness of a slope, as explained in engineering or mathematics. Describes the gradient or angle in which the camera is set in order to photograph properly. The pitch angle will be between 0 (pointing to the horizon) and -90 degrees (pointing straight down).

Gimbal - A platform that can pivot on one or more axes. Creates a balanced, smooth movement for the camera during flight. The DJI gimbal holds, steadies and aims the camera.

Altitude - Height in which the drone is programmed to fly.

Hypotenuse – The longest side of a triangle, opposite the right (90°) angle. Calculated using the Pythagorean Theorem: $a^2+b^2=c^2$

Part 2: Mission Plan

This first mission is called "Dronie", which is similar in concept to a "Selfie" but with the benefits of being:

1. Photographed from the air with a drone
2. Programmed solely by the students
3. Fully autonomous

The overall concept is to program a mission that tells the drone to take off, fly forward, turn around, pitch the camera gimbal down, and take a photo of the class… *Say cheese!*

One important lesson for students studying advanced math curriculum is that they can calculate the pitch of the camera gimbal using geometry (see **Figure 2.2** and **Part 3**). For younger students the teacher should pre-calculate the gimbal pitch or work the problem together.

Key components of the Dronie:

- Takeoff to altitude (DroneBlocks recommends 50 feet or a height that is clear of nearby obstacles)
- Fly forward a distance (DroneBlocks recommends 75 feet)
- Yaw right or left 180 degrees (turn around 180 degrees)
- Pitch gimbal down (discuss gimbal for stabilization and control)
- Take the photo (recommended for camera to be on auto exposure)
- Fly forward (to the original takeoff location)
- Land

The following is an example of the dronie mission program:

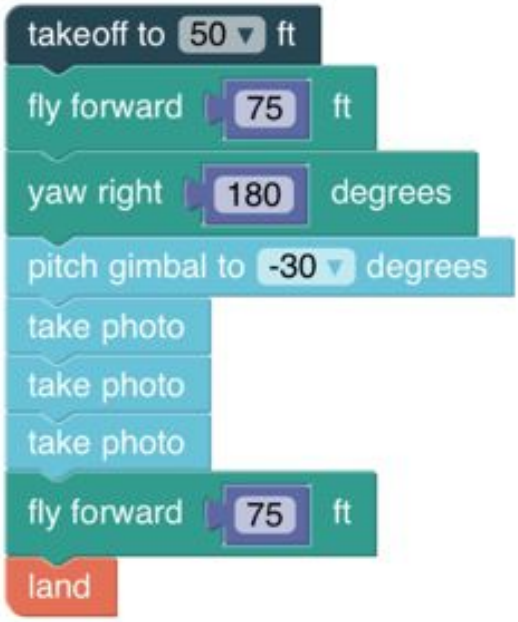

Figure 2.1

Students may individually program this mission on their own or in teams. You will find that some students may miss the yaw command or the pitch gimbal command. Some may even forget to fly forward. Let your students explain their missions, and select:

Preview Mission

REMEMBER:

- When running preview missions indoors, the aircraft and remote should be powered off.
- Never let the students connect to the aircraft indoors, as they could accidentally activate the mission, resulting in an extremely dangerous indoor flight.

Previewing missions allows you to see if your mission is programmed correctly. When programming you may forget a simple instruction. Seeing the code run on the preview simulator is a clear indicator of what needs to be fixed.

Educator Tip: Student missions can be saved in DroneBlocks! Before students begin, they should select LOGIN, then sign in with a Google Drive or Gmail account. This will enable students to name, save and revisit their missions. Visit this link to watch a quick tutorial on saving and sharing missions!

Extension Activity:

Are you ready to integrate this learning with Language Arts? Use procedural text to explain coding and programing to your students, unplugged! Have them write out a set of instructions and ask their partner to be a "robot", following their directions…exactly. Even making a sandwich without very specific instructions is impossible. (Take a look at Cookie Monster learning to make a sandwich: Cookie Monster - Procedural Text Video). The same is true when programming. Each step must be precise and deliberate to carry out the desired outcome. This is a valuable lesson for younger students and an excellent review for advanced students.

Part 3: Calculating the Gimbal Pitch With Geometry

This section is perfect for tailoring to meet the learning needs of your students. Students who are in elementary school have studied geometric shapes and angles but have not yet mastered formulas for figuring these shapes. In this case, facilitate the lesson by reviewing degrees of angles and how it relates to the angle of the camera. Discuss right angles, hypotenuse, and "SOHCAHTOA"!

For older students this is a great geometry lesson to calculate the gimbal pitch angle. By default the gimbal is pointed straight-forward at 0 degrees. To pitch the gimbal all the way down is -90 degrees. Therefore, the range is from 0 to -90 degrees.

For this lesson, the proper equation is TOA because we know the opposite leg length (take off altitude) and adjacent leg length (fly forward distance).

Did you know? SOHCAHTOA is a way of remembering how to compute the sine, cosine, and tangent of an angle. SOH stands for "**S**ine equals **O**pposite over **H**ypotenuse". CAH stands for "**C**osine equals **A**djacent over **H**ypotenuse". TOA stands for "**T**angent equals **O**pposite over **A**djacent".

