

Unit 1 Title: Introduction—What is Sustainability?

Grade Level: 9-12

Summative Prompt/Essential Question: What is Sustainability?

Standards:

Earth and Human Activity

1. **HS-ESS3-3:** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
2. **HS-ESS3-5:** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

Duration: 50 minutes

Unit 1—Introduction: What is Sustainability?

Learning Goals

1. Students will demonstrate their knowledge and sustainability ambition via a pre-assessment.
2. Students will be able to define sustainability in both an academic and personal context.
3. Students will observe the effects of resource depletion in the context of sustainability.

Materials/Activities

4. Sustainability NOW Pre-Assessment
5. Sustainability NOW Student Workbook
6. “Sustainability Easily Explained” Video
https://www.youtube.com/watch?v=_5r4loXPyx8
7. 1 roll of masking or painter’s tape
8. 2 sets of chopsticks or sticks of some kind
9. Assorted snacks or candy
10. 2 Cups or bowls

Teacher & Student Actions

11. Distribute pre-assessments—Content Knowledge & Sustainability Ambition Surveys (10 minutes)
12. Distribute ‘Sustainability NOW’ Student Workbooks.
13. Refer to Unit 1 in ‘Sustainability NOW’ Workbook.
 - a. Instruct students to read the unit (5 minutes)
14. Students will then view the “Sustainability Easily Explained” Video (5 minutes)
15. **Activity**—*Fishing/Sustenance Exercise in Sustainability* (10 minutes)
 - a. Divide students into two groups
 - b. Draw a lake on floor (large enough for two groups to gather on each side) with the masking or painter’s tape.
 - c. Scatter the snacks or candy into the ‘lake’ (approximately double the amount of candy or snacks per total participants)
 - d. Provide students with an overview of the situation:

- i. The two ‘tribes’ of students live next to this lake and share the resources (fish) for their own sustenance.
- ii. Each group must choose a designated ‘Fisherperson’ who’s goal is to capture 1 snack or piece of candy for everyone in their group.
- iii. Rules:
 - 1. The fisherperson can only use 1 set of chopsticks to capture their ‘fish’ and cannot go into the lake or cross the tape.
- e. After explaining the rules/guidelines above, instruct students to ‘fish’ for 1 minute, observing to ensure that students are adhering to the rules and guidelines.
- f. Then, replenish the ‘lake,’ adding about 1-2 snacks or pieces of candy to what’s already left in the lake for each participant.
- g. Instruct ‘fisherpersons’ to fish once more for 1 minute.
 - i. Rules:
 - 1. Fisherpersons can now put one foot into the lake and use their hands to sweep fish out of the lake area.
- h. After replenishing the lake one last time for 1 minute (same parameters as above), instruct the fisherperson to harvest the lake one final time.
 - i. Rules:
 - 1. Fisherpersons can now use their hands, chopsticks, and a solo cup to shovel fish out of the lake.

At this point in the activity, the ‘lake’ will become sparsely populated, allowing students to see the effects of over-harvesting/hunting and the environment’s inability to keep pace with the devastation in its regeneration of resources.

16. Group Activity/Reflection: divide students into groups and have students discuss/complete the reflection in their ‘Sustainability NOW’ workbook (10 minutes)

- a. What happened to the population of ‘fish’ in the lake when the fisher person was given more tools to fish?
- b. As our global population increases and new technologies/tools make processes like fishing easier, do you think this can do more harm than good? Why or why not?

17. Individual Journal Reflection: at the conclusion of Unit, students will answer the following question in their ‘Sustainability NOW’ journal reflection (10 minutes)

- a. What does sustainability mean to you?

References

Sustainability Easily Explained. (2012, July 25). Retrieved December 06, 2017, from https://www.youtube.com/watch?v=_5r4loXPyx8

Unit 2 Title: Climate Change

Grade Level: 9-12

Summative Prompt/Essential Question: How does Climate Change affect matters of sustainability in a global and local context?

