



What is Sustainability and How to Assess Sustainability for 8th Grade Science

Unit Summary:

In this unit, students will learn the concept of sustainability, the three pillars of sustainability: economy, environment and society, common sustainability issues, as well as two sustainability assessment methods: Ecological Footprint and Water Footprint. In addition, students will also learn how to apply the three overlapping circles model to analyze real world cases to determine if a community is sustainable or not.

The topic of sustainability is not a traditional one covered in 8th grade Science. However, this unit is closely connected to units such as human impact on land and water. The cross units coverage of this unit demonstrates various impacts of human activities on the nature.

Students do need some prior knowledge in order to master the learning objectives. Students need the concept of observation and inference to identify features of the three overlapping circles model. Students also use their knowledge about renewable and not renewable energy sources, water cycle, as well as interconnections among ecosystems, to conclude whether a behavior is sustainable or not. The concept of water footprint is closely connected to the concept of water cycle.

Michigan Content Expectations:

S.IP.07.11 Generate scientific questions based on observations, investigations, and research.

S.IP.07.13 Use tools and equipment (spring scales, stop watches, meter sticks and tapes, models, hand lens, thermometer, models, sieves, microscopes, hot plates, pH meters) appropriate to scientific investigations.

S.IP.07.15 Construct charts and graphs from data and observations.

S.IA.07.11 Analyze information from data tables and graphs to answer scientific questions.

S.IA.07.12 Evaluate data, claims, and personal knowledge through collaborative science discourse.

S.IA.17.13 Communicate and defend findings of observations and investigations.

S.IA.07.14 Draw conclusions from sets of data from multiple trials of a scientific investigation to draw conclusions.

S.RS.07.14 Evaluate scientific explanations based on current evidence and scientific principles.

S.RS.07.15 Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.

S.RS.07.17 Describe the effect humans and other organisms have on the balance of the natural world.

E.ES.07.41 Explain how human activities (surface mining, deforestation, overpopulation, construction and urban development, farming, dams, landfills, and restoring natural areas) change the surface of the Earth and affect the survival of organisms.

E.ES.07.42 Describe the origins of pollution in the atmosphere, geosphere, and hydrosphere, (car exhaust, industrial emissions, acid rain, and natural sources), and how pollution impacts habitats, climatic change, threatens or endangers species.

Learning Objectives:

Students will be able to describe the concept of sustainability, sustainability assessment, ecological footprint, and water footprint.

Students will be able to describe the three pillars of sustainability: economy, environment and society, as well as the interconnection among them.

Students will be able to conduct Ecological Footprint Quiz and Water Footprint Quiz.

Students will be able to identify ways that can make their life style and water usage more sustainable.

Students will be able to conclude if a community is sustainable or not given the behaviors or features of the community.

Table of Lessons:

Lesson Title- Brief Description	Learning Objectives	NGSS Addressed	Materials
<p>1. What is Sustainability – This lesson will be built on the introduction to the concept of sustainability, the three pillars of sustainability reflected in a three overlapping circles model, and common sustainability issues, such as energy, pollution, climate change, deforestation, biodiversity loss, water, and environmental justice.</p>	<ul style="list-style-type: none"> • Students will be able to describe the three pillars of sustainability: economy, environment, and society. • Students will be able to draw the three overlapping circles model of sustainability. • Students will be able to describe common sustainability issues such as energy shortage, water shortage, deforestation, biodiversity loss, pollution, food insecurity, environmental justice, and unemployment. • Students will be able to categorize a sustainability issue into one of the three pillars: economy, environment, and society. 	<p>S.RS.07.15 Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.</p> <p>S.RS.07.17 Describe the effect humans and other organisms have on the balance of the natural world.</p> <p>E.ES.07.41 Explain how human activities (surface mining, deforestation, overpopulation, development, farming, dams, landfills, and restoring natural areas) change the surface of the Earth and affect the survival of organisms.</p> <p>E.ES.07.42 Describe the origins of pollution in the atmosphere, geosphere, and hydrosphere, (car exhaust, industrial emissions, acid rain, and natural sources), and how pollution impacts habitats, climatic change, threatens or</p>	<ul style="list-style-type: none"> • Computer with Microsoft PowerPoint, internet access, audio and projector • What is Sustainability Student Worksheet • What is Sustainability PowerPoints

