DRONEBLOCKS

LESSON 1: SAFETY

Overview:

Students will study Federal Aviation Administration (FAA) regulations in relation to Unmanned Aerial Vehicles (UAVs), or drones. They will be introduced to non-negotiable rules that are in place to engage in safe and responsible flying, while protecting the privilege of flying UAVs. In this lesson, students will not be programming or flying a drone. They will be collaborating in activities to help them gain a deep understanding of expectations and general safety. In addition, students will have the opportunity to research these guidelines and present informative texts or discussion to build knowledge and understanding of this topic. The educator will act as a facilitator, guiding students to gain a deep understanding of this topic, while encouraging them to think in depth about the importance of safety guidelines, laws, and regulations.

Objective:

Students will:

- Learn basic FAA regulations for flying UAVs
- Understand the distance of maximum flying level (height)
- Determine how to measure wind speed
- Demonstrate complete understanding of UAV safety precautions
- Be encouraged to research local laws to gain a full understanding of regulations
- Present their ideas and knowledge, based on research

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.RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.

CCSS.ELA-LITERACY.RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.

CCSS.ELA-LITERACY.RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.

CCSS.ELA-LITERACY.W.5.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

CCSS.ELA-LITERACY.W.6.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

CCSS.ELA-LITERACY.W.5.7 / CCSS.ELA-LITERACY.W.6.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.

CCSS.ELA-LITERACY.SL.5.1 / CCSS.ELA-LITERACY.SL.6.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on topics, texts, and issues, building on others' ideas and expressing their own clearly.

CCSS.ELA-LITERACY.SL.5.5 / CCSS.ELA-LITERACY.SL.6.5 Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes.

CCSS.MATH.CONTENT.5.MD.A.1: Convert among different-sized standard measurement units within a given measurement system

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 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

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Materials Needed:

- Tool of Measurement, such as a Distance Measure, Open Reel Tape Measure, Measuring Tape, or 400 feet of string
- Anemometer, wind speed app, or weather app (such as The Weather Channel app)
- Paper and markers or a digital platform, such as Google Slides, Canva or Pages, to create a safety infographic
- Computer or device to conduct additional research

Checklist for the Educator

DroneBlocks hopes that learners of all levels will enjoy this curriculum. Lessons have been designed with flexibility in mind, allowing the educator to personalize each lesson for their students. If you are new to the world of UAVs, we would like to provide some quick references to get you ready to fly:

1. Be sure you have registered your drone(s). It is a simple $5.00 fee. You will need to have your registration number on your drone, easily accessible. We suggest writing the number on your drone battery or etching it on your actual drone.
    a. Here is the link to register: https://drone-registration.net/

2. There is a great deal of DroneBlocks support available to you.
    a. Be sure you have joined our FaceBook forum: DroneBlocks Community. This is an excellent place to ask questions, share your ideas, and troubleshoot.
    b. Be sure to join our DroneBlocks Discussion Group
    c. Follow and tag us @DroneBlocks on Twitter and Instagram. We cannot wait to learn from your mistakes and celebrate your successes.

3. Be aware of changes in laws, regulations, and guidelines that may pertain to you or the area in which you choose to fly.

Use the guidelines and link provided. Become an expert *with* your students. This will provide the best and safest learning experience and will hopefully foster an interest in drones and STEM/STEAM education.

Part 1: Safety for You and Property Around You

This section lists basic safety considerations. Students should think about WHY these rules are in place. Encourage them to research these questions and report their findings. The list below MUST be included. Students may find additional "rules" during their research that should be added to this list:

- All missions must include **TAKEOFF** and **LAND** blocks in the DroneBlocks app
- When indoors:
    - Be sure the propellers are OFF
    - Never power the drone on indoors
    - Never connect your ipad to your controller until you are out in the field (Students might accidentally execute a mission indoors.)
- Always have pilot in command (PIC). This must be an experienced adult facilitator that is 18 years of age or older.
- Drone weight: Research the weight of your drone (How heavy would it be falling out of the sky?)