Standards:

Earth and Human Activity

1. **HS NGSS Storyline** (*Based on CA State Standards*): Ecosystem Stability & the Response to Climate Change. Students use computer models to investigate how Earth's systems respond to changes, including climate change. They make specific forecasts and design solutions to mitigate the impacts of these changes on the biosphere.
2. **HS-ESS3-5**: Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
3. **HS-ESS3-6** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

Planning and Carrying Out Investigations

1. **HS-PS2-5**: Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

Analyzing and Interpreting Data

1. **HS-PS2-1**: Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Duration: 50 minutes

Learning Goals

1. Students will understand the relationship between the carbon cycle, CO₂ emissions, and human activity associated with climate change.
2. Students will understand the local effects of climate change in the form of ocean acidification and its correlation to climate change.

Materials/Activities

1. Sustainability NOW Student Workbook
2. <https://www.climateinteractive.org/tools/climate-bathtub-simulation/>

Teacher & Student Actions

3. Refer to Unit 2 in 'Sustainability NOW' Workbook.
 - a. Instruct students to read the unit (5 minutes)
 - b. Distinguish Climate vs. Weather as covered in the student workbook (5 minutes)

4. **Activity:** Climate Bathtub Simulation (15 minutes)

a. *Purpose:*

- i. This exercise will allow students to explore what happens if we cap carbon emissions at current levels, encourage their unlimited use, or reduce them. Students will use this simple animated simulation of the global carbon system to explore the relationship between carbon emissions and atmospheric CO₂.
- b. Direct students to the following link:
<https://www.climateinteractive.org/tools/climate-bathtub-simulation/>
- c. Explain the basics of the carbon cycle:
 - i. The carbon cycle is how the earth redistributes or ‘spreads-out’ carbon.
 - ii. Plants use both carbon dioxide and sunlight to make their food—a process called photosynthesis. Plants retain this carbon dioxide, and when they die, this carbon dioxide becomes fossil fuels like coal and oil over millions of years.
 - iii. This is a natural process of redistribution. However, when we burn fossil fuels, the carbon dioxide travels into the atmosphere. If too much accumulates, it acts like a blanket, trapping the carbon dioxide in our atmosphere, which increases temperatures and correlates with climate change.
- d. Explain the bathtub and its parts (i.e. Inflow=emissions, outflow= removals, & water in tub = CO₂ in the atmosphere).
- e. Next, press play on the simulation and pause the video around 1970. A good question to ask students at this point is why the CO₂ levels are increasing (because we are emitting more CO₂). Explain to students that more carbon is going in than coming out—stress this point throughout the activity. Emissions exceed removals.
- f. Hit play once more until 2007 or so. Again, emissions are exceeding removals.
- g. Next, divide students into manageable groups. Write the following ‘challenge’ on the board:
 - i. Choose a future that will keep CO₂ levels below 450ppm
 - ii. After about 5 minutes, students will discover that there is no way to prevent the tub from overflowing other than reducing the levels of CO₂ in the atmosphere.
 - iii. Ask students to complete the following discussion questions individually:
 - i. What happened when you selected the ‘Allow Increased CO₂ Emissions’ option? Is that option or choice sustainable? What are some real-life examples of ‘Allowing Increased CO₂ Emissions’?
 - ii. What happened when you selected the ‘Level off CO₂ Emissions’ option? Is that option or choice sustainable? What are some real-life examples of ‘Leveling off CO₂ Emissions’?
 - iii. What happened when you selected the ‘Reduce CO₂ Emissions’ option? Is that option or choice sustainable? What are some real-life examples of ‘Reducing CO₂ Emissions’?
 - iv. Is there a correct answer with respect to these options? What should we do?

After the Climate Bathtub Simulation activity, students will remain in their groups for a closing lab on one of the local effects of climate change, ocean acidification.

Learning Goals

1. Students will understand the local effects of climate change in the form of ocean acidification and its correlation to climate change.

