Sustainability NOW

Teacher Lesson Plans

UC SANTA CRUZ Educational Partnership Center
Creating college-bound communities

UC SANTA CRUZ GEAR UP
I'm Going To College
Educational Partnership Center

Unit 1: What is Sustainability?

Grade level: 9-12

Essential Question: What is sustainability?

Duration: 50 minutes

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 geo-science 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**.**

Learning Goals

- Students will understand the concept of sustainability and the consequences of depleting resources without regenerative interventions and considerations.

Materials Needed

- Sustainability NOW Pre-Assessment & Sustainability NOW Student Workbook
- "Sustainability Easily Explained" video
- 1 roll of masking or painter's tape
- 2 sets of chopsticks or sticks of some kind
- Assorted snacks or candy
- 2 cups or bowls

Structure / Activity

- Distribute pre-assessments **(10 minutes)**
- Distribute *Sustainability NOW Student Workbooks* **(5 minutes)**
  - Refer to Unit 1 in *Sustainability NOW Student Workbook*
  - Instruct students to read the unit
- Students will then view the "Sustainability Easily Explained" Video **(5 minutes)**

Unit 1: What is Sustainability?

Structure / Activity Continued

- Fishing/Sustenance Exercise in Sustainability **(10 minutes)**
  - Divide students into 2 groups.
  - Draw a lake on the floor (large enough for 2 groups to gather on each side) with the masking or painter's tape.
  - Scatter the snacks or candy into the "lake" (approximately double the amount of candy or snacks per total participants).
  - Provide students with an overview of the situation:
    - The 2 groups of students live next to this lake and share the resources (fish) for their own sustenance.
    - Each group must choose a designated fisher that will capture 1 snack or piece of candy for everyone in their group.
    - Rules:
      - The fisher can only use 1 set of chopsticks to capture their fish and cannot go into the lake or cross the tape.
  - After explaining the rules above, instruct students to fish for 1 minute.
  - Then, replenish the lake, adding about 1-2 snacks or pieces of candy to what's already left in the lake for each participant.
  - Instruct fishers to fish once more for 1 minute.
    - Rules:
      - Fishers can now put one foot into the lake and use their hands to sweep fish out of the lake area.
  - After replenishing the lake one last time for 1 minute (same parameters as above), instruct the fisher to harvest the lake one final time.
    - Rules:
      - Fishers can now use their hands, chopsticks, and a cup or bowl 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.

Group Activity / Reflection

- Divide students into groups and have students discuss/complete the reflection in their *Sustainability NOW Student Workbook* **(10 minutes)**
  - What happened to the population of fish in the lake when the fisher was given more tools to fish?
  - 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?

Individual Journal Reflection: at the conclusion of unit, students will answer the following question in their *Sustainability NOW Student Workbook* journal reflection **(10 minutes)**

- What does sustainability mean to you?

References

- Sustainability Easily Explained. (2012). https://www.youtube.com/watch?v=_5r4loXPyx8

Unit 2: Climate Change

Grade level: 9-12
Essential Question: How does Climate Change affect matters of sustainability in a global and local context?
Duration: 50 minutes

Standards

Earth and Human Activity

1. HS NGSS Storyline: 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. 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.

Learning Goals

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

Materials Needed

- **Climate Bathtub Simulation**
  - *Sustainability NOW Student Workbook*
  - Climate Change Bathtub Simulation
- **Local Effects of Climate Change, Ocean Acidification**
  - Several Pyrex beakers, at least 6 inches tall with an opening of at least 4 inches wide
  - Water or seawater
  - pH indicator paper or meters
  - Red cabbage juice indicator
    - To create a red cabbage indicator, chop ½ 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).
  - Dry ice (only the instructor will touch the dry ice)
  - Gloves, goggles, tongs
  - Hammer to chip dry ice
  - Ice chest to store dry ice

Unit 2: Climate Change

Structure / Activity

- Refer to Unit 2 in *Sustainability NOW Student Workbook*
- Instruct students to read the unit **(5 minutes)**
- Explain the difference between climate and weather as covered in the student workbook **(5 minutes)**
- Climate Bathtub Simulation **(15 minutes)**
  - 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.
  - Direct students to the following link: https://www.climateinteractive.org/tools/climate-bathtub-simulation
  - Explain the basics of the carbon cycle:
    - The carbon cycle is how the Earth redistributes or spreads out carbon.
    - 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.
    - 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 atmospheric temperatures.
  - Explain the bathtub and its parts (i.e. inflow=emissions, outflow= removals, & water in tub = CO2 in the atmosphere.
  - 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.
  - Hit play once more until 2007 or so. Again, emissions are exceeding removals.
  - Next, divide students into manageable groups. Write the following challenge on the board:
    - Choose a future that will keep CO2 levels below 450ppm.
    - 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.
  - Ask students to complete the following discussion questions individually:
    - 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**?
    - 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**?
    - 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**?
    - What do you think we should we do when considering these options-is there only one correct response?

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.