- Speed of motors can cut off fingers--Never touch them.
- When in the field, you should never be close to the drone. Remain at least 25 feet away, never close enough to reach out and touch it.
- Line of sight: Can you see the path you are flying along with possible obstacles?
- **DO NOT:**
  - Fly over or near people…ever!
  - Operate the drone indoors
  - Fly if winds are over 15 mph
  - Fly when it is dark
  - Fly within 5 miles of an airport
  - Fly above 400' (400 feet)
  - Fly over private property, especially when flying with a camera
- If you ever see or hear a manned aircraft of any type, descend and return to home immediately

Suggested resources in which to begin additional research: http://knowbeforeyoufly.org/

Part 2: How Far Is 400 Feet?

Take your tool of measurement and ask students to measure 400 feet. This measurement can be conducted in school hallways or outside where the drone will be flown. Discuss why 400 feet is the maximum height in which your drone may be flown.

Challenge students to decide a safe height in which they feel they should fly. What are the disadvantages/risks of flying higher (e.g. it becomes hard to see the aircraft and its orientation, winds can be stronger aloft, takes longer to land if something malfunctions)? Should they begin with a safer height of 75 feet to get a better feel for distance and how to best program their drone for flight? Discuss.

As an extension, ask students to convert feet into meters. Which form of measurement is best when using DroneBlocks?

Did you know? Most countries use the metric system for measurement. In 2014 the FAA began a Metrics Harmonization Act. What do you think is the reason for this Act? Why do you think you must fly under 400 feet and not 121.92 meters? Would this regulation be labeled differently outside the USA?

Part 3: How Can We Determine Wind Speed?

Practice measuring wind speed. Depending on what tools you have available to you, discuss why having a wind speed of less than 15 mph is crucial. An extension for this activity would be to map wind speeds throughout the day, over a period of a week. Students can create a windsock and test their creations.

- If wind is 15 mph or greater, do not fly. Wind moves small branches, raises dust and loose paper from the ground, which may interfere with flying.
- Strong winds may also throw off your programming measurements, potentially becoming unsafe.

Did you know? There is evidence that windsocks were used as early as 150 A.D. What is the earliest US patent you can find for the windsock? Hundreds of variations of the original design have also been patented. Which design do you think would work best for measuring wind speed before flying a drone?

Research the Beaufort Scale for Wind Speed Estimation. Students can learn to estimate wind speed by observing the angle of a flag or windsock, extended. Share the following adage with students and ask them to determine whether this is a good rule to remember:

If a flag is flapping in the wind and periodically extends straight out, you can estimate that winds are near 15 mph.

Additional resources to begin research:

http://www.windows2universe.org/earth/Atmosphere/tornado/beaufort_scale.html
http://www.wrh.noaa.gov/pqr/info/wind.php
http://www.hawaii.edu/gk-12/opihi/classroom/estimating_wind_speed.pdf

Part 4: Pre-Flight Checklist

During this lesson students will not yet be flying. It is crucial that they gain a strong understanding of safety and regulations first. In this section you will find a complete Pre-Flight Checklist.

Review the "DroneBlocks Pre-Flight Checklist" document included. It is imperative that this checklist be reviewed before each and every flight.

With the aircraft powered off:

1. Inspect aircraft for physical damage
    a. Ensure propellers are mounted securely

2. Ensure Batteries are fully charged
3. Check:
    a. Remote Controller
    b. Drone Battery
    c. Mobile Device

4. Determine if calibration (Compass and/or IMU) is necessary
    a. Perform calibrations if:
        i. You have updated the aircraft and RC firmware
        ii. You are flying in a new location
        iii. The aircraft has experienced a crash or hard impact

5. Evaluate flight area for safety
    a. Only fly in large open spaces. Do not fly at night.
    b. Ensure flying is allowed in your current location https://app.airmap.io/
    c. Drone is placed at take-off spot facing away from PIC
    d. Wind speed is less than 15 mph
    e. Flight mission is reviewed
    f. Flight path will not take the aircraft near or above any people, roads, structures or obstacles.
    g. Remember:
        1. DO NOT FLY THE AIRCRAFT OVER PEOPLE
        2. DO NOT FLY OVER 400' HIGH

6. Designate an Experienced adult over 18 years of age as Pilot In Command (PIC)
    a. PIC has reviewed procedures for aborting a mission and resuming control:
        i. **Practice switching to P-mode from F-mode**

ii. 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.

iii. When manually piloting, keep the red lights facing away to maintain proper orientation (as a visual, remember: "red = bad" and should always be facing away from you)

