To the Moon

Session Time: Three, 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)

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

ESSENTIAL QUESTIONS

1. How did the United States send people to the moon?

LEARNING GOALS

Students Will Know

- The three space programs involved in the race to the Moon
- The political undertones that fueled the Space Race

Students Will Be Able To

- *Summarize* key features of NASA's three space programs that led to a man on the moon. (DOK-L2)
- *Compare* the milestones that occurred in the Mercury, Gemini and Apollo programs. (DOK-L3)
- *Develop a logical argument* related to the impact of the programs that assisted the U.S. in winning the space race. (DOK-L3)

ASSESSMENT EVIDENCE

Warm-up
Students write a paragraph discussing what they think were the biggest challenges for the United States in sending a man to the moon.

Formative Assessment
In small groups, students will complete a jigsaw exercise where they research key details of the three NASA programs that contributed to the Space Race.

Summative Assessment
Individually, students will write a persuasive argument as to which of the three space programs were of greatest benefit to the United States in its goal to put a man on the moon.

LESSON PREPARATION

MATERIALS/RESOURCES

- To The Moon Presentation
- To The Moon Student Activity

To The Moon Timeline

- Newspaper or poster board
- Markers

LESSON SUMMARY

Lesson 1: The Space Race Begins

Lesson 2: To The Moon

Lesson 3: The Space Race Winds Down

Lesson 4: The Shuttle Program

This lesson will begin by students working in small groups to write and discuss the biggest challenges for the U.S. in sending a man to the moon. During a Think-Pair-Share exercise, students will consider what they must do to earn their driver's licenses and what skills they must possess to drive. Students will also hypothesize what qualifications astronauts must have to go to space.

The teacher will lead students through a discussion of Projects Mercury, Gemini, and Apollo. Students will then use a jigsaw approach to researching the three programs, then convene in mixed groups to share what they have learned.

During the third session of the lesson, students will collaborate on a class timeline that will illustrate the three programs that led the U.S. to the moon. The timeline can be drawn on newspaper roll, poster board or on a whiteboard.

As a summative assessment, students will participate in a debate about which innovation from the three space programs was most influential to future space programs.

BACKGROUND

On May 25, 1961, President John F. Kennedy laid down an ambitious goal of putting astronauts on the moon "before this decade is out." At that time, the United States had only sent one astronaut to space – Alan Shepard, on May 5, 1961. The flight was only suborbital, compared with Russian cosmonaut Yuri Gagarin's first trip around the Earth.

Three NASA projects of increasing complexity led the U.S. to the moon: Projects Mercury, Gemini and Apollo.

Project Mercury was the first human spaceflight program and put the first U.S. astronaut into orbit. Project Gemini allowed the U.S. to prepare for the techniques that would eventually allow astronauts to land and walk on the moon. These included performing missions outside the spacecraft, space rendezvous and docking, and extended duration missions in orbit. Project Apollo landed the first humans on the moon.

In July 20, 1969, Apollo 11 commander Neil Armstrong walked on the Moon, paving the way for 11 other American astronauts to follow after him.

MISCONCEPTIONS

Students may not realize that only 12 American men have walked on the Moon, and the last time someone was there was in 1972.

Students may not know about the role of women in the space program, or understand that the space program was built using few computers.

DIFFERENTIATION

To support verbal reasoning in the class discussion, organize the class into groups for Think-Pair-Share instead of 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. Sharing encourages all students to participate and practice skills, including metacognition.

LEARNING PLAN

ENGAGE

Teacher Material: To The Moon Presentation

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

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

Place students into small groups for the warm-up. Score up to 5 points based on completeness and participation. Take no more than 5 minutes of class time to complete the warm-up. [DOK 2; infer, predict]

Possible student answers:
Not knowing the effects of space on the human body, creating a recoverable spacecraft, creating a rocket powerful enough to travel to space and return, having enough oxygen and basic essentials to endure the trip, determining how to dock spacecraft together.

Warm-Up

In groups of two or three, have students write a paragraph discussing what they think were the biggest challenges for the United States in sending a man to the moon. Allow for a brief discussion and then collect student work.

EXPLORE

Teacher Material: To the Moon Presentation

Slide 5: During a Think-Pair-Share exercise, ask students to consider what they must do to earn their driver's licenses and what skills they must possess to drive. Have them write down their answers. Ask students to also hypothesize (research if time allows) what qualifications astronauts must have to go to space. Students should share their answers with a partner, and then the teacher will lead a class discussion.

Questions

You may be preparing to learn how to drive. What steps do you need to take to earn your license/ What skills do you need to successfully drive a car?

Sample answers may include passing the driving test, written test, proof of citizenship or residency, certain number of hours of classroom instruction, a certain number of hours behind the wheel, some hours at night, vision test, parent permission. Skills will require ability to park, drive at a faster speed, understanding of rules, knowledge of the car's controls, etc.

When the first Americans became astronauts, they were preparing to fly something unknown to them, unlike learning how to drive a car. What skills do you think they would need?