		endangers species.	
<p>2. The connection among the three pillars of sustainability – The purpose of this lesson is for students to understand the connection among the three pillars of sustainability: environment, society and economy. In addition, to apply their knowledge about sustainability and the three overlapping circles model to assessing whether a community is sustainable or not and why.</p>	<ul style="list-style-type: none"> • Students will be able to describe to the connection among the three pillars of sustainability: environment, society and economy. • Students will be able to identify sustainability issues in a given case. • Students will be able to categorize sustainability issues into appropriate sustainability pillars. • Students will be able to conclude whether a given case is sustainable or not. • Students will be able to describe the way in which the three pillars of sustainability: economy, society and environment interact with each other. 	<p>S.RS.07.15 Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.</p> <p>S.RS.07.17 Describe the effect humans and other organisms have on the balance of the natural world.</p> <p>S.RS.07.18 Describe what science and technology can and cannot reasonably contribute to society.</p> <p>E.ES.07.41 Explain how human activities (surface mining, deforestation, overpopulation, development, farming, dams, landfills, and restoring natural areas) change the surface of the Earth and affect the survival of organisms.</p>	<ul style="list-style-type: none"> • Computer with Microsoft PowerPoint, internet access, audio and projector. • The Interactions Among Three Pillars of Sustainability Student Worksheet • The Interactions Among Three Pillars of Sustainability PowerPoints • Reading material: Eater Island Sustainability
<p>3. How to assess sustainability – Ecological Footprint. In this</p>	<p><u>Students will be able to:</u></p> <ul style="list-style-type: none"> • Explain what the data contained in a chart mean. 	<p>S.IP.07.11 Generate scientific questions based on observations,</p>	<p>Per class</p> <ul style="list-style-type: none"> • Cutting board • Knife

<p>lesson, students will be introduced to the concept of ecological footprint as a tool for sustainability assessment. The teacher will conduct the “Imagine the Earth as an Apple” demonstration to engage students’ interest. Students will conduct the My Ecological Footprint Quiz online and analyze the impact of their lifestyle on the Earth. Students will also identify categories in which they have the greatest and smallest footprint and changes they could make to reduce their footprint.</p>	<ul style="list-style-type: none"> • Conclude according to data from multiple charts. • Conduct the Ecological Footprint Quiz on line. • Record their ecological footprint for food, mobility, shelter, and goods/services. • Calculate their total footprint. • Calculate how many planets he/she will need based on his/her ecological footprint. • Compare his/her ecological footprint with that of his/her classmates’, the average footprint of someone living in the United States, the average footprint of people living in other countries, as well as the average footprint for the world, and conclude whose life style is more sustainable. • Identify the category in which he/she has the greatest footprint. • Identify three areas that he/she can make changes to reduce his/her total footprint. 	<p>investigations, and research.</p> <p>S.IP.07.12 Design and conduct scientific investigations.</p> <p>S.IP.07.16 Identify patterns in data.</p> <p>S.IA.07.11 Analyze information from data tables and graphs to answer scientific questions.</p> <p>S.IA.07.12 Evaluate data, claims, and personal knowledge through collaborative science discourse.</p> <p>S.IA.17.13 Communicate and defend findings of observations and investigations.</p> <p>S.IA.07.14 Draw conclusions from sets of data from multiple trials of a scientific investigation to draw conclusions.</p> <p>E.ES.07.41 Explain how human activities (surface mining, deforestation, overpopulation, construction and urban development, farming, dams, landfills, and restoring natural areas) change the surface of the Earth and affect the survival of organisms.</p>	<ul style="list-style-type: none"> • Apple • Ecological Footprint Student Worksheet • Ecological Footprint PowerPoints <p>Per student</p> <ul style="list-style-type: none"> • Computer with internet access
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<p>This lesson will introduce to students the concept of water footprint. Students will conduct a water footprint quiz and analyze how is their use of water impact the Earth's water.</p>	<p><u>Students will be able to:</u></p> <ul style="list-style-type: none"> • Calculate how much percent of the Earth's water is drinkable. • Summarize why not all the Earth's fresh water is useable. • Describe the following definitions: water footprint, direct water use, indirect water use, and product water footprint. • Calculate their water footprint. • Compare their water footprint with the U.S. average and their classmates. • Conclude why they have higher or lower water footprint than U.S. average and their classmates. 	<p>S.RS.07.15 Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities. S.RS.07.17 Describe the effect humans and other organisms have on the balance of the natural world. E.ES.07.41 Explain how human activities (surface mining, deforestation, overpopulation, development, farming, dams, landfills, and restoring natural areas) change the surface of the Earth and affect the survival of organisms.</p>	<ul style="list-style-type: none"> • Computer with Microsoft PowerPoint, internet access, audio and projector • Water Footprint Student Worksheet • Water Footprint PowerPoints
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Safety Considerations:

