Classifying Aircraft

Session Time: One, 50-minute session

DESIRED RESULTS

ESSENTIAL UNDERSTANDINGS

The intended purpose and use of an aircraft drives the aircraft design considerations and construction techniques, materials, and components. (EU1)

ESSENTIAL QUESTIONS

1. What value is there in sorting aircraft into categories and classes?
2. Why are there so many variations of aircraft types?

LEARNING GOALS

Students Will Know

- Categories and classes of aircraft
- Why various categories and classes of aircraft are necessary
- Strategies for identifying types of aircraft

Students Will Be Able To

- *Identify* the characteristics of different aircraft types. (DOK-L1)
- *List* the basic characteristics of common aircraft. (DOK-L1)
- *Explain* aircraft categories and classes. (DOK-L2)
- *Utilize* aircraft characteristics to accurately *classify* an unfamiliar aircraft. (DOK-L2)

ASSESSMENT EVIDENCE

Warm-up
Students watch segments of a video about a number of 1940s aircraft in flight and are asked to predict how the various aircraft that are shown would be categorized.

Formative Assessment
Using a Four Corners activity, students are presented with pictures of four different aircraft and are asked to note identifying characteristics of aircraft such as landing gear configuration, number of engines, wing position, category, and class.

Summative Assessment
Students are presented with pictures of five different aircraft not previously presented in the lesson, and are asked to identify important characteristics of the aircraft as well as to what category and class each aircraft belongs.

LESSON PREPARATION

MATERIALS/RESOURCES

- Classifying Aircraft Presentation
- Classifying Aircraft Student Activity 1
- Classifying Aircraft Student Activity 2
- Classifying Aircraft Teacher Notes 1
- Classifying Aircraft Teacher Notes 2
- Classifying Aircraft Teaching Aid

LESSON SUMMARY

Lesson 1: Classifying Aircraft
Lesson 2: Classifying UAS

The lesson will begin with students watching a video that depicts various 1940s-era aircraft in flight. Students are asked to predict how the aircraft in the video would be characterized. This is followed by a discussion of aircraft certification category and class, and why these distinctions are necessary. Students will watch a brief video providing more information on these terms, and then will examine a number of identifying characteristics of aircraft that can be useful in aircraft recognition, including number of engines, engine type, wing configuration, and landing gear type.

In the next section of the lesson, students engage in a formative assessment consisting of a Four Corners activity. During this activity, students will be shown pictures of various aircraft and will be asked to identify important characteristics of each aircraft. The goal of this activity is to have students think about what defines category and class aircraft.

The remainder of the lesson will be spent introducing students to a number of common aircraft with a consideration of their basic characteristics. Students also will be introduced to a number of specific airplanes (e.g., Cessna 172, Piper Cub, Boeing 737, and Airbus 320) and provided basic information about their size, speed, and engine type. This process will be repeated using a number of rotorcraft (e.g., gyroplanes and Robinson R44). The teacher will explain to the students how to differentiate between the category and class of a particular aircraft. Finally, students will be presented with pictures of five different aircraft not previously presented in the lesson, and be asked to identify important characteristics of the aircraft and determine to which category and class each aircraft belongs.

BACKGROUND

The primary goals of this lesson are to familiarize students with the concepts of aircraft certification category and class. As a part of this process, students will also gain knowledge about identifying characteristics of various aircraft. It is quite likely that students will already have some familiarity with passenger airplanes and a basic appreciation of the fact that aircraft of different sizes and with different characteristics will exhibit differences in performance, weight, and speed.

The FAA divides aircraft into categories and classes so that it knows which set of certification rules to apply. Aircraft with very different characteristics, such as airplanes and helicopters , must be evaluated using rules and standards appropriate to the category and class of aircraft to which they belong. For example, rules applying to a tail rotor would have no place in the certification of an airplane.

MISCONCEPTIONS

The most likely misconception related to this material is an assumption that aircraft category and class are synonymous. This is not the case. As the lesson will point out, in the context of aircraft certification, category generally refers to some intended use or function (e.g., transport, utility, etc.) and aircraft class refers to broad groupings of aircraft having

similar characteristics of propulsion, flight, or landing (e.g., airplane, rotorcraft, glider, etc.). Another source of confusion is that the way these terms are used in aircraft certification is different from how they are used in airman certification.

DIFFERENTIATION

To support different learning preferences in the **EXPLAIN** section, consider including both the photograph and a corresponding video for each aircraft in the formative assessment.

To support students who struggle with the unfamiliar aircraft categories and classes in the summative assessment in the **EVALUATE** section, the teacher can remind the students of the common identifying physical characteristics which differentiate aircraft by category and class.