These men were skilled military test pilots, very confident and competitive, as well as physically fit to handle the stresses put on the body when going into the unknown of space. They spent a lot of time in a classroom, studying, and training. They were willing to accept risks. Astronauts must have good vision, be able to handle emergency situations, etc.

Teaching Tips

For further explanation on the topic, you may show an additional video: "Classic NASA Film- Mercury Training" http://video.link/w/C8Ld (Length 2:47).

EXPLAIN

Teacher Material: To The Moon Presentation

Slide 6: President Eisenhower stated that he "would rather have a good Redstone than be able to get to the Moon, for we didn't have any enemies on the Moon." President Eisenhower was implying that he would rather focus spending funds on protecting the United States here on Earth rather than focus efforts on going to the moon.

The Redstone rocket was America's first large surface-to-surface missile and Eisenhower was worried about the impending threat of nuclear weapons by the Russians, as well as just ending the Korean War in 1953.

However, in 1961, John F. Kennedy made an announcement that the United States would send a man to the Moon before the end of the decade. This generated a lot of excitement and energy about space exploration.

Show students a video of JFK's speech at Rice University on September 12th, 1962 setting the goal of the space race during the 1960's.

- "We Choose To Go To The Moon" (Length 2:11)

  http://video.link/w/mcPd

Slide 7: Explain to students that three major NASA programs culminated in U.S. winning the space race.

Project Mercury was the first human spaceflight program and put the first U.S. astronaut into orbit. Project Gemini allowed the U.S. to prepare for the techniques that would eventually allow astronauts to land and walk on the moon. These included performing missions outside the spacecraft, space rendezvous and docking and extended duration missions in orbit. Project Apollo landed the first humans on the moon.

Slide 8: The Mercury Project lasted almost five years, the first flight occurring on May 5, 1961 and the last flight occurring on May 15-16, 1963.

Astronauts made a total of six spaceflights during Project Mercury. Two of those flights reached space and came right back down (called suborbital flights.) The other four flights went into orbit and circled Earth.

Alan Shepard made the first Mercury flight. That flight made him the first American in space. The 15-minute flight went into space and came back down.The Project Mercury spacecraft was a capsule, with 100 cubic feet of habitable space, just enough for one astronaut crew. The controls and switches inside the small capsule rivel what one would find inside a modern-day, medium-sized aircraft possessing a combination of switches, fuses, and levers totaling 120 controls. The spacecraft was equipped with environmental control systems, parachute systems, communications equipment, as well as the heat shield that protected the spacecraft upon reentry. One thing that the spacecraft did not have onboard were computers for calculations, relying solely on ground control to transmit the needed calculations.

Show a video of Alan Shepard's launch into space on Mercury 7.

- "The Mercury 7 and Shepard's Launch" (Length 0:56)
  http://video.link/w/G8Ld

Slide 9: The first American astronauts were military test pilots. They went through physical, psychological and mental examinations. On April 9, 1959, NASA announced the Mercury 7 program astronauts to the public at a press conference in Washington, DC.

Slide 10: The first Mercury spaceflight was a 15 min, 28 sec suborbital flight that put Americans in space and the last flight by Gordon Cooper lasted more than 34 hours to determine what effects one day in space might have on the human body.

Slide 11: The Gemini program helped get astronauts ready for Apollo moon landings.

The Gemini capsules were larger than Mercury capsules and could hold two astronauts instead of one. Unlike Mercury capsules, the Gemini capsules could vary which orbit they were flying in by adjusting their speed.

Gemini was used to prepare for trips to the moon by testing the effects of long-duration spaceflights on the human body. The program also completed the first successful spacewalks (extra-vehicular activity) and docked with other spacecraft.

Astronaut Ed White became the first American astronaut to venture outside of a spacecraft on Gemini 4. The first American spacecraft, Gemini 8, docked on March 16, 1966, with an unmanned spacecraft.

The Gemini module differed in that many of the components that were integrated into the Mercury capsule were, for the Gemini program, were contained in the adapter module. The Gemini module also contained computers, contrary to the Mercury module.

Slides 12-13: Now that NASA was one step closer to the moon by its accomplishments in Mercury and Gemini, it was ready for the next step.

Apollo was a three-part spacecraft-command module (crew quarters and flight control), service module (propulsion), and the lunar module (take crew to the lunar surface and return them).

The spacecraft used for the Apollo program was of a modular design, to accommodate the mission of landing on the moon. The command/service module was a two part system, the command module with similar shape and design to previous capsules, was this time large enough to carry three astronauts into space, and return them back home safely. The support module was was cylindrical and housed the extended life support systems, communications equipment, as well as an orbital instrument package, the support module also included a engine.

The second half to the modular system was the Lunar module, designed specifically to land astronauts on the moon, and then launch them off once again. The system, never needing to fly within earth's atmosphere was designed with little aerodynamic consideration in regards to shape as well as construction materials

Slide 14: In thinking about the space race, the Russians were first in many areas-first man in space (first to orbit the Earth, first woman in space, first man to complete a spacewalk, etc.) However, the United States claimed to have won the space race by being the first to put a man on the moon.