Lesson 3 – Use caution when slicing the apple.

Evaluation Plan:

In order to assess students' understanding to the new concepts and tools, four work sheets will be given to students for each lesson: what is sustainability Student Worksheet, the interactions among the three pillars of sustainability student worksheet, ecological footprint student worksheet, as well as water footprint student worksheet. What is sustainability student worksheet aims to give students the opportunity to observe the three pillars of sustainability model and make reference about what are the three pillars, their relationship, and what means to achieve sustainability. The interactions among the three pillars of sustainability student worksheet will have students make conclusions about sustainability issues in the Eater Island community and which pillar they belong to, after reading the

Easter Island Sustainability article. The ecological footprint and water footprint worksheet will be used for students to record their personal impact on land and water, as well as explore how they can live a more sustainable life.

Resources (websites):

<http://www.history.com/topics/easter-island>

This webpage provides a brief history of the Easter Island in texts and some videos.

www.footprintnetwork.org

This is the website for Global Footprint Network. It contains comprehensive information about ecological footprint, including scientific research results and a ecological footprint calculator.

<http://www.footprintnetwork.org/en/index.php/GFN/page/calculators/>

This is the webpage students will get on to do their ecological footprint quiz.

http://www.footprintnetwork.org/en/index.php/GFN/page/footprint_data_and_results/

This webpage contains information about a report done by the National Footprint Accounts, tracking how humanity's demand on nature across over 200 countries and regions.

<http://www.waterfootprint.org/?page=files/home>

The website of Water Footprint Network. This website contains comprehensive information about product footprint, national footprint, and scientific research data about water footprint.

<http://environment.nationalgeographic.com/environment/freshwater/change-the-course/water-footprint-calculator/>

This is the webiste where students will take their water footprint quiz.

Brief description of how this unit relates to your graduate research. (1 page):

My graduate research is about the sustainability of China's biofuels production with a focus on water-related impacts. Sustainability has three pillars: economy, environment and society. In order to achieve real sustainability, all three pillars have to be addressed. Each pillar is associated with various sustainability issues. These concepts will be introduced in lesson 1.

The three pillars of sustainability are connected to each other and they are equally important in order to achieve sustainability. One pillar's unsustainability can often cause problems in other pillars. One common mistake we make is emphasize the economy pillar and ignore environment and society pillars, which is why we are having so many environmental and social issues around the world now a days. A lesson (lesson 2) is designed to look at a classical case of sustainability – Easter Island, in order for students to see how one pillar's (in this case the environment) fall can cause issues in the other two pillars, even causing one community to almost die out.

In order to know if we are on the right track to sustainability, various ways of sustainability assessment can be adopted. A common way to evaluate a person, a community or a country's general impact on the Earth is by measuring his/her or their ecological footprints. By looking at our ecological footprints, we can identify areas that have larger footprints and make effort to reduce footprints in these areas. The concept of ecological footprint will be introduced in lesson 3.

Since my research has a focus on water-related impacts of biofuels production, I would like to introduce to students the concept of a water footprint, another way of sustainability assessment. In addition, I would like students to understand that there are direct and indirect use of water. Indirect use of water, such as biofuels production, even though is not obvious to students, can have large impacts on both water quality and quantity. Through lesson 4, students will be able to have knowledge about human activities' impact on water.