The takeoff altitude as indicated in **Figure 1** is 50 feet. The fly forward distance is 75 feet, but you must consider, for safety purposes, that the class is 25 feet behind the drone. Total distance from the

students to drone will actually be 100 feet. Knowing these values we can solve for the gimbal pitch by doing the following:

- tan (angle) = 50/100 (50 foot altitude with a total forward distance of 100 feet)
- tan (angle) = ½
- angle = atan(.5) = 26.6 degrees (It's okay to round to a pitch of -30 degrees in the gimbal block)

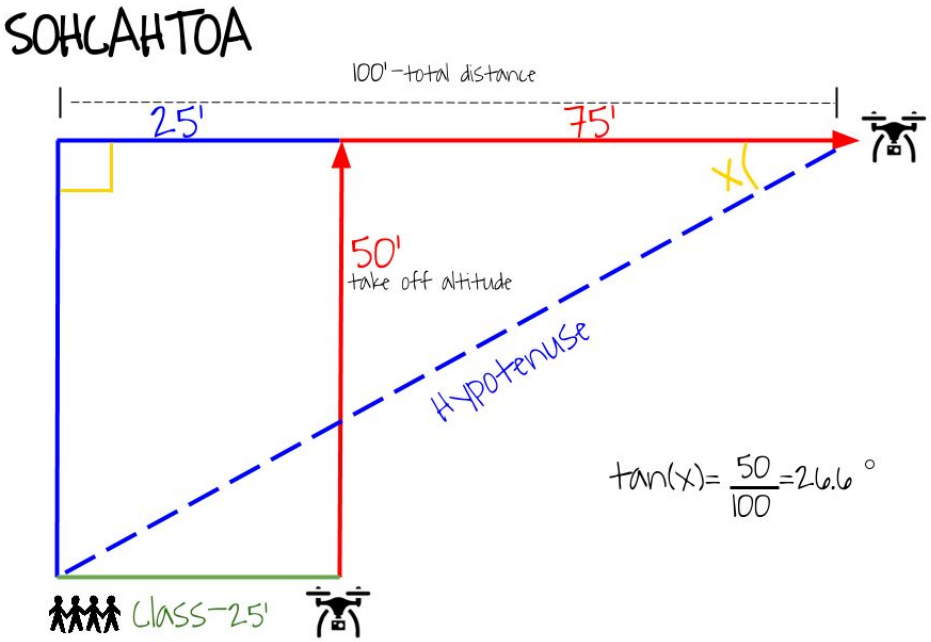

Figure 2.2

Part 4: Field Mission

Now that the mission has been reviewed by the teacher and run in the preview mission, it is time to take the program to the field. Most of the hard work has already been done and now it is time to enjoy the rewards of programming and testing. Before running the mission at the field make sure to review the safety steps as you have done previously. These steps will apply to every field mission.

IMPORTANT:

- Take a copy of the Pre-Flight Checklist to the flying area, and complete every step of the pre-flight checklist before running the mission.
- As the Phantom 3 is flying, always be prepared to manually take control of the aircraft if it behaves unexpectedly by switching back to P-mode. If operating a Phantom 4, manually resume control by switching to S-mode. Click here for a video discussing flight modes.
- Note: As tempting as it may be to take a photo directly beneath your drone, don't ever do this. You should not operate a drone above or within 25 feet of people under any circumstances.

Your mission is now complete! Share your dronies with @droneblocks and tag us #droneblocks so that we can see your hard work. This is an opportunity to let the world see what you have programmed and created!

Did you know? Aerial photography was first introduced in the mid-1800s. A French balloonist took photographs as he flew over Paris. The first "selfie" was believed to be taken by photographer Robert Cornelius in 1839. What additional information are you able to discover about photography entrepreneurs?

Part 4: Extensions

First, try experimenting with different altitudes and distances, which will ultimately impact your gimbal pitch angle. Take multiple photos from different angles. Make lots of silly faces, "Do the Dab", get inspired and share your dronies with us!

Finally, review digital citizenship and use this project to share with the world to receive feedback via Twitter, Facebook, or other social media platform. Because this is not a close-up photograph of students, the picture is a safer choice to share online, as opposed to portraits or other identifiable photographs. Use this as a relevant teachable moment to remind your students to be cautious when posting, commenting, and collaborating online. Visit: www.commonsensemedia.org for more educator tips on digital safety and citizenship.

Additional Resources

Would you like to learn more about calculating the gimbal pitch using geometry?

https://www.khanacademy.org/math/trigonometry/trigonometry-right-triangles
http://learnopengl.com/#!Getting-started/Camera
http://www.mathopenref.com/trigprobslantangle.html

Would you like to learn more about aerial photography?
http://www.fsa.usda.gov/programs-and-services/aerial-photography/index
http://www.usgs.gov/pubprod/aerial.html
http://www.historicaerials.com
http://www.telegraph.co.uk/travel/snowandski/skiing-news/10988393/The-selfie-is-dead.-Introducing-the-dronie.html

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