7. Ensure the remote is switched to F-Mode for Phantom 3 and P-Mode for Phantom 4

8. Close the DroneBlocks App (do not worry, your work will be saved)

With the remote and aircraft powered on:

1. Wait for the lights to flash green on your drone

2. Open the DJI Go App and connect to camera view
    a. You should see a green "Ready to Fly" status

3. Double tap iPad home button and swipe the DJI Go App closed

4. Open the DroneBlocks App

5. Ensure the satellite count shows at least 10 satellites connected

6. Ensure all students are at least 25 feet away from the aircraft and free of the takeoff and landing zone.

7. Click "Preview Mission" and confirm the flight path will not take the aircraft near or above any people, roads, structures or obstacles.

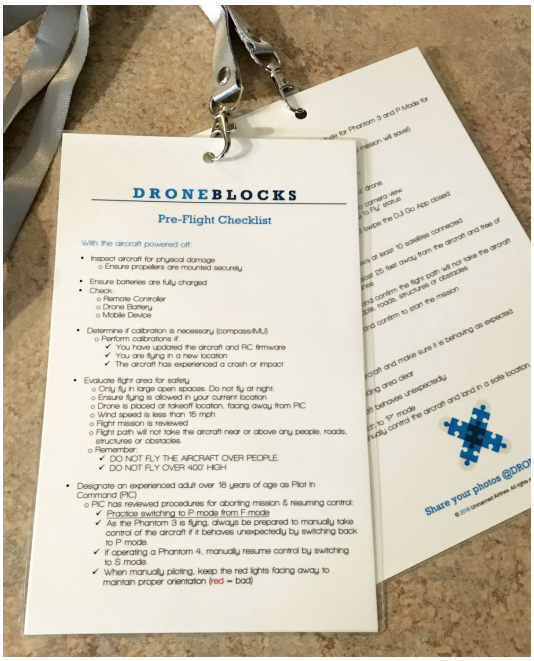
8. Click "Start Mission" and confirm to start the mission

While airborne:

1. Observe the aircraft and make sure it is behaving as expected

2. Keep the landing area clear

3. If the aircraft behaves unexpectedly:
    a. Switch to "P" mode
    b. Manually control the aircraft and land in a safe location



Educator Tip: We suggest making a copy of the "Pre-Flight Checklist" PDF included in your curriculum download. After you print the PDF, fold in half, laminate, then add to a lanyard! You will have great reference lists to take with you to the field. Appoint two students to be responsible for making sure all safety measures are taken and rules are followed to keep you and your students safe!

Part 5: What are *Your* Rules?

As the facilitator, have your personal rules planned in addition to safety measures outlined above. Having specific expectations for your students will personalize their learning for the safest experience.

Examples of rules you might add:

- All students must stay in a designated area during flight
- Students must not run towards the UAV while landing
- Observers must be behind the PIC
- All flights must include a test flight before being taken outside, etc.

Have students write any rules they feel should be added and explain why. Ask them to include information they have learned through researching this topic and present their idea to the group. This writing exercise may also be used to take rules away but evidence and research must post a strong argument, as most added rules are necessary for safety. This provides an opportunity for valuable thought and discussion among your students.

Part 6: Show What You Know!

Once basic rules and regulations have been thoroughly taught, students should create an info-graphic* to teach the class a safety review. Students should draw pictures and label each safety "rule".

Using paper is also a great tool if there is not enough for all students to have a computer or device. Remember, having limited technology can also be beneficial, as having to share computers or devices requires students to collaborate and communicate to conduct their research.

Have students speak and present their info-graphic projects. Allow time to discuss the projects in small groups. Make sure all students have a clear understanding of your rules and the importance in which they have while flying UAVs.

**An infographic is a pictorial or visual diagram of information or knowledge.*

Additional Resources

Would you like to learn more about safety and regulations? Each state also has its own laws in place. Encourage your students to research and develop a better understanding of local regulations.

Start by visiting these websites:

http://knowbeforeyoufly.org/

http://drones.newamerica.org/

http://www.ncsl.org/research/transportation/current-unmanned-aircraft-state-law-landscape.aspx

https://app.airmap.io/

http://www.faa.gov/uas/tfr/

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