Unit 2: Climate Change

Structure / Activity Continued

- Local Effects of Climate Change, Ocean Acidification **(20 minutes)**
  - First, divide students into groups.
  - Next, write the following steps on the whiteboard:
    - Pour water into the beakers until approximately ½ full.
    - Use the pH strip or meter to assess the pH (document this in the *Sustainability NOW Student Workbook*.
    - Add cabbage juice to water (should change the color to a bluish-purple).
    - Test the pH again, noting the results in the workbook. Take a picture of the solution with your cell phone to refer to later.
    - Ask your instructor to put a piece of dry ice into the mixture and observe the effects, taking notes in your *Sustainability NOW Student Workbooks*.
  - 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.
  - Conclude the lab by lecturing on the following points:
    - When carbon dioxide (dry ice) is added to water, the process of sublimation begins, which represents what is happening to our oceans are 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.
  - Clean-up **(10 minutes)**

References

- Climate Bathtub Simulation. https://www.climateinteractive.org/tools/climate-bathtub-simulation
- Climate Kids. https://climatekids.nasa.gov/climate-change-meaning
- Jones, D. et al. (2007). Climate Bathtub Sim Coach Notes and FAQs. https://www.climateinteractive.org/wp-content/uploads/2014/01/Climate_Bathtub_Sim_Facilitator_Guide.pdf
- Ocean Acidification Demonstration. http://www.cisanctuary.org/ocean-acidification/PDFs-WorkshopPage/Hands_on_acivities/OA_dry_ice_demo.pdf
- Resource Issues: Climate Change. https://montereybay.noaa.gov/resourcepro/resmanissues/climatechange.html

Unit 3: Population Growth

Grade level: 9-12

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

Duration: 50 minutes

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.

Learning Goals

- 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 Needed

- *Sustainability NOW Student Workbook*
- https://www.populationeducation.org/content/world-population-video
- http://worldpopulationhistory.org/map/1/mercator/1/0/25/
- Whiteboard or butcher paper (discussion question share-out)
- Butcher paper for group posters (enough for several small groups)

Structure / Activity

- Begin by asking students to read the opening section of the unit in the *Sustainability NOW Student Workbook* and show the World Population Video at the link above **(15 minutes)**
    - Divide students into groups to answer the following question in their *Sustainability NOW Student Workbooks*. In answering the below question, students can refer to the corresponding map at the link above.
        - When did you notice the most growth in the global population? Identify 3 events, scientific/technological innovations, and social changes that contributed to the rise in global population.
- Students will then present their answers to the class, selecting one team member to write the responses on the whiteboard **(10 minutes)**
- Once students have answered the discussion 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) **(25 minutes)**
    - 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.
        - Guidelines:
            - Every group must create a poster that creatively expresses the main point of their article.
            - Every group must present their findings to the class and offer a potential solution to the local challenge associated with population growth.
            - At the conclusion of the presentations, students will select a group that offered the best solution to said challenge.

References

- World Population video. https://populationeducation.org/curriculum-and-resources/world-population-video
- World Population History. https://worldpopulationhistory.org/map/1/mercator/1/0/25

Unit 4: Technological Automation

Grade level: 9-12

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

Duration: 50 minutes

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.

Learning Goals

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

Materials Needed

- *Sustainability NOW Student Workbook*
- Resilience to Robots online calculator

Structure / Activity

- Begin by showing students the automation will replace millions of jobs video linked here **(5 minutes)**
- Divide students into groups and refer them to the *Sustainability NOW Student Workbooks* to read the unit. after reading the first page of their workbooks, students will proceed to the second page and review the World Economic Forum's *Future of Jobs Survey* info graphic, taking note of jobs at high risk of automation. Students will then navigate to the Resilience to Robots online calculator to explore a chosen career's risk of automation. Students will discuss as a group and respond to the questions in their workbook **(20 minutes)**
- Students will stay in their groups and review page three and four of the *Sustainability NOW Student Workbook* which cover the most sought after skills in a rapidly evolving job market. Students will review the info graphic, and respond to the discussion questions in their workbooks, talking with their peers about their insights. If time permits, ask students to share out with the larger group **(25 minutes)**

References

- Gaskell (2022). Worried Automation Is Coming For Your Job? This Tool May Offer Alternatives. https://www.forbes.com/sites/adigaskell/2022/08/02/new-tool-offers-possible-career-alternatives-for-those-threatened-by-automation/?sh=4b093f321555
- Hughes (2022). Automation could make 12 million jobs redundant. Here's who's most at risk. https://www.zdnet.com/article/automation-could-make-12-million-jobs-redundant-heres-whos-most-at-risk
- Resilience to Robots. https://lis2.epfl.ch/resiliencetorobots/#

Unit 5: Finding Your Voice

Grade level: 9-12

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?

Duration: 50 minutes

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.

Learning Goals

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

Materials Needed

- *Sustainability NOW Student Workbook*
- https://www.footprintcalculator.org/home/en
- https://sustainabilitymag.com/sustainability/faces-of-change-the-top-five-youth-climate-activists-named-greta-emissions-change-pledge
- https://youtu.be/TMrtLsQbaok?si=uV-hq5h55UPROeBv

Structure / Activity

- Students will begin by taking the "What is your Ecological Footprint?" assessment **(10 minutes)**
  - Next, students will explore their reactions to the assessment and the solutions tab.
- Referencing the examples listed, students will then complete the first question in the individual reflection section of the *Sustainability NOW Student Workbook* **(5 minutes)**
- Next, divide students into groups and ask them to read the introduction to the unit, explore the top five youth climate activists article and watch the video **(15 minutes)**
- In their groups, students will discuss possible ways to take action based on recommendations and respond to the remaining individual reflection questions **(15 minutes)**
- Instruct the students to complete the *Sustainability NOW* Post-Assessment **(5 Minutes)**

References

- Greta Thunberg to world leaders: 'How dare you? You have stolen my dreams and my childhood' https://youtu.be/TMrtLsQbaok?si=uV-hq5h55UPROeBv
- Hope, B. (2022). Get to know the world's top five youth climate activists. https://sustainabilitymag.com/sustainability/faces-of-change-the-top-five-youth-climate-activists-named-greta-emissions-change-pledge
- My Ecological Footprint. https://www.footprintcalculator.org/home/en
- Shapiro, D. (n.d.). Teaching about Teaching Sustainability. Lecture. https://serc.carleton.edu/bioregion/examples/59400.html