The University of Texas at Austin
Environmental Science Institute

Space Sustainability

Lesson Plan for Grades: 12th grade
Length of Lesson: 90 minutes

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Subject area/course: Environmental Science

Materials:
- 15-20 devices with Internet connection
- 15-20 exploration handouts

TEKS/SEs:
§112.37. Environmental Systems
(3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to:
- (A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student
- (B) communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials;

Lesson objective(s):
- Students will be able to identify several functions of satellites.
- Students will be able to explain the importance of space sustainability in relation to future science and daily-life events.
- Students will be able develop a plan that could help sustain space using available resources.
- Students will be able to support their plan with factual evidence during class research.
- Students will be able to critique classmates' plans by providing supporting arguments and questionings.

Differentiation strategies to meet diverse learner needs:
- The lesson plan will utilize visual, oral, and hand-on research that would accommodate different learning styles.
- Students will learn to collaborate within their group and provide feedback to their classmates.
- The teacher will provide instructions verbally and visually, and will also be available to accommodate the students with any difficulties throughout the lesson.

ENGAGEMENT (15 minutes)
- Watch the video as a class (play from 2:30 to 5:15): Sustainability of Outer Space by Dr. Moriba Jah, https://www.youtube.com/watch?v=OvBl-Ju_FcQ
- The video talks about satellites and their benefits in daily-life functions (e.g. smartphone, weather forecast)
- Discuss the video with possible questions:
  - What is a satellite?
  - What are some functions of satellites?
  - What is the specific concern revolving space the video discusses? (Sustainability)

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- What are other benefits of space exploration? (Habitable planet discovery, inventions, raw materials, extraterrestrial life, etc.)

- Watch the video as a class (play from 7:50 to 10:55): Sustainability of Outer Space by Dr. Moriba Jah, https://www.youtube.com/watch?v=OvBl-Ju_FcQ
- The video discusses space debris, a huge obstacle to current and future space exploration.
- Transition into the exploration by saying: "Now it's your turn to find some ways to sustain space for future exploration."

EXPLORATION (30 minutes)

- Divide students into 4 groups (4-5 students/group), representing 4 major players/countries in space exploration: USA, China, Russia, and Japan.
- Following the handout below, groups will create a plan that would help sustain space using provided sources and more, including:
  - Identify the causes of space debris
  - Agreements between countries that are already in place to support space sustainability
  - Restrictions or limits on the existing agreements and their effectiveness
  - Resources utilized by your country to help fight space debris
  - Your country's available resources that are not yet allocated and how they can be used to solve the problem
  - Several proposals as to how sustain space (either locate existing plans or propose new ones with supporting evidence)
  - Proposals should include steps needed to be made by your country and collaboration between different countries as a whole to support space sustainability
- Students will choose to divide the work among their group as they see fitting. Equal efforts within group collaboration will be evaluated.

EXPLANATION (35 minutes)

- Each group will have 5 minutes to present their plan and 3 minutes for questions and criticism.
- Classmates will ask questions and critique the group's proposal constructively.
- The teacher will contribute to the discussion by asking guiding questions, such as:
  - Why is it difficult to effectively enforce an international agreement?
  - What are the costs of implementing your plan?
  - What could be changed or improved from the current methods being used?

ELABORATION (10 minutes)

- Teacher will redefine key vocabulary, including **space sustainability, satellites, and space debris**.
- Teacher will ask students to apply their knowledge to other problems by asking:
  - What is the connection between Earth and space sustainability? (Similarities, differences, and how can one support the other)
- Teacher will ask students to think-pair-share for discussion.

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EVALUATION (throughout the entire lesson)

- Evaluation will be assessed based on active participation (during class discussions), group collaboration (equal efforts are put in during exploration and explanation), and completion of exploration.
- There are no correct answers; the lesson is meant for the students to collaborate and design potential solutions to a current problem of society.

SOURCES AND RESOURCES

- ESA and the Sustainable Development Goals,
- Space Trash: The Next Big Pickle
- NASA's Sustainability Portal
- National Archives
- US Department of Defense Space Development
- Federal Aviation Administration
- China National Space Administration
- United Nations and China
- U.S. and China Relations in Space
- State Space Corporation Roscosmos
- The Moscow Times
- Russian Space Junk
- Japan Aerospace Exploration Agency
- Astroscale
- The Japan Times
- Secure World Foundation
- United Nations Office for Outer Space Affairs
- Space.com
- *Hot Science – Cool Talk* #121 "Sustainability of Outer Space" by Dr. Moriba Jah, https://www.youtube.com/watch?v=OvBl-Ju_FcQ

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Exploration: Space Sustainability

Group's name: Country:
Individuals' name:

Today, you will construct an elaborate plan that would help sustain space for future exploration!
Use this handout as a guide to come up with an out-of-this-world plan:

Step 1: Use the provided sources below to start your research:

USA:
NASA's Sustainability Portal
National Archives
US Department of Defense Space Development
Federal Aviation Administration

China:
China National Space Administration
United Nations and China
U.S. and China Relations in Space

Russia:
State Space Corporation Roscosmos
The Moscow Times
Russian Space Junk

Japan:
Japan Aerospace Exploration Agency
Astroscale
The Japan Times

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General sources:
Secure World Foundation
United Nations Office for Outer Space Affairs
Space.com

*As you do your research, these sources might take you to different websites. Feel free to utilize those additional sources, but remember to keep track of them and make sure they are credible sources! Some credible sources include TIME, New York Times, NPR, etc. Ask the teacher if you have questions.

Step 2: Use the questions below to guide your research

1) Define space debris. What are some causes leading to space debris?

2) Why is it important to sustain space?

3) What are some international agreements already made to help sustain space? Are they effective? Explain.

4) What are some measures made by your country to help fight space debris? How much is your country contributing to space debris?

5) Are the measures made by your country effective? Are there difficulties enforcing those measures?

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6) How can you utilize your country's available resources to support space sustainability? (e.g. increase NASA's funding)

7) What are some ways that multiple countries can come together to fight space debris (or ways to better enforce existing international agreements)?

8) What are some ways an individual can help with space sustainability?

9) List some facts and information you found interesting during your research.

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10) List some ways that your group came up with to help sustain space and arguments to why your methods would be effective.

    OR locate available methods that were or are being implemented (this could be from your country, other countries, private corporations, or individuals) and explain how effective these methods are and what could be improved.

Step 3: Using step 2, construct a plan for space sustainability that includes the following:

a) Existing international agreements on space sustainability, their effectiveness, and needed improvements.
b) Your country's measures to fight space debris or lack of those measures
c) Proposals as to how you can utilize your country's available resources to support space sustainability
d) Proposals as to how an individual can contribute to space sustainability
e) Identify at least 3 methods that were or are being implemented to sustain space and their effectiveness **OR** come up with your own ideas as to how to sustain space or decrease space debris and back them up with supporting facts.

*Plans can be in any format you want. Bullet points also work. Be clear and concise on your ideas.