Fundamentals of Aviation Safety

Session Time: Two, 50-minute sessions

DESIRED RESULTS

ESSENTIAL UNDERSTANDINGS

Understand the importance of professionalism, ethics, and dedication as they relate to all aviation/aerospace operations. (EU5)

Develop an uncompromising safety mindset, understanding that growth and development in the aviation/aerospace industry must always be accompanied by responsive safety initiatives. (EU6)

ESSENTIAL QUESTIONS

1. What is an appropriate definition of safety for aviation?
2. How can we mitigate risk in aviation?
3. How involved should the Federal Aviation Administration be in maintaining the safety of flight?

LEARNING GOALS

Students Will Know

- Key elements related to maintaining safety in aviation.
- An appropriate definition of aviation safety.
- What risk management is and the kinds of tools used to manage risk.

Students Will Be Able To

- *Define* aviation safety. (DOK-L1)
- *Construct* a basic safety management system. (DOK-L3)
- *Apply concepts* of risk management to everyday decision-making. (DOK-L4)

ASSESSMENT EVIDENCE

Warm-up
Students will watch an aviation safety video and then write several sentences about the importance of aviation safety and what it means.

Formative Assessment
In teams, students will develop safety management systems and present them to the class.

Summative Assessment

Students will complete self-assessments that measure their basic understanding of safety, with an emphasis on the use of risk management tools learned in this lesson.

LESSON PREPARATION

MATERIALS/RESOURCES

- Fundamentals of Aviation Safety Presentation
- Fundamentals of Aviation Safety Student Activity 1
- Fundamentals of Aviation Safety Student Activity 2
- Fundamentals of Aviation Safety Teacher Notes

LESSON SUMMARY

Lesson 1: Fundamentals of Aviation Safety

Lesson 2: The Federal Aviation Administration

This two-session lesson will begin by having students create their own definitions of safety and then record their perceptions about safety based on personal experience(s). Through class discussion and classroom activities, students will learn the FAA's definition of safety, and they will explore concepts such as perceived and accepted risk. The teacher will describe the "Recognize, Analyze, Implement, and Determine" (RAID) model that is commonly used to define and mitigate risk. Students will discuss scenarios and make safety decisions using RAID. Students also will learn the definition and parts of a safety management system (SMS).

As an extension, students will create their own safety management systems in teams of four to six. Students will present these systems to their classmates upon completion.

Finally, students will complete a self-assessment that asks them to rewrite their definitions of safety and answer questions about improving safety in their own lives by applying tools they have learned in this lesson.

BACKGROUND

Aviation safety is a broad term that encompasses the theory, investigation, and prevention of aviation accidents and incidents. Creating a safe aviation environment requires regulation, education, and training.

The Federal Aviation Administration (FAA) has defined aviation safety as the "freedom from those conditions that can cause death, injury, occupational illness, or damage to or loss of equipment or property, or damage to the environment."

A significant part of creating a safe aviation system is risk management, which is a systematic way of dealing with hazards. Risk management involves a logical process of weighing the potential costs of risks against the possible benefits of allowing those risks to stand uncontrolled. It is a decision-making process designed to identify hazards systematically, assess the degree of risk, and determine the best course of action.

According to the FAA, a Safety Management System (SMS) is a "formal, top-down, organization-wide approach to managing safety risk and assuring the effectiveness of safety risk controls. It includes systematic procedures, practices and policies for the management of safety risk." Reduced to its simplest form, an SMS includes provisions for: 1) hazard identification and mitigation; 2) employee involvement; 3) safety training and promotion; and 4) safety culture.

Risk management tools (like RAID) are often part of an SMS.

MISCONCEPTIONS

Aviation safety is not about achieving complete freedom from harm, injury, or death as much as it is the management of hazards and risks in order to prevent injury and death.

DIFFERENTIATION

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

LEARNING PLAN

ENGAGE

Teacher Material: Fundamentals of Aviation Safety Presentation
Student Material: Fundamentals of Aviation Safety Student Activity 1

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

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

Show students an Air Safety Institute video to set the stage for the important section on aviation safety. After they watch the video, ask students to individually write a 1-2 sentence response to the questions. Allow for a brief discussion. Take no more than 5 minutes for this activity. [DOK 2; relate, summarize]

- "Feeling Rundown" (Length 00:39)

  http://video.link/w/oQde

Warm Up

Working individually, students will watch an aviation safety video and then write 1-2 sentence answers for the following questions:

- What comes to your mind when you think of the words "aviation safety"?
- Why is this a serious and important topic?

Slide 5: Show students a humorous photo and discuss how the image relates to the statement "Be Safe."