LEARNING PLAN

ENGAGE

Teacher Material: Classifying Aircraft Presentation

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

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

Warm-Up

Show students "1940s Civil Aviation Film" (Length 9:25). You may stop the video after about 6 minutes.

- http://video.link/w/nNTd

In the video, students will see a number of different 1940s-era aircraft in flight. Have students individually write their answers to the following

- List at least three different aircraft shown in the video.
- Describe how they were used.
- Describe at least one special feature for each aircraft listed (e.g., number of wings, amphibious or land, etc.).

Ask volunteers to share their answers with the class. Allow for a brief discussion after the video. Collect student work.

The following time points in the video are where each type of aircraft is first discussed: biplane (0:45), monoplane (1:55), high wing airplane (3:44), autogyro (3:53), seaplane (5:05), and amphibious airplane (5:53).

[DOK-L2; *categorize, predict*]

EXPLORE

Teacher Material: Classifying Aircraft Presentation

Slide 5: The FAA divides aircraft into categories and classes so that it knows which set of certification rules to apply. Aircraft with very different characteristics, such as an airplane and a helicopter, must be evaluated using rules and standards appropriate to the category and class of aircraft to which they belong. For example, rules applying to a tail rotor would have no place in the certification of an airplane.

Slide 6: Distinguish between aircraft category and aircraft class. These two concepts are likely to be assumed to be similar, but in reality, they refer to different things. Aircraft categories are generally based on the intended use or operating limitations of an aircraft: normal, utility, acrobatic, transport, restricted, etc.

Slide 7: Explain common aircraft categories, which includes:

- Normal: airplanes that have a seating configuration of 9 or less with a maximum takeoff weight of 12,500 pounds or less
- Utility: same definition as normal category but can be used for limited acrobatics
- Acrobatic: aircraft intended for use without restrictions
- Transport: jets with 10 or more seats or propeller-driven airplanes with 19 or more seats that weigh 12,500 pounds or more
- Restricted: heavy- or light-weight aircraft used for specific purposes, such as agricultural spraying

Slide 8: Aircraft classes are broad groupings of aircraft having similar characteristics of propulsion, flight, or landing.

- Airplane: an engine-driven, fixed-wing aircraft
- Rotorcraft: a heavier-than-air aircraft that relies on lift generated by one or more rotors
- Glider: a heavier-than-air aircraft whose free flight does not depend on an engine
- Balloon: lighter-than-air aircraft that uses gas buoyancy or an airborne heater

Teaching Tips

According to the Pilot's Handbook of Aeronautical Knowledge (PHAK), these definitions vary depending on whether they are used in the context of certification of an aircraft itself (see above definitions) or in the context of the certification of airmen (category and class take on new meanings). When discussing airman certification, category relates to the specific type of aircraft (e.g., airplane, rotorcraft, etc.) and class refers to other defining characteristics (e.g., single-engine, multi-engine, etc.). This could obviously lead to confusion, so it may be worthwhile to point out that the specific meaning of these words varies depending on the context in which they are used. The category and class in relation to airman certification will be included in a later lesson on regulation.

Slide 9: Show a video that illustrates how the terms *category* and *class* are used when referring to aircraft.

- "Aircraft Category and Class" (Length 4:13)
  http://video.link/w/1OTd

Questions

Ask students to consider why sorting aircraft into categories and classes is necessary and helpful. Students should briefly discuss their answers with a partner.

Possible response: *To help group aircraft of similar characteristics more appropriately, which simplifies aircraft certification and design requirements of similar aircraft. Aircraft with very different characteristics, such as an airplane and a helicopter, must be evaluated using rules and standards appropriate to that aircraft.*

Slide 10: Aircraft can be classified based on the number of engines. Point out the engines in each photograph. Note that a twin-engine aircraft is a type of multi-engine aircraft, but not all multi-engines are twins. For example, the Boeing 747 is a multi-engine aircraft with four engines.

Teaching Tips

Students may be curious about why a pilot might choose to fly a multi-engine aircraft over a single engine aircraft. Explain that additional engines increase an aircraft's payload and speed. Extra engines also improve takeoff and climb performance. Safety is another important consideration by having extra engines in case of a failure.

Slide 11: Aircraft may also be characterized by engine type. Typically, this will be either a piston or turbine engine. Piston engines operate on the same principle as a car engine and are attached to either a propeller or rotor.

Slide 12: Turbine engines may also be attached to a propeller or rotor, or may operate as a jet.

Slide 13: Another identifying characteristic of an aircraft is its wing configuration. This slide shows a few variations of wing configurations.

Monoplane (1 set of wings)

- Low wing: wings are mounted near the bottom of the fuselage
- Mid wing: wings are mounted halfway up the fuselage
- High wing: wings are mounted on the upper part of the fuselage

Biplane (2 sets of wings of similar size)

Triplane (3 stacked sets of wings)

Slide 14: Aircraft can also be classified based on their type of landing gear. The three main classifications of landing gear are tailwheel, tricycle, and tandem.

