Government and Commercial Space

Session Time: One, 50-minute session

DESIRED RESULTS

ESSENTIAL UNDERSTANDINGS

Aspire to the highest level of technical proficiency as it relates to flight operations and engineering practices. (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. If private companies are engaged in space exploration for profit, what is NASA's role?

LEARNING GOALS

Students Will Know

- How private space exploration companies developed
- Challenges and opportunities that exist when government and private industry work together in space exploration

Students Will Be Able To

- *Compare* goals and challenges that government and private industry have in exploration. (DOK-L3)
- *Summarize* challenges and opportunities for the private space industry. (DOK-L2)

ASSESSMENT EVIDENCE

Warm-up
After watching a rocket land on a drone ship, students will individually write their response to a question about the benefits of reusable space equipment.

Formative Assessment
To help students understand the level of private-sector investment happening today, they will research one established or start-up space company and present its mission and goals, capabilities, technologies, challenges, and its potential for future profit and success.

Summative Assessment
Check for student understanding by asking students to write answers to questions about private industry and its role in space exploration.

LESSON PREPARATION

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MATERIALS/RESOURCES

- Government and Commercial Space Presentation
- Government and Commercial Space Student Activity

LESSON SUMMARY

Lesson 1: Government and Commercial Space

This lesson will focus on the private space industry and its relationship with NASA. Students will be introduced to a variety of private space companies and their missions.

Students will watch a video of a SpaceX rocket landing on a drone ship. Students will discuss what they think some of the benefits of reusing rocket components might be. Teachers then will lead the class through a presentation about the "New Space Race." To help students understand the level of private-sector investment, students will complete individual research about one private space company. The lesson will conclude with students answering questions about private industry and space exploration.

BACKGROUND

In unit four, students studied the first "Space Race," which pitted the United States and the Soviet Union in a battle to be first on the moon. The "New Space Race" is between private companies that are attempting to make their marks (and make money) in the relatively new commercial space business.

MISCONCEPTIONS

Students may have some difficulty understanding the different roles that government and private industry play when it comes to space exploration.

DIFFERENTIATION

To support verbal reasoning in the class discussion, organize the class into groups for Think-Pair-Share instead of a whole group discussion in the **EXPLORE** section of the lesson plan. This allows learners to think about the questions, 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: Government and Commercial Space Presentation

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

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

Private space companies are pushing the boundaries of what it means to explore space. Show students the video of the SpaceX rocket landing on an aircraft carrier.

- "Successful Drone Ship Landing" (Length 1:01)

  http://video.link/w/LvMd

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Explain to students that a reusable launch system is capable of launching a payload into space more than once, it saves money, construction time, and more.

Ask volunteers to share their answers with the class. Allow for a brief discussion. Allow up to 5 minutes for the warm-up. [DOK-L1; stats, DOK-L2; infer]

Warm-Up

After watching the drone ship landing, students will individually write their response to the question: "What are the benefits of reusing rocket components?"

Questions

Possible responses:

The costs for launching becomes much cheaper as materials costs are reduced, space travel and launching payloads to space will become less expensive, saves time in building and construction, less waste is better for the environment.

EXPLORE

Teacher Material: Government and Commercial Space Presentation

Slide 5: Present the challenges for NASA that may make cooperation with private industry mutually beneficial.

NASA has goals to explore beyond where humans have gone before, such as Mars, and into deep space. This requires more funding than in the past. Sharing costs with the private sector to continue to make trips to the International Space Station allows NASA to invest in the pursuit of new frontiers in space.

Slide 6: Lead the class through a presentation on the "New Space Race." Explain that this "New Space Race" is an era of private space exploration that involves private industry.

Questions

Pose the question to students, "When thinking about these seven areas of current and future space exploration, where do you think private companies want to invest money and why?"

Responses may include: *living in space, space tourism, space mining, etc.*

EXPLAIN

Teacher Material: Government and Commercial Space Presentation

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Slides 7-10: Continue the discussion on the "new space race" with examples of how the private sector is investing in space exploration.