Underscore with students that planning ahead is a critical piece of aviation safety and that thinking through every aspect of a flight may be the most important part of the mission. Advance preparation and thinking will minimize risks in the air and improve safety.

Slide 6: Show students a more serious photo and discuss how the image relates to the statement "Be Safe."

Students should never underestimate the importance of always running checklists and ensuring proper procedures are followed for every flight. In the photo on the slide, the aircraft was loaded with too much weight toward its tail. The

total weight and its distribution must be properly calculated before flight for every aircraft - large and small. In the case of the aircraft in the photo, if it hadn't tipped on its end on the ground, this situation could have led to uncontrollable handling problems on takeoff.

Slide 7: Students will prepare for learning about aviation safety by creating their own definitions of safety. They will record their perceptions about safety based on personal experience(s) on **Fundamentals of Aviation Safety Student Activity 1**.

Once the students have completed the activity, allow them to share and discuss their definitions of the term "safety." Facilitate the discussion by identifying and tracking the similarities and differences among the definitions provided by the students. The teacher can create a list of similarities or differences on the board as students share their definitions to use for later discussion.

Teaching Tips

If desired for efficiency, divide the students into relatively equal groups and have each group develop a common definition that can be shared with the rest of the class. Students will need to collaborate and delegate a person to be the speaker/voice for the entire group.

EXPLORE

Teacher Material: Fundamentals of Aviation Safety Presentation

Slide 8: Provide students the FAA's definition of "safety." Emphasize the term "freedom" and have a discussion with students about whether or not they think it will ever be possible to remove all risk from aviation.

Slide 9: Present several ways in which safety is measured in society today. Allow students to offer their own suggestions. Ask students to complete the statement, "Safety can be measured by the amount, level, or degree of …"

Facilitate the contributions by identifying and tracking the similarities and differences among the answers provided. Potential answers may be associated with:

- Injury/harm
- Loss of property or life
- Damage
- Frequency or magnitude of the event

Slides 10-11: Risk is the chance of an adverse outcome. It is the exposure of someone or something to danger, harm or loss. Explain to students that safety is a relative term based on two things: an individual's perception of the risk and the acceptance of risk.

Perceived risk is subjective and based on an individual's judgement regarding the probability of something bad happening and the severity of the consequences. Ask students to give their perceived risk of taking a flight in a single-engine airplane in the middle of a snow storm. Would a flight in that same airplane have fewer perceived risks if the weather was different?

Accepted risk involves a subjective balancing of benefits and risks. It is the level of human and property loss that can be tolerated.

Two people could perceive the level of risk for flying a single-engine airplane in a snowstorm in the same way, but their acceptance of that risk could be different.

Present students with another perceived/accepted risk scenario that might be familiar to them in their daily lives.

EXPLAIN

Teacher Material: Fundamentals of Aviation Safety Presentation
Student Material: Fundamentals of Aviation Safety Student Activity 2

Slide 12: Explain that a significant part of creating a safe aviation system is risk management, which is defined as a systematic way of dealing with hazards. Risk management involves a logical process of weighing the perceived and accepted risks and ensuring those risks are controlled. It is a decision-making process designed to identify hazards systematically, assess the degree of risk and determine the best course of action.

In aviation, proper and disciplined use of risk management ensures that the risks associated with the hazards of flight are systematically identified, assessed and managed within acceptable safety levels.

Slide 13: RAID is a common model used to assess and manage risk. Students will learn about this model and apply it to several scenarios during this lesson.

Slide 14: The "R" in the model stands for *recognize.* Students must recognize and identify the hazard(s) which are events, objects, or circumstances that could contribute to an undesired outcome. They can ask themselves, "What bad things could happen?" Prompt students with examples like weather, carrying more weight than planned, heavier air traffic than expected, etc.

Slide 15: The "A" in the model stands for *analyze.* Students must analyze the perceived risk(s) based on probability (likelihood) and severity. The FAA categories probability and severity as the following:

There are 5 general categories of probability: frequent, probable, occasional, remote, and improbable.

There are 4 general categories of severity: negligible, marginal, critical, and catastrophic.

For example, a pilot might determine that the probability of encountering severe turbulence when flying through an area of heavy precipitation is "frequent." They may also determine that the severity of that scenario could be "catastrophic."

Slides 16-17: Explain that the risk assessment matrix is a way to analyze risk based on probability and severity. Give students several scenarios to apply to the matrix and have them decide where the activities could fall.