- Tailwheel: In this configuration, the main gear is located near the front of the airplane, while a third wheel supports the tail of the airplane. This is also known as conventional landing gear due to the fact that early aircraft used this configuration.
- Tandem: The front and rear gear are aligned along the longitudinal axis of the aircraft. It is used in some military aircraft and gliders.

- Tricycle: This is the most commonly used landing gear configuration. In this configuration there is a single nosewheel in the front of the aircraft and two main wheels farther back on the aircraft. Tricycle landing gear is much more stable than conventional landing gear during takeoff and landing.

EXPLAIN

Teacher Materials: Classifying Aircraft Presentation, Classifying Aircraft Teacher Notes 1, Classifying Aircraft Teaching Aid
Student Material: Classifying Aircraft Student Activity 1

Slide 15: Conduct the **Formative Assessment**.

Formative Assessment

Provide each student with **Classifying Aircraft Student Activity 1**. Conduct this activity using a Four Corners instructional strategy. To prepare for this activity, use the four photographs of the aircraft located in the **Classifying Aircraft Teaching Aid**. This formative assessment will help students learn to classify aircraft by category and class based on an aircraft's physical features, displayed in each of the four photographs of this activity.

1. In each corner of the room, display one of the four printed photographs from **Classifying Aircraft Teaching Aid**.
2. Divide the class into four groups.
3. Assign each group to a corner.
4. Give students a few minutes to take notes on the activity sheet.
5. Then, ask student groups to rotate to the next corner.
6. Repeat until every student group has studied the photograph in each corner.

Answers to this assessment are found in **Classifying Aircraft Teacher Notes 1**.

This activity should take the remainder of the first session.

[DOK-L2; *distinguish*, *interpret*, DOK-L1; *identify*]

EXTEND

Teacher Material: Classifying Aircraft Presentation

In the next part of this lesson, students will consider why understanding the common characteristics of various aircraft is important and has practical value for pilots. Students will examine several tables that describe common aircraft and their characteristics.

Slide 16: Identifying and understanding basic aircraft characteristics is how people in aviation communicate about aircraft. For example, if an air traffic controller tells a pilot to "Follow the tailwheel aircraft to Runway 36," it's important for all parties to understand what that means. It is also helpful to be able to identify common aircraft by name and/or manufacturer. A controller might say "You're cleared to land number two behind the Piper on short final." In this case it would be enough to know that most Pipers are small, low wing aircraft.

Slides 17-20: These slides provide basic information about size, speed, and engine type for common aircraft. Spend a minute or two reviewing each aircraft and its characteristics.

EVALUATE

Teacher Material: Classifying Aircraft Presentation, Classifying Aircraft Teacher Notes 2
Student Material: Classifying Aircraft Student Activity 2

Slides 21-24: Quiz the students several practice test questions from the Private Pilot Knowledge Test on aircraft category and class.

Slide 25: Conduct the **Summative Assessment**.

Teaching Tips

Unless intended purpose or use is obvious, students may need to refer to their notes or be allowed to conduct limited Internet searches to determine the categories of aircraft that are shown in the summative assessment.

Summative Assessment

Provide students with **Classifying Aircraft Student Activity 2**. The activity contains five photographs of aircraft the students haven't yet seen in this lesson. Ask students to fill out a table for each aircraft which focuses on category and class (in the context of aircraft categorization), engine(s) configuration, wing characteristics, and landing gear. Collect student work and grade using the assessment rubric. The correct answers are provided in the **Classifying Aircraft Teacher Notes 2**.

[DOK-L2; *categorize*; *classify*]

Summative Assessment Scoring Rubric

Follows assignment instructions
Written explanation includes:

- an ability to recognize different types of aircraft and state their characteristics
- an ability to recognize aircraft by categories and classes
- an ability to categorize unfamiliar aircraft

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

GOING FURTHER

If time allows, ask students to select a category/class of aircraft that they'd be most interested in flying and explain why they are interested in it.

STANDARDS ALIGNMENT

NGSS STANDARDS

Three-dimensional Learning

- **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
        - None

COMMON CORE STATE STANDARDS

- **MP.2** - Reason abstractly and quantitatively.
- **MP.7** - Look for and make use of structure.
- **RI.9-10.4** - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
- **SL.9-10.1** - Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9-10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
- **W.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.
- **W.9-10.9** - Draw evidence from informational texts to support analysis, reflection, and research.

REFERENCES

https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/phak/media/03_phak_ch1.pdf

ttps://docs.lib.purdue.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1103&context=jate