Expert Mode

Session Time: Four, 50-minute sessions

DESIRED RESULTS

ESSENTIAL UNDERSTANDINGS

It is imperative that a remote pilot conduct thorough research on a UAS prior to attempting to operate it.

Learning by teaching is an effective way for students to grow in their understanding of UAS topics.

ESSENTIAL QUESTIONS

1. How can experts on certain facets of the drone (e.g., systems, maintenance, etc.) summarize essential information in a manner that is educational and engaging?

LEARNING GOALS

Students Will Know

- Details about the classroom drone's systems (including both UAV systems and ground equipment), its flight modes, and how it should be operated.
- How to research information about a particular UAS model, and how to synthesize this information to create an effective briefing for other crew members.

Students Will Be Able To

- *Collect and display* information about the classroom drone(s) using a variety of sources for research. [DOK-L2]
- *Summarize* research by deciding upon the most salient points to convey to an audience. [DOK-L2]
- *Construct* a briefing offering details about the classroom drone(s)—a briefing that will be given to other students. [DOK-L3]

ASSESSMENT EVIDENCE

Warm-up
Students will be introduced to the class project, in which they will collaborate in teams to research and report about the classroom UAS.

Formative Assessment
There is no formative assessment for this lesson.

Summative Assessment
There is no separate summative assessment for this lesson, as students shall demonstrate their mastery of the learning goals by briefing the class on their research.

LESSON PREPARATION

MATERIALS/RESOURCES

- Expert Mode Presentation
- Expert Mode Teaching Aid
- Expert Mode Project Packet
    - Expert Mode Instructions (by Group)
        - Expert Mode Instructions (Aircraft and Ground Systems)
        - Expert Mode Instructions (Aircraft Control)
        - Expert Mode Instructions (Aircraft Setup and Maintenance)
        - Expert Mode Instructions (Flight Operations and Safety)
    - Expert Mode Project Information Sheet (Day 1)
    - Expert Mode Daily Goal Sheet (Day 2)
    - Expert Mode Daily Goal Sheet (Day 3)
    - Expert Mode Rubric

Teaching Tips

Prior to beginning this lesson, create a Project Packet for each team. Each team's packet should contain a copy of the project information sheet (Day 1) and rubric, plus each daily goal sheet (Days 2–3); you will also need to include the set of instructions for each team's topic. (Each team follows the same procedure, but each set of instructions contains key concepts and reminders that are specific to the team's topic.)

In the classes leading up to the team briefings, encourage students to begin gathering their notes from previous classes (including from previous semesters). Although students will be able to conduct new research on their team's topic during this lesson, their notes will provide an important foundation to help them create and conduct their briefing.

LESSON SUMMARY

Lesson 1: The Right Drone for the Job
Lesson 2: Expert Mode
Lesson 3: Learning to Fly: Fundamentals of Control

On Day 1, students will split into teams and conduct research that focuses on a particular aspect of the classroom drone: aircraft and ground systems, aircraft control, aircraft setup and maintenance, or flight operations and safety. Each team will determine which team members are responsible for different aspects of research and who will prepare and give a briefing to the class in the last lesson.

During the next part of the lesson (Days 2 and 3), students in each team will continue to conduct research on their assigned topic. They will also confer and share information with the other teams.

On the last day (Day 4), each team will give a 5- to 10-minute briefing on the most essential information necessary for anyone who may be flying the classroom drone for the first time.

BACKGROUND

Because of the many makes and models of drones, as well as their many applications, it is important for remote pilots to become familiar with all aspects of a drone before operating it. Even seasoned remote pilots will need to study a new

drone carefully and read its manual to learn about how it has been designed and how operating and flying it might be different from drones they have operated in the past.

As the drone industry continues to evolve, new drones are continually released, sometimes annually. Developments in control design and updates to software and firmware require remote pilots to keep their knowledge current. Whether flying a new drone or using a familiar drone after updates, operators need to educate themselves about UAVs and ground systems, controls, setup and maintenance, and flight operations and safety procedures are areas. The variety of flight operations a remote pilot may be required to manage, such as mapping, photography, rescue operations, and inspections, all require specific knowledge and an in-depth understanding of how to safely operate a specific UAS make and model.

MISCONCEPTIONS

Because remote pilots tend to have in-depth knowledge about a specific make and model of drone, some students may incorrectly assume that it is unnecessary for them to learn about a new or different make and model of drone. In fact, many drone manufacturers design their drones, controls, and software systems differently. These differences can be minor, such as the ergonomics of a controller, or they can also be pronounced, such as the user experience (UX) design of a UAS software system. Every new drone requires a remote pilot's careful study and inspection before flight.

Another common misunderstanding students might have is that because the remote pilot is in charge of and responsible for the flight operations and safety of a UAS, the support crew need not be familiar with every aspect of a drone. This lesson will give students the opportunity to work as a team while sharing knowledge freely with other groups.

Teaching Tips

Much like the Part 107 review project in Unit 8 (lesson 8.A.1), the object of this lesson will be for students to work in teams to become experts in a specific field related to the classroom UAS and to share their knowledge with the rest of the class.

