



Intro to Sustainability: Spaceship Earth

Sustainability is an issue that students will need to address in the future. This lesson is designed to provide students with a basic definition of sustainability, and engage students with the concepts of systems thinking, complexity, trade-offs, and unintended consequences that are inherent to sustainability problems.

By participating in the Spaceship Earth activity, students have an opportunity to explore life-support systems and social systems that are required to keep a population functioning in a closed system. Students will work through the three pillars of sustainability, discussing how systems from the spaceship activity fit into one, two, or all three pillars. The lesson concludes with a brief conversation about sustainability problems on the national, state, city, and high school levels.

Before beginning, students should: think about what they know about sustainability, and be prepared to discuss their ideas.

Essential Question(s): What does sustainability mean, and why is it important? What do we need to create a sustainable society?

The objective of this lesson is to help students understand the characteristics and elements needed for a closed sustainable system.

At the end of the lesson, students will be able to:

1. *define sustainability in terms of present and future generations*
2. *describe life support and social systems needed to sustainably maintain a population*
3. *describe how features of an ecosystem relate to the three pillars of sustainability*
4. *think about sustainability challenges in the world around them*



Adapted by Laurel Kruke from "Introduction to Sustainability" lesson developed by Nigel Forrest and Auriane Koster, in conjunction with Tempe High School Sustainability project team (Jessica Hauer, Mary Bridget Nowicki, Rosanne Stapka, Mike Warner)

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Standards Addressed: *Science Strand 3: Science in Personal and Social Perspectives, Concept 1: Changes in Environment; Science Strand 3: Science in Personal and Social Perspectives, Concept 3: Human Population Characteristics; Science Strand 6: Earth and Space Science, Concept 1: Geochemical Cycles;*

Social Studies Strand 4: Geography, Concept 3: Physical Systems; Social Studies Strand 4: Geography, Concept 5: Environment and Society;

Common Core and 21st Century Skills: Environmental Literacy; Common Core and 21st Century Skills: Creativity and Innovation; Common Core and 21st Century Skills: Critical Thinking and Problem Solving

Themes: Systems thinking, scale

Skills: Team skills, problem solving skills

Key Vocabulary

Sustainability: *meeting the needs of a community, or a population, without compromising the ability of other communities, or future generations, to meet their needs.*

System: *an entity that behaves as a whole but is made up of individual components, which interact with each other (e.g. a bicycle is a system made up of a frame, pedals, chain, wheels, handlebars, brakes and a rider).*

Life Support Systems: *elements required to maintain life and healthy populations (e.g. food systems, water sources and cycles, energy and oxygen producing systems, and waste production and management systems).*

Social Systems: *systems required to support societal growth and community welfare (e.g. education systems, healthcare systems, safety and security considerations, governance strategies, and recreational considerations).*

Three Pillars of Sustainability: *three components that make up a sustainability problem or sustainable system; emphasis on the connections and relationships between Environmental, Social, and Economic elements of a system.*

Economy: *process by which goods and services are produced, distributed and consumed; the system within which jobs, markets, currency, etc. function in society.*

Environment: *surroundings and forces that act upon living organisms; ecosystems, landscapes, surroundings that impact people and other organisms.*

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Society: a community, nation, or broad grouping of people having common traditions, institutions, and collective activities and interests (Merriam-Webster); human society includes all the people in the world.

Closed Loop Systems: a system that relies only on internal components, and does not rely on matter or elements from outside of that system

Materials Needed

- **Spaceship Earth Worksheet pdf (1 copy for each student)**
- **Introduction to Sustainability PowerPoint slide presentation pdf**
- **Introduction to Sustainability PowerPoint slide notes pdf**

Safety Precautions: None

Teaching Instructions

Advanced Preparation

Prior to class, you should review the presentation and notes to familiarize yourself with the definition of sustainability and the activity. It will also be helpful to be prepared with an example of how a system fits into the three pillars of sustainability, in case the class needs an example to get the discussion started.

Engagement

1. Introduce Sustainability
 - a. Introduce the following problem: The Earth has been severely degraded to the point where it will no longer sustain our population. You and your team must design a spaceship to sustain survivors for 6,000 years. What can you do to make your spaceship system sustainable? What does that mean?
 - b. Ask students what they think of when they hear the term “sustainability.” Common answers may include recycling, protecting the environment, using resources wisely. Most students think about sustainability in environmental terms. This is a great opportunity to highlight that sustainability is about more than just the environment, and that’s what you will be talking about today.

Engagement

2. Define Sustainability
 - a. Introduce the Brundtland definition of Sustainability – meeting the needs of the present without compromising the ability for future generations to meet their own needs.