Materials/Activities

5. Several Pyrex beakers, at least 6 inches tall with an opening of at least 4 inches wide
6. Water, freshwater or seawater
7. pH indicator paper or meters
8. Red Cabbage Juice indicator
 - a. To create a red cabbage indicator, chop $\frac{1}{2}$ red cabbage and simmer it in water until the cabbage loses its color. Cool, then strain the cabbage water into a glass jar and store it in the fridge until ready for use. Key: Acidic solutions, red=pH 2, purple=pH 4; neutral: violet pH 6, blue pH 8; basic, blue-green=pH 10 and lastly green-yellow=pH 12).
9. Dry ice (only the instructor will touch the dry ice)
10. Gloves, goggles, tongs
11. Hammer and/or screw driver to chip dry ice
12. Ice chest to store dry ice

13. **Activity:** Local Effects of Climate Change, Ocean Acidification (15 minutes)
 - a. First, divide students into groups.
 - b. Next, write the following steps on the whiteboard:
 - i. Pour water into the Pyrex beakers until approximately $\frac{1}{2}$ full
 - ii. Use the pH strip or meter to assess the pH (document this in the Sustainability 'NOW' workbook.
 - iii. Add cabbage juice to water (should change the color to a bluish-purple)
 - iv. Test the pH again, noting the results in the workbook. Take a picture of the solution with your cell phone to refer to later
 - v. Ask your instructor to put a piece of dry ice into the mixture and observe the effects, taking notes in your Sustainability NOW workbooks.
 - vi. While the dry ice is being added, explain to students that dry ice is a form of solid carbon dioxide and that the effect they're observing is called sublimation, or changing from a solid to a gas.
 - vii. Conclude the lab by lecturing on the following points:
 1. When carbon dioxide (dry ice) is added to water, the process of sublimation begins, which represents what is happening to our oceans as carbon dioxide levels continue to build on planet earth. Connect this to the earlier activity, there's no outlet for the level of carbon emissions we're experiencing—that means the carbon is trapped in our atmosphere and oceans. Effectively, the process that students are observing is our oceans becoming more acidic as a result of this excess carbon.
18. Clean-up (10 minutes)
19. To conclude, students will write an **Individual Journal Reflection** question in their 'Sustainability NOW' workbook (5 minutes)

References

Climate Bathtub Simulation. (2017, July 11). Retrieved December 06, 2017, from <https://www.climateinteractive.org/tools/climate-bathtub-simulation/>

Climate Kids. (n.d.). Retrieved December 06, 2017, from <https://climatekids.nasa.gov/climate-change-meaning/>

Jones, D. et al. (2007, July 19). Climate Bathtub Sim Coach Notes and FAQs. Retrieved December 5, 2017, from https://www.climateinteractive.org/wp-content/uploads/2014/01/Climate_Bathtub_Sim_Facilitator_Guide.pdf

Ocean Acidification Demonstration. (n.d.). Lecture. Retrieved December 5, 2017, from http://www.cisanctuary.org/ocean-acidification/PDFs-WorkshopPage/Hands_on_activities/OA_dry_ice_demo.pdf

Resource Issues: Climate Change. (n.d.). Retrieved December 06, 2017, from <https://montereybay.noaa.gov/resourcepro/resmanissues/climatechange.html>

Unit 3 Title: Population Growth

Grade Level: 9-12

Summative Prompt/Essential Question: How does population growth affect matters of sustainability in a global and local context?

Standards:

Earth and Human Activity

1. **HS-ESS3-3:** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.

Ecosystems: Interactions, Energy, and Dynamics

1. **HS-LS2-1:** Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

Duration: 50 minutes

Learning Goals

1. Students will be able to identify changes in global population over the past 2,000 years and identify reasons why unfettered population growth can impact matters of sustainability in a local and global context.

Materials/Activities

1. Sustainability NOW Student Workbook
2. <http://www.populationeducation.org/content/world-population-video>
3. <http://worldpopulationhistory.org/map/1/mercator/1/0/25/>
4. Whiteboard or Butcher Paper (Discussion Question Share-Back)
5. Butcher Paper for Group Posters (enough for several small groups)

Teacher & Student Actions

1. Begin by showing the World Population Video at the link above (10 minutes)
2. Divide students into groups to answer the following question in their Sustainability NOW workbooks. In answering the question, students can refer to the corresponding 'map' at the following link: <http://worldpopulationhistory.org/map/1/mercator/1/0/25/>
 - a. When did you notice the most growth in global population? Identify 3 events, scientific/technological innovations, and social changes contributed to rise in global population.