The difference between the teamwork in this lesson and that in previous lessons is that in this lesson the topics assigned to different teams will overlap. For this reason, over the course of the sessions, students should be encouraged to work not only within their teams, but also across teams. The entire class should be thought of as a large team, with different subgroups representing particular areas of expertise. Students should feel free to discuss aspects of their research with other teams throughout the project.

DIFFERENTIATION

While the main activity for this lesson is already highly differentiated, there are some things you can do to further support or challenge students, based on their abilities and interests. For instance, at the start of the activity in the **ENGAGE** section of the lesson plan, you might want to strategically group students, as opposed to allowing them to form their own teams. During the **EXPLAIN** section of the lesson plan, you may need to spend more time with some groups to provide additional support or guidance (e.g., help them develop daily goals, direct them to resources for research, etc.), while other groups may function more autonomously; for these more autonomous groups, challenge them to go beyond the list of topics to research or to come up with a creative way to present their briefing (e.g., as a skit, news broadcast, etc.).

LEARNING PLAN

ENGAGE

Teacher Material: Expert Mode Presentation

Session 1

Slides 1–3: Introduce the topic and learning objectives of the lesson.

Slides 4–5: Conduct the **Warm-Up**.

Warm-Up

At the beginning of the Warm-Up, talk to the class as a whole. Explain to students that in this lesson they will be splitting up and working in four teams. To become experts on a specific topic, each team will focus their research efforts on a specific area related to the classroom drone. Teams should be encouraged to share information with one another. The goal for each team will be to collectively learn as much as they can about their topic. Then, teams will brief the class on the area of their expertise before the class as a whole conducts flight operations.

Given what students have learned so far, they should be able to understand the areas the following topics are likely to cover. Have students form teams based on the topic in which they are most interested in gaining expertise. If necessary, adjust the teams so the sizes are relatively even.

Topics will be as follows:

- Aircraft & Ground Systems
- Aircraft Control
- Aircraft Setup & Maintenance
- Flight Operations & Safety

After splitting into teams, have students share their current knowledge with one another on the classroom drone as well as any resources on their chosen topic from previous lessons.

EXPLORE

Teacher Material: Expert Mode Presentation

Slide 6: Tell students that they will watch a video that demonstrates how to operate most simple UAVs. Also explain that the video is a good example of how to conduct a concise briefing. Remind students to pay attention to the way the video uses simple language to explain each aspect of using and controlling the drone.

Slide 7: Explain to students that the following video presents the basics of how to set up and fly a Mavic Mini to an audience unfamiliar with drones.

- "Mavic Mini | How To Fly Mavic Mini" (Length 4:10)
  https://video.link/w/r454
  For teachers unable to access Safe YouTube links, the video is also available here: https://youtu.be/mI31SUeHpAY

EXPLAIN

Teacher Materials: Expert Mode Presentation, Expert Mode Teaching Aid
Student Materials: Expert Mode Project Packet (Instructions, Project Information Sheet, Rubric)

Slide 8: Explain to students that this lesson consists of three sessions of research and a final session in which each team presents its research to the other teams. As students research their topics on Days 1–3, you will be circulating to help teams that need guidance conducting their research and preparing their briefings.

Slide 9: Hand out the **Day 1 Project Information Sheet** and the **Project Instructions** for each team. Remind students that the lists of key concepts in the various instructions handouts are not exhaustive; teams should work to research all available information on their area of focus, using UAS manufacturer documents, online information, and previous lessons as resources.

Teaching Tips

After handing out the **Project Packet** for each team, ask students to take a few minutes to familiarize themselves with the contents of their packet, including the rubric, while reviewing slides 10–13.

Slide 10: The Aircraft & Ground Systems Team will research any ground-related systems required for the operation of the classroom UAS, including the screen interface (e.g., a mobile device or a tablet), software, remote control transmitter (e.g., ground station controller), required cables, payload components, and power sources. This team should also research systems on the UAV, including the airframe, electrical system, and propulsion system, including motors and propellers.

Slide 11: The Aircraft Control Team will research how the classroom UAS is intended to be operated, including how the remote control transmitter (e.g., ground station controller) should be used during flight. This team will also research all the available flight modes (e.g., normal, manual, auto) and failsafe procedures (e.g., obstacle avoidance, Return to Home). Finally, they will research the software for flight operations (e.g., instructions and icons and symbols) and controls for the payload (e.g., camera, light attachments).

Slide 12: The Aircraft Setup & Maintenance Team will research all relevant maintenance procedures for the classroom UAS to keep it in proper working order. These should include not only maintenance procedures recommended by the manufacturer, but also recommendations from users online. The team should create a maintenance log that the class can use to keep a record of the classroom UAS operations over time. Also, the team should research any additional setup requirements necessary for the UAS prior to flight.

Slide 13: The Flight Operations & Safety Team will research procedures for flying the classroom UAS. One of this team's tasks will be creating preflight and postflight checklists. The team should also research crew resource management (CRM) recommendations for flight operations. Additionally, the team should compile a safety list and rules for anyone using the classroom UAS. Finally, they should research procedures to follow during in-flight emergencies like lost links, flyaways, and battery fires.

