UAS Fundamentals

Session Time: Two, 50-minute sessions

DESIRED RESULTS

ESSENTIAL UNDERSTANDINGS

Develop interest in one or more aviation/aerospace career pathways and learn what is required to pursue future employment in the industry. (EU3)

Aspire to the highest level of technical proficiency as it relates to flight operations and engineering practices. (EU5)

ESSENTIAL QUESTIONS

1. Are UAS toys or tools?
2. Do UAS solve or create problems?

LEARNING GOALS

Students Will Know

- Terms and definitions related to UAS
- Common UAS applications and potential uses in the future

Students Will Be Able To

- *Explain* why UAS are used and what problems they solve. (DOK-L2)
- *Analyze* the utility of UAS against various applications and operations. (DOK-L4)

ASSESSMENT EVIDENCE

Warm-up
Gauge students' familiarity of UAS by having students write four facts they know about UAS.

Formative Assessment
Students will examine real-world scenarios where UAS are being applied to increase safety, practicality, and efficiency.

Summative Assessment
Students will analyze whether or not UAS could be useful for various applications and operations.

LESSON PREPARATION

MATERIALS/RESOURCES

- UAS Fundamentals Presentation
- UAS Fundamentals Student Activity 1
- UAS Fundamentals Student Activity 2
- UAS Fundamentals Teacher Notes

LESSON SUMMARY

Lesson 1 UAS Fundamentals
Lesson 2 UAS Operation and Safety

The first session of this lesson begins by asking students to provide four facts about unmanned aircraft systems (UAS), which will help the teacher gauge students' familiarity with UAS.

Teachers then will use the presentation and student activity to help students discover the fundamentals of UAS, including common terms, useful applications, and challenges facing the industry.

The second session will begin by students exploring real-world scenarios where UAS are being applied to increase safety, practicality, and efficiency. If the classroom has access to a drone, students will become familiar with the parts of the drone, learn the basic controls and review the process for preparing the UAS for flight.

Finally, students will analyze whether or not UAS might be useful for various applications and operations.

BACKGROUND

Refer to **UAS Fundamentals Teacher Notes** for a full background and glossary on unmanned aircraft systems.

MISCONCEPTIONS

Several terms may be confusing for students. The term unmanned aerial vehicle, or UAV, refers to the actual unmanned aircraft that is flown. A UAV is commonly referred to as a drone. An unmanned aircraft system (UAS) is the group of components required to operate the UAV, which could include the aircraft, the controller, the sensors, communication equipment, and more.

DIFFERENTIATION

To support verbal reasoning in the **ENGAGE** section, organize the class into groups for Think-Pair-Share instead of a whole group discussion. This allows learners to think about the question, discuss their thoughts with a partner before sharing with the larger group. It encourages all students to participate and practice skills, including metacognition.

LEARNING PLAN

ENGAGE

Teacher Material: UAS Fundamentals Presentation

Slides 1-3: Introduce the topic and learning objectives for today's lesson.

Slide 4: Conduct the **Warm-Up.**

At this point, no student answers are considered incorrect. This is only an opportunity for students to share what they know. Collect student papers when they are done for grading. The warm-up should take no more than 5 minutes. [DOK 1; recall, list]

Warm-Up

Have students write four facts that they know about about drones. When students are finished, ask volunteers to share their answers and as they do, write them on the whiteboard.

Teaching Tips

Optional Approach: You may ask students to work in pairs or small groups to compile their answers.

EXPLORE

Teacher Material: [UAS Fundamentals Presentation]

Slides 5-6: Ask students what a UAS is and what it stands for.

UAS stands for Unmanned Aircraft System. An Unmanned Aircraft System is the group of components required to operate an unmanned aerial vehicle (UAV) or drone. The UAS includes the drone, the controller and sensors, communication equipment and anything else needed to operate the drone.

Slides 7-8: Ask students to state the difference between a UAS and a UAV.
The term unmanned aerial vehicle (UAV) refers to the actual unmanned aircraft that is flown. A UAV is also commonly referred to as a "drone."

Remind students that a UAV, or drone, is part of a UAS. A UAS, or unmanned aircraft system, is the group of components required to operate a drone. A UAS includes the drone, the controller and sensors, communication equipment and anything else needed to operate the drone.

Slides 9-10: Ask students to name some uses, or purposes, for UAS. Keep a list of student ideas on the board.

Student responses may include, search and rescue, surveillance, photography, agricultural purposes, security, scientific research, fire-fighting, and warfare.

Show students a video of one important use for drones related to agriculture.

- "UAS Have Potential for Agricultural Use" (Length 1:37)
  http://video.link/w/eGJd

Slides 11-12: Finally, ask students what problems UAS help solve.

Some experts say UAS are used for operations that fall into the the "3 Ds" – dirty, dull, and dangerous. UAS can be helpful in missions where it may be dirty, where the flight might be dull, or when the situation might be dangerous.

They can survey toxic or dangerous environments, scout remote locations to ensure businesses are complying with laws and regulations, perform crowd control, find missing people in remote locations, and many others. Often times, UAS can perform these tasks at a much lower cost.

Have students watch a video about a fire department that used a drone to ensure the safety of its firefighters when a fire broke out near stores of dynamite in a quarry.

- "DJI Stories - Above the Flames" (Length 3:15)

  http://video.link/w/A6Rd

Teaching Tips

Now that students have an understanding of what a UAS can do, ask them to brainstorm some issues facing their community. How can UAS be used to solve these problems? Are there any specific examples they can think of for how UAS is currently being utilized in their community?

