Aviation and World War I

Session Time: Two, 50-minute sessions

DESIRED RESULTS

ESSENTIAL UNDERSTANDINGS

Appreciate the rich, global history of aviation/aerospace and the historical factors that necessitated rapid industry development and expansion. (EU1)

Understand the operational differences between general, commercial, and military aviation as well as how these differences influence the modern aviation/aerospace industry. (EU2)

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 factors in World War I drove innovations in aircraft design?
2. How does necessity become the mother of invention?

LEARNING GOALS

Students Will Know

- Advancements in aircraft design during World War I
- Innovations that occurred as aircraft started to be used for military purposes

Students Will Be Able To

- *Explain* the influence World War I had on aviation and aircraft design. (DOK-L3)
- *Analyze and interpret* data in order to draw conclusions about engine design and airplane performance. (DOK-L4, L2)

ASSESSMENT EVIDENCE

Warm-up
Students will list materials that might have been used to construct airplanes in World War I and explain what those materials would have likely been used for.

Formative Assessment
Students choose an aviation innovation developed during World War I they believe was the most instrumental to wartime efforts and justify their choice.

Summative Assessment

Students will work in groups to create a timeline that illustrates advancements in aviation from the beginning to the end of World War I.

LESSON PREPARATION

MATERIALS/RESOURCES

- Aviation and World War I Presentation 1
- Aviation and World War I Presentation 2 **(Going Further)**
- Aviation and World War I Student Activity 1
- Aviation and World War I Student Activity 2
- Aviation and World War I Student Activity 3 **(Going Further)**
- Aviation and World War I Teacher Notes 1
- Aviation and World War I Teacher Notes 2
- Aviation and World War I Teacher Notes 3 **(Going Further)**
- Aviation and World War I Teacher Notes 4 **(Going Further)**

World War I Innovation Timeline

- Poster board or rolled paper
- Markers

LESSON SUMMARY

Lesson 1 - Beginnings of U.S. Commercial Airline Service
Lesson 2 - Aviation and World War I
Lesson 3 - Airmail and the Transcontinental Airway System

This lesson introduces military aviation to students, as well as the technological, design, and combat issues inherent in this segment of aviation early in its history. Students will begin by brainstorming the materials that would have been useful in the creation of military aircraft. Students will then learn about how countries used airplanes during World War I in combat and how airplanes evolved from being used primarily for intelligence gathering to air-to-air combat to the delivery of bombs to their targets.

As students progress through the lesson, they will learn about advances made in airplane technology. Specifically, they will be exposed to advancements in design, construction materials, engine development and weapons/armament. Students will be asked to identify and justify which aviation innovation that occurred during this time period was most influential in the war effort.

An extension activity involves using two of the engineering practices students have learned this semester. By using mathematics and computational thinking and analyzing and interpreting data, students will draw connections between engine design and airplane performance.

During the summative assessment, students will work in groups to create a timeline that illustrates advancements in aviation from the beginning to the end of World War I.

BACKGROUND

World War I saw many technological advances in aviation. These advances were driven by each side's goal to win the war. To meet that goal, airplanes needed to be more reliable and more capable than those in production prior to the war. Initially aircraft were used as intelligence gathering platforms, flying over the enemy and recording troop positions and movements. Desire to prevent the enemy from obtaining such important information led to aerial combat. By the

end of the war, aircraft were used in air-to-air combat and for delivering bombs to targets. A few of the technological advances that took place during World War I that increased the effectiveness of the airplane as a military machine included:

- New wing configurations, including two (bi-) and three (tri-) wing configurations. These types of configurations allowed for more maneuverability, a key component to aerial combat.
- More powerful engines, which allowed airplanes to travel faster and/or carry heavier loads, including armament such as guns and bombs.
- Airplane structures were modified heavily, transitioning from open truss designs with fabric covered wings to enclosed fuselages of wood and metal materials strong enough to mount weapons.
- The interrupter gear mechanism was developed, allowing a machine gun to be mounted directly in front of the pilot without worrying about damaging the propeller from firing the weapon.

For additional background information, see **Aviation and World War I Teacher Notes 1**.

DIFFERENTIATION

To support verbal reasoning in the **ENGAGE** section, organize the class into groups for Think-Pair-Share to complete warm-up exercise. This allows learners to think about the question, discuss their thoughts with a partner before sharing with the larger group.

To support student motivation in the **EVALUATE** section of the lesson plan, allow students the option to create a poster instead of an infographic to present the same information.

LEARNING PLAN

ENGAGE

Teacher Material: Aviation and World War I Presentation 1

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

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

Warm-Up

Show students a photo of a World War I airplane and ask them to list all of the materials that might have been used to construct the airplane and what those materials were likely used for. Keep a list of common materials that they mention. Take no more than 10 minutes of class time to complete the warm-up.