3. Students will then present their answers to the class, selecting one team member to write the responses on the whiteboard.
4. Once students have answered the discussions questions, ask the students to remain in their groups. Students will then research the effect of population growth in a local context. Ask students to find one article online that demonstrates the effect of population growth on the local environment (Bay Area, Santa Cruz, or Monterey).
5. Once students have identified an article, they will summarize the findings in a brief presentation accompanied by a poster wherein students can work together to showcase their creativity/artistic abilities.
 - a. Guidelines:
 - i. Every group must create a poster that creatively expresses the main point of their article.
 - ii. Every group must present their findings to the class and offer a potential solution for the aforementioned ‘local’ challenge associated with population growth.
 - iii. At the conclusion of the presentations, students will select a group that offered the best solution to said challenge.

References

(2015, October 02). Retrieved December 06, 2017, from <http://www.populationeducation.org/content/world-population-video>

World Population History. (n.d.). Retrieved December 06, 2017, from <http://worldpopulationhistory.org/map/1/mercator/1/0/25/>

Unit 4 Title: Technological Automation

Grade Level: 9-12

Summative Prompt/Essential Question: How does technological automation affect matters of sustainability in a global and local context?

Standards:

HS Engineering and Design

1. **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.

Duration: 50 minutes

Unit 4: Technological Automation

Learning Goals

1. Students will be able to identify specific industries that will be impacted by the threat of automation in a local and global context.

Materials/Activities

1. Sustainability NOW Student Workbook
2. “Job losses due to automation could hit retail industry hardest” CBS This Morning Video
https://youtu.be/_hERITbwSy4
3. KQED Video (For Breakout Groups)
 - o <https://ww2.kqed.org/education/2016/05/13/will-robots-replace-us-at-work/>

Teacher & Student Actions

1. Begin by showing students the “Job losses due to automation could hit retail industry hardest” CBS This Morning Video https://youtu.be/_hERITbwSy4 (5 minutes)
2. Divide students into break-out groups.
3. Once students are in groups, refer to Unit 4 in their ‘Sustainability NOW’ Workbook.
 - o Instruct students to read the unit and watch the KQED Video (10 minutes)
4. Students will research the effect of automation in the local context (35 minutes)
 - o Refer students to this example:
<https://www.bizjournals.com/sanjose/news/2017/06/06/salinas-valley-agriculture-tech-farming-robots.html>
 - o Guidelines:
 - Once students have identified an industry, they will complete the concept map in their Sustainability ‘NOW’ Workbook.
Instructions:
 - In the center of the map, name the industry that will be affected by technological automation.
 - After listing your industry, please identify three potential causes for automation in the industry you identified (ex. Labor shortage) on **the top row**.
 - After listing causes, please work with your group to determine three potential impacts (ex. Loss of Employment/Wages) on **the bottom row**.
 - Once complete, students will share their concept map with their peers.

References

Job losses due to automation could hit retail industry hardest [Video file]. (n.d.). Retrieved December 5, 2017, from https://youtu.be/_hERITbwSy4

Rotman, D. (2015, June 16). Who Will Own the Robots? <https://www.technologyreview.com>. Retrieved December 5, 2017, from <https://www.technologyreview.com/s/538401/who-will-own-the-robots/>

Schaber, Olivia. (2017, June 6). “Robots take over traditional farming practices, but not jobs, in the ‘Silicon Valley of agriculture’” . Retrieved September 09, 2017, from <https://www.bizjournals.com/sanjose/news/2017/06/06/salinas-valley-agriculture-tech-farming-robots.html>

Unit 5 Title: Finding Your Voice

Grade Level: 9-12

Summative Prompt/Essential Question: How can we impact matters of sustainability (Climate Change, Population Growth & Technological Automation) in the local context? How do we advance the narrative toward solutions?

Standards:

Weather and Climate

1. **HS-ESS2-6 & HS-ESS2-4:** Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.