Slide 11: There are many challenges for private space companies. To begin, they face enormous research and development costs and oftentimes, there is no immediate revenue stream. Many of these companies are also very new and face a steep learning curve. They have very bold visions, but there are many questions about bringing many of their dreams to reality. Finally, getting to space is dangerous and its questionable if some of these new companies could withstand a major disaster or accident.

EXTEND

Teacher Material: Government and Commercial Space Presentation
Student Material: Government and Commercial Space Student Activity

Slide 12: Conduct the **Formative Assessment.**

Students will use the activity sheet to research a private company (real or start-up) that was mentioned during the presentation or they can research a different company. Provide each student with a copy of **Government and Commercial Space Student Activity.**

Students will imagine they are a consultant for a financial company and they have been assigned the task of identifying an established or start-up private space company the firm should make an investment in. Students will need to identify a company, understand its mission, goals and capabilities, describe the innovations and technologies the private space company has developed or will use to accomplish its mission, challenges this company is facing, and a description for its potential profit and success.

Ask volunteers to share their research and participate in a brief discussion. Allow up to 10-15 minutes for students to complete their research. [DOK-L3; investigate, DOK-L2; collect and display]

Formative Assessment

To help students understand the level of private-sector investment happening today, they will research one established or start-up space company and present its mission and goals, capabilities, technologies, challenges, and its potential for future profit and success.

Teaching Tips

If students are having difficulty finding a private space company, some suggestions include: SpaceX, Boeing, Lockheed Martin, Sierra Nevada, Orbital ATK, Blue Origin, Bigelow, Virgin Galactic, Mars One, and Deep Space Industries.

EVALUATE

Teacher Material: Government and Commercial Space Presentation

Slide 13: Conduct the **Summative Assessment**. Collect student work at the end of class and grade using the scoring rubric. [DOK-L3; compare, DOK-L2; summarize]

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Responses may include: *The private space industry might be able to assist NASA and create competition, which can lower prices and make space travel more cost effective. DIfficulties may include lack of regulation and also the conflict between safety and financial gain. Challenges for the space industry includes turning a profit, absorbing enormous research and development costs, and surviving a major disaster or accident.*

Summative Assessment Scoring Rubric

Follows assignment instructions

Student writing shows evidence of one or more of the following:

- Knowledge of how the government works with private industry in space exploration
- Understanding of the challenges that private industry faces when it comes to space exploration

Student writing shows an understanding of the concepts covered in the lesson

Student writing shows in-depth thinking including analysis or synthesis of lesson objectives

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

Ten minutes before the end of class, have students individually write a 3- to 5-sentence response to each question.

- Can the private space industry assist NASA? Do we really need them to?
- What difficulties do you see in government agencies and private companies working together?
- Describe a challenge that private industries have when it comes to space exploration.

GOING FURTHER

Students will use what they have learned in this lesson to envision their own private space company. They need to respond to the following:

- What would be your company's mission?
- How would it achieve this mission?
- What technology or innovation would you develop to complete this mission?
- What kind of skills would employees need at your company?
- What would you name your company?

Show students a SpaceX documentary about rocket reusability (Length 53:02)

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http://www.spacex.com/news/2013/03/31/reusability-key-making-human-life-multi-planetary

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
    - ETS2.B: Links Among Engineering, Technology, Science, and Society: Influence of Engineering, Technology, and Science on Society and the Natural World
- 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
    - ETS2.B: Links Among Engineering, Technology, Science, and Society: Influence of Engineering, Technology, and Science on Society and the Natural World
    - ETS1.C: Optimizing the Design Solution

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

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HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

- Science and Engineering Practices
    - Using Mathematics and Computational Thinking
- Disciplinary Core Ideas
    - ETS1.B: Developing Possible Solutions
    - ETS2.B: Links Among Engineering, Technology, Science, and Society: Influence of Engineering, Technology, and Science on Society and the Natural World
- Crosscutting Concepts
    - Systems and System Models

COMMON CORE STATE STANDARDS

- **RL.9-10.7** - Analyze the representation of a subject or a key scene in two different artistic mediums including what is emphasized or absent in each treatment.
- **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.

REFERENCES

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