Possible answers: Fabric for the wings, wood for the aircraft frame/structure, metal for the engine and landing gear, rubber for the tires, leather for the seats.

[DOK-L1; *list*]

EXPLORE

Teacher Materials: Aviation and World War I Presentation 1, Aviation and World War I Teacher Notes 1
Student Material: Aviation and World War I Student Activity 1

Slides 5-6: Explain that World War I saw many technological advances in aviation. Each side's desire to win the war drove these advances. To meet that goal, airplanes needed to be more reliable and more capable than those in production before the war.

Show students the first seven minutes of the video:

- "WWI Uncut 8: Combat in the Skies" (Length 7:00)
  http://video.link/w/HKJd

Slide 7: Initially, aircraft were used for intelligence gathering; flying over the enemy and recording troop positions and movements. Desire to prevent the enemy from obtaining such important information led to aerial combat. By the end of the war, aircraft were used in air-to-air combat and for delivering bombs to targets.

The technological advances made to aviation during the war could be classified into one of the following: design, construction materials, engine development, or weapons/armament.

Slides 8-9: Introduce the design changes that went into the construction of airplanes during World War I. Explain that the need for more maneuverable airplanes grew out of aerial combat.

Aircraft manufacturers started to test and build airplanes with different wing configurations including two (bi) and three (tri) wings.

The bi- and tri-wing airplanes were more maneuverable. The stacked wings helped increase lift and allowed the wings to be kept short. Shorter wings allowed for a lower moment of inertia and the ability to perform faster rolls and turns—similar to when an ice skater pulls their arms into their body to spin faster. However, a by-product of this increased maneuverability was a decrease in stability. The pilots of these faster, more maneuverable aircraft could not be distracted from flying for even a moment.

Slides 10-11: Airplane structures were modified heavily in World War I, transitioning from open truss designs with fabric covered wings to enclosed fuselages of wood and metal materials strong enough to mount weapons.

Many aircraft designers believed that metal was much too heavy to use on airplanes, but German Professor Hugo Junkers proved them wrong when he built the Junkers J1. This airplane flew only 12 years after the Wright brothers' first powered, controlled flight!

Slides 12-13: Advances in technology allowed airplanes to carry heavier loads. The load could be a gun for air-to-air combat or bombs to attack ground targets from the air. With the introduction of machine guns, the best way for a pilot to fire those guns was in the direction of travel. But pilots risked hitting their propeller with bullets if they mounted the gun in line of sight from the pilot to the nose of the airplane.

Slide 14: Conduct a class discussion by asking students where they would mount a gun if they were designing a one-person airplane for air-to-air combat.

Teaching Tips

There could be several possible answers to the question. Given the desire to fly and aim the gun at the same time, the best place to mount it would be on the nose, in line of sight from the pilot to the nose of the airplane.

As a follow-on question, ask students what the biggest concern is with mounting the gun on the nose, directly in front of the pilot. Of course, the biggest concern would be that bullets fired from the gun would pass through the propeller area, potentially damaging or destroying the propeller.

Slide 15: Show students a short video on interrupter gear, which was a mechanical device that synced the firing of a mounted machine gun with the position of the crankshaft/propeller in the engine to ensure that bullet fired from the gun would not impact the propeller blade.

- "The Interpreter" WWI Machine Guns on Planes (Length 2:15)
  http://video.link/w/LKJd

Slide 16: Using the remaining time in the first session, assign students **Aviation and World War I Student Activity 1.** Ask students to complete the graphic organizer using notes, illustrations or a combination to synthesize the main ideas and key facts they take away from the class discussion. Teachers may assign this as homework. Use **Aviation and World War I Teacher Notes 1** to assist in evaluating student work.

EXPLAIN

Teacher Material: Aviation and World War I Presentation 1

Slides 17-18: Start the second session of instruction by discussing engine development. Explain that more powerful engines developed during the war allowed airplanes to travel faster and/or carry heavier loads, including armament such as guns and bombs.

Early airplane engines were water-cooled, heavy and unreliable. Air-cooled engines eliminated the plumbing required in water-cooled engines, which made them lighter.

Rotary engines gained popularity throughout World War I. But while they had a better power-to-weight ratio, rotary engines made the handling characteristics for airplanes a challenge because of gyroscopic precession. This precession was created because the entire crankcase and all the engine cylinders rotated around as a unit.

Slide 19: Conduct the **Formative Assessment.**

When students finish writing about their chosen innovation, ask each student to share their responses. On the whiteboard, write the innovations in one column and the reason for its importance in another. Allow for a brief discussion and collect student work.

[DOK-L3; *justify*, *support*]

Formative Assessment

Working individually, have students choose an aviation innovation developed during World War I they believe was the most instrumental to wartime efforts. Have students write two paragraphs in response to the following questions.