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- b. Go through the three main phrases of the definition with the students, asking what they think each phrase means:
 - i. Meets the needs” – what do we mean by “needs”; what are basic human needs? (see PPT Notes for examples)
 - ii. “the present” – what do we mean by “the present”? Discuss that the present doesn’t just mean the class at that second, but includes all people today (all countries, races, religions, etc.)
 - iii. “future generations” – what do we mean by future generations? This refers to generations beyond the students’ children. Encourage the class to think about considerations and consequences of their actions for the future. (See PPT Notes for additional questions.)
- c. Ask students why they think the concept of sustainability might be important. How will they apply it to the design of their spaceship? Particularly, what must they consider apart from the environment?

Exploration

3. Spaceship Earth Activity
 - a. Arrange the class into groups of 2-4 students.
 - b. Pass out worksheets. (1 worksheet for each person; you may collect at the end of class)
 - c. Describe the scenario. (See PPT Notes, or top of worksheet for instructions). The class will need to think of life support systems and social systems to help keep the population on their spaceship happy, healthy, and safe until their ancestors can return to Earth.
 - d. Have half the class work on the Life Support Systems section of the worksheet; have the other half of the class work on the Social Systems section of the worksheet. Give the groups ~10 minutes to go through their questions and jot down ideas.

Explanation

4. Class Discussion
 - a. Bring the class back together and go through each question as a group, letting the Life Support and Social Systems groups share their respective ideas. Have students fill out the table on their worksheet. (10-15 minutes)
 - b. Allow students to drive the discussion, but guide them by referring to the following features of a sustainable spaceship/planet:
 - i. Clean, renewable power
 - ii. Sustainable agriculture
 - iii. Hydrological cycle and water recycling/reusing technology
 - iv. Oxygen generating forest and ocean ecosystems
 - v. Closed loop cycles of production and consumption
 - vi. Stable population
 - vii. Social and gender equity (e.g. in employment)
 - viii. Diverse skills and abilities
 - ix. Meaningful roles and responsibilities for all
 - x. Different types of governance
 - c. Prompt students to reason why each of these may be necessary for

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sustainability and give examples of solutions to incorporate them.

Elaboration

5. Introduce the three pillars of sustainability (or three concentric circles) model of sustainability. Direct students to make notes on the diagram on the back of their worksheet.
 - a. Ask students to name systems or features discussed from the spaceship activity, and place them in one of the sustainability spheres.
 - b. Prompt students to start making connections between the various spheres, noting how systems can be interconnected in two or three circles.
 - c. Guide students through a few examples of systems. (Waste, agriculture, education are good examples to start with).
 - i. Food/agriculture example:
 1. Food fits into environment because of the plants and animals we eat, and the land that it takes to grow/raise them.
 2. Food can fit into society because of cultural aspects of production and consumption and its impacts on human health.
 3. Food fits into the economy because of supply and demand, the farmers who grow and sell, and the consumers who purchase.

Elaboration

6. Discuss sustainability efforts on national and local scales.
 - a. Ask students what efforts they have heard of in the United States, Arizona/Phoenix, and at their high school.
 - b. Possible examples:
 - i. National effort: BP Oil Spill
 - ii. Arizona/Phoenix efforts: Solar power/energy production, Reinvent Phoenix
 - iii. High school efforts: recycling, student clubs (are there specific initiatives at your high school?)
 - c. Ask students to think about how these sustainability efforts connect to the three pillars.

Evaluation

7. Student worksheets will reflect participation in the spaceship group planning session, class discussion of life-support and social systems and diagramming the three pillars/circles of sustainability.

Extension

8. You may return to the definition of Sustainability, perhaps at a later date, and ask students to re-evaluate the concept.
 - a. How have their definitions changed? What would they change about their spaceships now?

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- b. Would they include more or fewer components in their system? Are there features they consider important that did not seem important at first?
 - c. How do the systems of their idealized spaceship compare to the current systems on Earth?
9. Students may actually draw, diagram, or model their spaceship design, including descriptions of functions and connections among the systems. They could also label each part as to which pillar(s) of sustainability it addresses.

Additional Resources

The Sustainability Science for Sustainable Schools website includes another introductory lesson entitled Defining Sustainability.

<https://sustainableschools.asu.edu/files/2012/10/DefiningSustainabilityLessonPlan.pdf>

Sources for original lesson

Goekler, J. (2009). Teaching for the future: systems thinking and sustainability. In Grant, T, & Littlejohn G. (2009). *Teaching Green: The high school years*. New Society: Gabriola Island, B.C.

Facing the Future. People and the Planet.

Pfizer. Defining Sustainability. Pfizer's Green Chemistry.

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