- Breaking a bone during football practice
- Texting and driving on your way to school
- Taking off in an airplane with friends and not checking the fuel level before you depart
- Deciding enroute to land at an airport that has a very short runway with trees on either end

Slide 18: The "I" in the model stands for *implement.* Pilots must implement management, mitigation, and control tools in order to make a flight as safe as possible. Students should ask themselves, "What are some ways to make this activity as safe as possible?" and then implement those tools.

Examples might include that a pilot waits for a thunderstorm to pass over the airport before taking off, or if a pilot is anticipating having to divert around thunderstorms, they might reduce the cargo onboard to allow for additional fuel.

Slide 19: The "D" in the model stands for *determine.* Pilots must determine if the risks are worth the outcome of the operation. If you decide the risks are worth it, this is accepted risk. After determining the probability and the severity of something bad happening, and after considering all the things one can do to reduce the risk, a pilot must determine if it is worth completing the activity.

Slide 20: With students, apply the RAID strategy to the given scenario.

Scenario 1: Weather

It is the morning of your first flight in a small airplane after you've received your pilot's license. You have been looking forward to this day for weeks, and of course you are very excited! The plan is to take off at 2:00 p.m. It is now 8:00 a.m. The weather is clear, cool, and dry—perfect for flying. But wait—what did the forecaster just say? "Around 3:00 p.m., expect increasing cloudiness, 75 percent chance of rain, and poor visibility. After 5:00 p.m., the weather will improve and will be clear and dry, with clouds at 10,000 feet, and will remain this way until the following morning."

Slide 21: R – Recognize

Weather affects a pilot's ability to stay out of clouds and see other airplanes; it is a big risk factor. In addition, the pilot' s certificate only allows them to fly in clear skies (visual flight rules). They don't yet have the training to fly in the clouds (instrument flight rules).

Slides 22-23: A – Analyze

Remind students there are 5 general categories of probability: frequent, probable, occasional, remote, improbable; and 4 general categories of severity: negligible, marginal, critical, catastrophic.

To analyze a situation, look at both the probability and severity of the situation. If the probability of an event is remote, and the severity of the outcome of that event is negligible, then the level of risk is low. The counter would be an event that is very probable to occur with catastrophic results, including fatal injuries. That would be a high level of risk.

Words like *"may, might, perhaps, maybe, should…"* are all based on uncertainty. A pilot just doesn't know what will happen. "You *may* be able to fly" really means the pilot shouldn't risk the weather getting worse earlier than predicted. In this scenario, it seems probable that the conditions will be bad and the severity of an incident would be catastrophic.

It seems very risky to make the flight as originally planned.

Slide 24: I – Implement

There is a good chance, according to the weather forecaster, that things will be very nice later in the day.

But what if the flight could be done earlier—say at 9:00 a.m.?

A good course of action would be to call the flight school and see if the flight could be done earlier. If not, then reschedule the flight for after 5:00 p.m. or even another day.

Slide 25: D – Determine

Do they go?? Pilots should review the weather as they get closer to the planned flight time—whenever that is.

By planning to fly earlier or later, they have "bracketed" the risk of the worsening weather and are more likely to have a safe flight experience.

This pilot has managed the risk down to accepted level.

Slide 26: To complete the first session of the lesson, split students into small groups and have them apply the RAID model to a second scenario. Students may approach this scenario in several different ways. Some ideas are included below. Lead a class discussion once the teams have completed their models.

Scenario: Mechanical Issue

You are lucky enough to be joining your Mom on a trip in her company's business jet. You get to the airport with plenty of time, and one of the pilots kindly shows you around the plane, and lets you help with preflight preparations. As you walk around the outside of the airplane, you notice a strong smell of jet fuel. No one else seems to have noticed it, and you just don't know if this is normal or not. You don't want to appear "stupid," so you are reluctant to say anything. But what if the smell is not normal?

R - Recognize

The smell could be normal, but the student doesn't have anything to compare it with. What if it is a fuel leak, which could be potentially very serious? This seems like it could be a real problem.

A – Analyze

If it is a fuel leak, the airplane would have less fuel than planned. Would it still have enough fuel for the trip? Also, could the leak cause a fire? The student doesn't like the risk of either of these things happening. Although the student may not know the probability of a situation related to a fuel smell, they can guess that the severity of an event could be critical. For this reason alone, the perceived risk seems to be pretty high.

I – Implement

The student determines that it is simply too risky not to say something so they tell the pilot about the smell of fuel. The pilot double checks the engine and finds a small leak.

D - Determine

Even though the student may have been "the new kid," they were worried about a strong smell, and rather than just stay quiet, they spoke up. Although he was concerned the pilot would think they were stupid or intrusive, not doing something would be an even bigger risk. The leak was fixed, and the flight was completed, albeit a little later than planned.