EXPLAIN

Teacher Material: UAS Fundamentals Presentation
Student Material: UAS Fundamentals Student Activity 1

Slide 13: To complete the first session, use a Think-Pair-Share exercise to help students discover the fundamentals of UAS, including common terms, helpful applications, and challenges facing the industry. Provide students with **UAS Fundamentals Student Activity 1** to complete this exercise.

Instruct students to read the background information on the sheet that appears after the questions. Then have students write answers to questions associated with the reading. Students should share their answers with a classmate, and then the teacher should lead a class discussion. Answers to the questions are included below.

Questions

1. Describe the differences between manned and unmanned aircraft.

An unmanned aircraft is remotely commanded without a pilot on board the actual aircraft. A manned aircraft has a pilot on board to manipulate the controls directly. Unmanned doesn't mean "pilotless." Someone is still operating the UAS, even if he or she isn't sitting in it.

2. Why is it important to think of a single drone as part of a larger unmanned aircraft system? What else is included in a UAS besides the drone?

A single drone cannot operate on its own. It is just one component of an interconnected system. The other components could include the controller to navigate the system, sensors that allow the drone to know where it is, communication equipment, and more. All components of the UAS must function together.

3. Is it possible for a drone to fly completely on its own without human input? Why or why not?

Drones cannot operate completely autonomously today. UAS must be controlled from the ground or be programmed to behave in specific ways. Humans have yet to develop advanced artificial intelligence that would allow UAVs to make decisions and fly without human assistance.

4. Name at least two examples of how UAS are currently used. How do you think UAS might be used in the future? What are some possible careers that may involve the use of UAS?

Today, drones are used for search-and-rescue missions, surveillance, photography, agricultural purposes, security, scientific research, fire-fighting, warfare, and recreation. Careers include spraying crops and mapping fields, aerial photography and cinematography, and designing drones and technology to increase their use and application. Future uses might include forecasting weather, delivering mail and packages, and flying people.

5. As we develop more and better remotely piloted technology, what considerations should be made to keep everyone safe?

Hundreds of thousands of drones have been registered with the Federal Aviation Administration. One of the challenges with UAS in the future will be integrating them into the airspace with manned aircraft. Operators of both manned and unmanned aircraft must work together to bring drones safely into the airspace.

EXTEND

Teacher Material: UAS Fundamentals Presentation
Student Material: UAS Fundamentals Student Activity 2

Slide 14: Conduct the **Formative Assessment**.

In the second session, students will work in small groups and explore scenarios where UAS are being used. Each of the scenarios utilize UAS to increase safety, practicality, and efficiency.

Provide each student with **UAS Fundamentals Student Activity 2.** Collect student work. [DOK 4; design, create]

Formative Assessment

Create six groups and assign one of the six scenarios included in **UAS Fundamentals Student Activity 2** to each of the small groups. Instruct students to complete the scenario their group was assigned. When all groups have completed their work, students share what they learn about their scenarios with the rest of the class.

Slide 15: If the classroom has access to a drone, allow students to become familiar with the parts of the drone such as the propellers, motors, and body. Referencing the controller, help students determine how to get the UAS off the ground and how the controls affect the drone's direction of flight.

Review the process for preparing the UAS for flight. Tell students that after they learn more about the safe drone operations in the next lesson, they will be given an opportunity to fly.

EVALUATE

Teacher Material: UAS Fundamentals Presentation

Slide 16: Conduct the **Summative Assessment.**

Students will analyze if UAS could be useful for a list of possible applications and operations. Collect student work and grade according to the rubric. [DOK 2; summarize, DOK 4; apply concepts, analyze]

Summative Assessment

Provide students with the following list of possible UAS applications and operations: Reporting on news story, tracking a criminal, delivering pizza, and preflighting a Boeing 747. For each item on the list, students should write a three to four sentence summary that includes the following:

- If a UAS could be useful for the stated purpose (if not, explain why)

- Summarize how it could be useful
- Determine if its use might save money
- Potential challenges with its use for the stated purpose

Summative Assessment Scoring Rubric

Criteria:

- Follows assignment instructions.
- Student responses show evidence of one or more of the following:
  - Knowledge of the kinds of problems UAS help to solve.
  - Applies concepts related to the utility of UAS.
  - Shows in-depth thinking including analysis or synthesis of lesson objectives
- Student work shows overall understanding of the concepts covered in the lesson.

Points	Performance Levels
9-10	Consistently demonstrates criteria
7-8	Usually demonstrates criteria
5-6	Sometimes demonstrates criteria
0-4	Rarely to never demonstrates criteria

STANDARDS ALIGNMENT

NGSS STANDARDS

Three-dimensional Learning

- **HS-ETS1-1** - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
  - Science and Engineering Practices
    - Asking Questions and Defining Problems
    - Constructing Explanations and Designing Solutions
  - Disciplinary Core Ideas
    - ETS1.A: Defining and Delimiting Engineering Problems
  - Crosscutting Concepts
    - Systems and System Models
    - Influence of Science, Engineering, and Technology on Society and the Natural World
- **HS-ETS1-3** - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
  - Science and Engineering Practices
    - Constructing Explanations and Designing Solutions
  - Disciplinary Core Ideas

        - ETS1.B: Developing Possible Solutions
    - Crosscutting Concepts
        - Influence of Science, Engineering, and Technology on Society and the Natural World

COMMON CORE STATE STANDARDS

- **RST.9-10.2** - Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
- **RST.9-10.4** - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- **WHST.9-10.2** - Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- **WHST.9-10.6** - Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
- **WHST.9-10.8** - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
- **WHST.9-10.9** - Draw evidence from informational texts to support analysis, reflection, and research.

REFERENCES

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