Teaching Tips

The class has prepared some documents (e.g., a preflight checklist, best practices) earlier in the semester. These documents do not need to be rewritten now, but the operations team should review them as part of its research.

On Days 2 and 3, circulate and interact with teams to provide guidance and feedback about their research. If necessary, redisplay slides 10–15 to help teams focus their work.

Briefly speak with each team near the end of each of the first three sessions to review that day's goal sheet and to ask them about the progress they made toward the goals they identified. To help students focus on specific tasks, provide guidance as necessary.

Slide 14: After reviewing the topic-specific instructions for its project, each team should use remaining class time to complete its **Project Information Sheet**, and then—following your approval—to begin to research the classroom drone. Encourage students to discuss what they think are the most important points as they work together to construct a short briefing that they will give to their classmates on Day 4. Teams should submit supplemental materials for their briefing (e.g., important notes, diagrams, maintenance checklists, preflight and postflight checklists, and logs) should prepare them as they conduct research.

Teaching Tips

Supplemental materials that students submit need not be extensive. Like the briefing itself, the supplemental materials should capture the salient points of the group's topic. For example, the Aircraft Control team may choose to submit a diagram of the UAS control pad layout with labels.

Student Materials: Expert Mode Project Packet (Students will be referring to: Instructions, Daily Goal Sheet (Day 2))

Session 2

Slide 15: On Day 2, instruct students to continue researching and gathering information about their team's topic. Remind students to fill out the **Daily Goal Sheet (Day 2)**. Encourage students to discuss and share information with other teams. Circulate among teams that need guidance and give feedback about each team's research and briefing preparation. Students will need to conduct any necessary research; the **Teaching Aid** document suggests useful starting points.

Session 3

Student Materials: Expert Mode Project Packet (Students will be referring to: Instructions, Daily Goal Sheet (Day 3))

Slide 16: On Day 3, instruct teams to finish researching their topics and prepare for the briefing presentation. Remind students to fill out the Daily Goal Sheet (Day 3). Encourage students to discuss and share information with other teams. Circulate among teams that need guidance and give feedback about each team's research and briefing preparation. Instruct teams to finalize their briefing preparations before the next class.

Session 4

Student Materials: Expert Mode Project Packet (Students will be referring to: Instructions, Rubric)

Slide 17: On Day 4, give each team 5–10 minutes to present its briefing.

Teaching Tips

Display slides 18–21 for each team as it presents its briefing.

Slide 18: Display this slide while the Aircraft & Ground Systems Team presents its briefing.

Slide 19: Display this slide while the Aircraft Control Team presents its briefing.

Slide 20: Display this slide while the Aircraft Setup & Maintenance Team presents its briefing.

Slide 21: Display this slide while the Flight Operations & Safety Team presents its briefing.

EXTEND

Teacher Materials: Expert Mode Presentation, Expert Mode Rubric
Student Materials: Expert Mode Project Packet (Students will be referring to: Instructions, Rubric)

Slide 22: After all teams have presented their briefings, the teams should work together to assemble a complete Classroom Operations Manual using the supplemental materials and checklists that the students have created. As expert teams on each topic of concentration, the class will now be ready to work together to prepare, operate, and fly the classroom UAS safely and responsibly.

EVALUATE

Teacher Materials: Expert Mode Presentation, Expert Mode Rubric

Summative Assessment

Each team's briefing (including the supplemental materials the team contributes to the Classroom Operations Manual) serves as its Summative Assessment for this lesson. Use the Rubric provided in the Project Packet to score groups; assign point values to each criterion as you think best.

[DOK-L3; *construct*, DOK-L2; *summarize,* DOK-L2; *collect and display*]

STANDARDS ALIGNMENT

COMMON CORE STATE STANDARDS

- **RST.11-12.2** - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- **RST.11-12.7** - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- **RST.11-12.9** - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
- **WHST.11-12.2** - Write informative/explanatory texts, including the narration of historical events, scientific procedures /experiments, or technical processes.
- **WHST.11-12.4** - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- **WHST.11-12.6** - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
- **WHST.11-12.7** - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- **WHST.11-12.8** - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
- **WHST.11-12.9** - Draw evidence from informational texts to support analysis, reflection, and research.

REFERENCES

- Mavic Mini: How To Fly Mavic Mini," YouTube: https://youtu.be/mI31SUeHpAY
- Project instructions for the Flight Operations & Safety Team: FAA Remote Pilot – Small Unmanned Aircraft Systems Study Guide. https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/media/remote_pilot_study_guide.pdf
- Project Instructions for the Aircraft Setup & Maintenance Team: Routine Drone Maintenance Checklist. https://www.process.st/checklist/routine-drone-maintenance-checklist/
- Project Instructions for the Aircraft Control Team: Rotor Drone Pro, "Drone Flying: Flight Modes 101—Flip a switch for precision control! https://www.rotordronepro.com/flight-modes-101-2/#visitor_pref_pop