EXTEND

Teacher Materials: Fundamentals of Aviation Safety Presentation, Fundamentals of Aviation Safety Teacher Notes

Student Material: Fundamentals of Aviation Safety Student Activity 2

Slide 27: According to the FAA, a Safety Management System (SMS) is a "formal, top-down, organization-wide approach to managing safety risk and assuring the effectiveness of safety risk controls. It includes systematic procedures, practices and policies for the management of safety risk."

Reduced to its simplest form, an SMS includes provisions for: 1) hazard identification and mitigation; 2) employee involvement; 3) safety training and promotion; and 4) safety culture.

Slide 28: The first component of an SMS is Hazard Identification and Mitigation. An SMS is a risk management model that is useful for identifying risks and determining the best course(s) of action. The use of risk management tools (like RAID) are often part of an SMS and could be an important part of this first component.

The second component of an SMS is Employee Involvement. Often rules, policies, and procedures are put in place to manage risk and prevent accidents/incidents. Employee involvement may include routine audits of procedures and data and information.

Slide 29: The third component of an SMS is Safety Training and Promotion. Everyone has a role in a successful SMS. Employees must be regularly trained, and the system must be promoted often in order to encourage full adoption. This could include training classes, web-based courses, videos, safety posters, and more.

The fourth component of an SMS is Safety Culture. This could be described as "the way we do things around here." A positive safety culture has a set of attitudes and beliefs that are shared by all employees from the senior leadership all the way down to the most junior employees.

Slide 30: Conduct the **Formative Assessment**.

Students will create their own safety management system in teams of four to six. Provide students with **Fundamentals of Aviation Safety Student Activity 2**.

Assign each team one of the following goals. The teacher should determine whether or not to have the students actually perform the task.

- Goal 1: Stand up on a chair to put a book on a high shelf.

- Goal 2: Move a table from one corner of the room to the other.
- Goal 3: Change an overhead light bulb.

Refer to **Fundamentals of Aviation Safety Teacher Notes** for examples and ideas to complete goal number one. Use this to guide students as they develop their own SMS.

[DOK 4; create, DOK 2; construct, relate]

Formative Assessment

In teams, students will develop their own safety management systems which will allow them to complete their assigned goal as safely as possible. Students will present their safety management systems to the class.

EVALUATE

Teacher Material: Fundamentals of Aviation Safety Presentation

Slide 31: Summarize what students have learned about safety and aviation. Emphasize that safety in aviation is not about achieving complete freedom from harm. Perfect safety is unknown in transportation and probably in most of life's endeavors. However, aviation, especially commercial aviation, is probably the safest mode of transportation. This is because of the tremendous emphasis placed on aircraft, air crews and the air traffic control system. This applies to other modes of aviation, as well.

Slide 32: Conduct the **Summative Assessment**.

Ask students to rewrite their definitions of safety and answer questions about improving safety in their own lives by applying risk management tools they have learned in this lesson. Ensure that students have their completed versions of **Fundamentals of Aviation Safety Student Activity 1** in order to make comparisons.

Use the following questions for this self-assessment:

- Using the knowledge acquired from the lesson, rewrite your definition of safety.
- In what ways has your definition changed based on this lesson?
- Based on the results of the first activity, where you rated your own ability to maintain safety in your daily activities and lifestyle, briefly explain how you can improve your personal safety or identify elements that have not yet been considered that would increase the likelihood of a safe outcome. Which risk management tools would you use to do this?

[DOK 4; analyze, DOK 3; compare, DOK 2; relate]

Summative Assessment Scoring Rubric

- Follows assignment instructions
- Illustration shows evidence of one or more of the following:
    - Understands an appropriate definition of aviation safety.
    - Knowledge of key elements related to maintaining safety in aviation and risk management.

- Shows ability to reflect on personal safety and willingness to participate and practice safety using the skills and tools learned in this lesson

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

Summative Assessment

Students will complete self-assessments that measure their basic understanding of safety, with an emphasis on the use of risk management tools learned in this lesson. They should take no more than 10 minutes of class time to complete the assessment.

GOING FURTHER

Encourage students to explore other areas in their daily lives or other environments (i.e., school, employment, sports) in which the fundamental components of aviation safety management are being used and/or can be applied to improve safety.

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

- **RL.9-10.2** - Determine a theme or central idea of a text and analyze in detail its development over the course of the text, including how it emerges and is shaped and refined by specific details; provide an objective summary of the text.
- **RL.9-10.3** - 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.
- **RL.9-10.4** - Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the cumulative impact of specific word choices on meaning and tone (e.g., how the language evokes a sense of time and place; how it sets a formal or informal tone).
- **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

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