Ask students if they know what famous phrase Neil Armstrong said when he first stepped on the moon. A video replays the phrase.

- "Watch Neil Armstrong's first steps on the moon" (Length 00:26)

  https://video.link/w/kGiKb

Slide 15: After Neil Armstrong walked on the moon and the Apollo 13 near-tragedy, Americans lost interest in going to the moon. The United States settled for a more conservative space program, using leftover rockets. The tensions between the Soviet Union and the United States had reduced.

Slide 16-17: Explain to students that space exploration involves many people who have different yet important tasks. All of them are needed to support each mission.

Explain that at the beginning of the Space Race, NACA (the precursor to NASA) engineers didn't have calculators or computers to do math problems. Their research was slowed because they spent so much time doing calculations. In 1935, NACA hired five white women to serve as "computers" to complete calculations quickly. In the 1940s, NACA bought its first computer and it took up a huge room. These computers were slow and unreliable. NACA found the women to be more accurate, efficient, and didn't complain. They paid them less – cheap labor for a better job done.

In 1943, NACA hired the first African American women "computers." These women all had college degrees in mathematics and flourished although they faced racism and sexism.

Show the video about Katherine Johnson, who was highlighted in the full-length feature film Hidden Figures.

- "NASA Mathematician" (Length 3:42)
  http://video.link/w/98Ld

Slide 18: Dr. William Lovelace, a researcher who was a contractor for NASA, helped develop the tests for the Mercury 7 astronauts and wondered how women would do if taking the same tests. He asked Jerrie Cobb, an experienced pilot, to participate and she passed all three phases of testing. This encouraged Dr. Lovelace to test more women, and eventually, 13 more women passed the same tests. They never flew in space, although one of the women, Wally Funk, is planning to take a flight to space via Virgin Galactic. These women were referred to as the First Lady Astronaut Trainees (FLATs). Another name for these women was the Mercury 13.

Ask students what factors might have been involved in selecting the FLAT candidates. Although the women were pilots and had thousands of flight hours, (they were recruited through the 99's, an all female pilot association started by Amelia Earhart), women were not allowed to fly in the military in the 1960's so were not "qualified" to be astronauts according to NASA's eligibility requirements at the time.

EXTEND

Teacher Material: To The Moon Presentation
Student Material: To The Moon Student Activity

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

During the second session of the lesson, divide students into groups of three for a jigsaw exercise. Provide students with **To The Moon Student Activity.** Next, assign each student within the jigsaw groups one of the three NASA programs: Mercury, Gemini or Apollo. On an individual basis, have the students do research and complete the provided activity sheet for their assigned NASA program.

Once the students finish their activity sheets, have all the students assigned to the same NASA project get together to compare notes, resolve differences in their answers, and practice the presentations they will give when they reassemble into the original jigsaw groups.

To complete the jigsaw exercise, students will gather in their original jigsaw groups and make a 3- to 5-minute presentation on their assigned program. Each student should take notes during their classmates' presentations. Inform students they will use these notes to create a class timeline during the next session.

Collect student work and score up to 10 points based on completeness, accuracy, and student participation. [DOK-L2, L3; summarize, compare]

Formative Assessment

In groups of three, have students complete a jigsaw exercise where they research key details of the three NASA programs that contributed to the Space Race. The exercise will culminate by students making presentations about their assigned program to classmates.

Slide 20: During the first session of the third lesson, have students collaborate on a class timeline that will illustrate the three programs that led the U.S. to the moon. The timeline can be drawn on newspaper roll, poster board or on a whiteboard.

Divide students into three groups and assign each group one of the programs: Mercury, Gemini or Apollo.

Each student will add a different program milestone to the timeline. Ensure that students work together as a class to add the milestones in a sequential order.

EVALUATE

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

Individually, students will write a persuasive argument as to which of the three space programs were of greatest benefit to the United States in its goal to put a man on the moon. Their argument should include an introductory paragraph that "hooks" the reader, it should make a thesis statement that clearly establishes the writer's position, the body should include points of evidence supporting their thesis based on the knowledge they have gained about NASA's three space programs throughout the lesson, and an a concluding paragraph. [DOK-L3; compare, develop a logical argument]

Summative Assessment Scoring Rubric

- Follows assignment instructions
- Argument shows evidence of one or more of the following
    - A creative introduction that grabs the reader's attention
    - A clear position on the matter
    - Several points of strong evidence that supports the student's position using knowledge gained during the lesson
    - A concise conclusion
- Shows understanding of 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

Summative Assessment

Individually, students will write a persuasive argument as to which of the three space programs were of greatest benefit to the United States in its goal to put a man on the moon.

GOING FURTHER

This optional animated video of the space race may inspire students for a future project. http://video.link/w/f9Ld

Learn more about NASA women. https://www.nasa.gov/modernfigures

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.9-10.1** - Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
- **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** - 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.
- **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.9-10.8** - 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.
- **HSN-Q.A.1** - Reason quantitatively and use units to solve problems.
- **HSA-REI.B.3** - Solve equations and inequalities in one variable.

REFERENCES

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