Duration: 50 minutes

Learning Goals

1. Students will demonstrate their knowledge and sustainability ambition via a post-assessment.
2. Students will be able to identify their carbon footprint, and outline steps to reduce their impact on the environment in a local context.
3. Students will understand how to utilize collaboration and cooperation as means by which to advance their goals/objectives.

Materials/Activities

4. Sustainability NOW Student Workbook
5. http://myfootprint.org/en/visitor_information/
6. http://myfootprint.org/en/take_action/reduce_your_footprint/
7. <https://www.youtube.com/watch?v=eRLJscAlk1M>
8. 2 Red/Green Cards (One-side red, the other side green)

Teacher & Student Actions

9. Students will begin by taking the “My Carbon Footprint” Assessment (10 minutes)
 - a. Once students receive their ‘Ecological Footprint,’ instruct them to document it in their ‘Sustainability NOW’ workbook.
10. Next, students will click the ‘Reduce your Footprint’ button, which will take them to the following link: http://myfootprint.org/en/take_action/reduce_your_footprint/
11. Using the examples listed, students will then complete the ‘Reducing Your Footprint’ Worksheet in the ‘Sustainability NOW’ workbook (10 minutes)
12. **Activity:** Red-Green Game (20 minutes)
 - a. Purpose: The goal of this game is to teach students that by communicating and collaborating with one another, we are more likely to achieve shared goals and objectives. Students will understand that operating purely on self-interest works against mutual goals and objectives.
 - b. Divide the classroom into two groups of students and have them form a line, with each line facing one another. Explain the Red-Green Game:
 - i. The player at the head of each line will be given a card that is red on one side and green on the other.

- ii. Every person in line will have a chance to compete against his or her counterpart in the opposing team's line.
- iii. Students will take turns showing one side of the card to the opposing team member, with the instructor observing which color each student chooses to show.
- iv. There are two rounds.
- v. They will be awarded points depending upon the side of the card they show and the side their opponent shows as follows:
 1. If you show green and your opponent shows green, you each get 3 points.
 2. If you show green and your opponent shows red, you get 1 point, your opponent gets 4 points.
 3. If you show red and your opponent shows green, you get 4 points, your opponent gets 1 point.
 4. If you both show red, you each get 2 points.
- vi. Rules:
 1. No clarifying questions will be answered outside of these rules.
 2. No talking unless the instructor permits it.
 3. Both teams try to score as many points as possible.
- vii. Start the Game:
 1. First Round: Students will go through one cycle, with every student having a chance to choose which color they elect to show. The instructor will tally the results as they game goes.
 2. Once the first round is complete, scores will be tallied. In general, students tend to show red because their chances of scoring more points is higher.
 3. Students now have an opportunity to strategize with their peers for approximately 5 minutes.
 4. Second Round: Students will once again go through one cycle, with every student having a chance to choose which color they elect to show. The instructor will continue to tally the results.
 5. Once the second round is complete, complete the tally. In general, students tend to select green, as it is more consistent in points awarded. This is because students have had an opportunity to strategize and realize that by showing green, and cooperating/communicating with one another, they can ensure their collective or mutual success.

13. Next, show the video “Dear Future Generations” Video (5 minutes)

<https://www.youtube.com/watch?v=eRLJscAlk1M>

- a. Stop the video at 4:50

14. Instruct the students to complete the Sustainability NOW Post-Assessment.

15. Individual Journal Reflection: at the conclusion of Unit, students will read “Unit 5: Finding your Voice” and answer the same question addressed in Unit 1 journal reflection (10 minutes)

- a. What does sustainability mean to you?

References

Ea, P. (2015, April 20). Dear Future Generations: Sorry. Retrieved December 06, 2017, from <https://www.youtube.com/watch?v=eRLJscAlk1M>

My Ecological Footprint. (n.d.). Retrieved December 06, 2017, from <http://myfootprint.org/>

Shapiro, D. (n.d.). Teaching about Teaching Sustainability. Lecture. Retrieved December 5, 2017, from <https://serc.carleton.edu/bioregion/examples/59400.html>