- What innovation did you choose and what problem did it solve?
- In your mind, what made this innovation the most instrumental during the war?

EXTEND

Teacher Materials: Aviation and World War I Presentation 1, Aviation and World War I Teacher Notes 2
Student Material: Aviation and World War I Student Activity 2

Slide 20: The extension activity involves using two of the engineering practices students have learned this semester: Using mathematics and computational thinking; and analyzing and interpreting data.

As World War I progressed, engines became more powerful. Working in small groups, ask students to complete Internet research to complete the chart for a series of French World War I fighter airplanes in **Aviation and World War I Student Activity 2**. A website, http://www.historyofwar.org/weaponsN.html, has been provided to assist students in their research.

After they have completed the chart, students will calculate the power to weight ratio for each airplane and draw connections between engine design and airplane performance. The power to weight ratio is a fundamental indicator of aircraft performance. It is a direct expression of Newton's Second Law: F=ma. Since aircraft performance can be thought of as an acceleration, measuring the power that an aircraft can produce and comparing it to the weight will essentially tell us how well an aircraft can be expected to perform. Put in simple terms, a lot of power with a small amount of weight will result in good performance, whether you're talking about a car, boat or airplane.

Answers can be found on **Aviation and World War I Teacher Notes 2.**

EVALUATE

Teacher Material: Aviation and World War I Presentation 1

Slide 21: Conduct the **Summative Assessment.**

Summative Assessment

In groups of two to three, have students create a timeline that illustrates advancements in aviation from the beginning to the end of World War I. No specific dates are required on the timeline, but the order of each advancement should be accurate.

Provide each group of students a poster board or rolled paper to complete their timelines. Encourage students to use pictures and illustrations to complete their timelines. If time permits, allow for a brief discussion. Collect group work and grade using the scoring rubric.

[DOK-L4; *create*, DOK-L2; *organize*]

Summative Assessment Scoring Rubric

- Follows assignment instructions
- Interactive infographic shows evidence of one or more of the following:
  - Advancements in aircraft design during World War I
  - Innovations that occurred as aircraft started to be used for military purposes. Show understanding of concepts covered in the lesson.
  - Includes relevant pictures and illustrations.

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

Teacher Materials: Aviation and World War I Teacher Notes 3, Aviation and World War I Teacher Notes 4, Aviation and World War I Presentation 2
Student Material: Aviation and World War I Student Activity 3

Let the students compete in a World War I quiz show! For homework, assign the **Aviation and World War I Student Activity 3**. Students will use the activity sheet to guide their research on three famous pilots. Refer to **Aviation and World War I Teacher Notes 3** for answers to the activity. Explain to the students that the information learned in this lesson and on the activity sheet will culminate in a game of World War I Aviation Quiz Show. The majority of the quiz show questions will be based on what they learned during the lesson and their homework assignment. Emphasize to the students they should read carefully as they do their homework because not all the quiz show questions will appear on the student activity worksheet.

To conduct the quiz show, split the class evenly into three or four groups (based on class size). These groups will compete against one another. Refer to **Aviation and World War I Teacher Notes 4** for game set-up. Prior to playing World War I Aviation Quiz Show, have the students in the small groups compare and review their answers from the previous night's homework assignment for 10-15 minutes. The students also should review the notes they took on their graphic organizers. The quiz show (presented as a PowerPoint) can be found at **Aviation and World War I Presentation 2**.

The teacher may want to show students the second half of the video "WWI Uncut 8: Combat in the Skies," which includes a fun discussion about dogfighting in World War I and how technology influenced the way they fought. http://video.link/w/OKJd.

Divide students into three groups (or six, depending on class size) and assign each group a section of the article: "The Aircraft Engine: An Historical Perspective of Engine Development Through World War I." Have groups read and discuss their sections. Then, organize students into new groups consisting of one member from each of the original groups. They should present the important ideas of their sections to their classmates. As a group, review the article, then discuss the charts at the end of the article. Ask students what changed over the years in terms of fuel and power and how do these two factors related to engine type.

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-ETS1-2** - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
    - Science and Engineering Practices
        - Constructing Explanations and Designing Solutions
    - Disciplinary Core Ideas
        - ETS1.C: Optimizing the Design Solution
    - Crosscutting Concepts
        - none
- **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.
- **RST.9-10.7** - Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
- **WHST.9-10.2** - Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- **WHST.9-10.4** - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- **WHST.9-10.6** - 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.9-10.7** - 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.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

http://www.junkers.de/junkers-j1-the-worlds-first-all-metal-aircraft
http://www.bbc.com/news/magazine-29612707
http://blog.covingtonaircraft.com/2012/06/05/aircraft-engines-liquid-cooled-vs-air-cooled/
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