

<b>CAREER CLUSTER:</b> Manufacturing	<b>DURATION:</b> Approximately 20 sessions, but can be modified to fit classroom schedules. (Session = 45 to 50 Minutes)	<b>TEACHER:</b>	<b>U.N. SUSTAINABLE DEVELOPMENT GOAL:</b> #14 — Life Below Water
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## GLOBAL ISSUE OVERVIEW

Oceans are a key component to life on earth. They provide numerous benefits ranging from environmental to economic. Maintaining healthy oceans is essential to the well-being of humans and other species around the world. According to the National Oceanic and Atmospheric Administration, the ocean produces over half of the world’s oxygen and stores more than 50 times the carbon dioxide stored in our atmosphere. In addition, the ocean regulates our climate and weather patterns by transporting heat from the equator to the poles. Oceans are also a major source of food, medicine, transportation, and recreation. Economically speaking, oceans provide employment through ocean-based businesses for almost three million people (NOAA, 2018). For these reasons, among others, it is essential to maintain healthy oceans through conservation and sustainability practices.

The threats to our oceans are compounding exponentially. Some of the biggest threats to the oceans include warming and acidification of the water as a result of global climate change, plastic pollution, overfishing, and lack of protected marine areas. For example, each year an estimated eight million metric tons of plastic enter the ocean, and it is further estimated that there are more than five trillion plastic pieces already afloat in the oceans (McCauley, 2018). These issues are only increasing in severity, so immediate action is essential to attempt to curb the destruction and regain the health of these critical bodies of water.

As overwhelming as it may seem, there are things that can be done on a global and local level to help support ocean conservation and sustainability. The global indicator framework developed by the Inter-agency and Expert Group on SDG Indicators, in conjunction with the United Nations Statistical Commission, included this issue in United Nations Sustainable Development Goal (SDG) #14 in 2016. Each year, progress on this issue is reported and strategies from continued success and improvement are discussed. Their targets for this goal include:

- Preventing and significantly reducing marine pollution.
- Sustainably managing and protecting marine and coastal ecosystems.
- Minimizing and addressing the impacts of ocean acidification.
- Effectively regulating harvesting and ending overfishing, illegal, unreported, and unregulated fishing and destructive fishing practices and implementing science-based fishing management plans.
- Conserving at least 10 % of coastal and marine areas.
- Prohibiting certain forms of subsidies for fisheries which contribute to overcapacity, overfishing, illegal, unreported, and unregulated fishing.
- Increasing the economic benefits for the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism, for small islands, and underdeveloped countries.
- Increasing scientific knowledge and developing research capacity regarding oceanic studies.
- Providing access to marine markets and resources for small-scale artisanal fishers.
- Enhancing the conservation and sustainable use of oceans and their resources by implementing international law.

On an individual basis, there is much that can be done as a society to help curb, and even reverse, the damage being done to the marine environment. For example, individuals can practice basic environmentally-friendly actions that will have a positive effect. Eliminating single-use plastics, only eating fish caught via responsible fisheries, and even driving an electric or hybrid car is helping to conserve the oceans. If we act both locally and globally to help protect our marine environments, we can work our way back to healthy oceans which, in turn, will contribute to healthy lives for all who inhabit our planet.

#### **Global Competencies Addressed:**

- *Investigate the World:* Initiate investigations of the world by framing questions, analyzing and synthesizing relevant evidence, and drawing reasonable conclusions about global issues.
- *Recognize Perspectives:* Recognize, articulate, and apply an understanding of different perspectives.
- *Communicate Ideas:* Select and apply appropriate tools and strategies to communicate and collaborate effectively — meeting the needs and expectations of diverse individuals and groups.
- *Take Action:* Translate ideas, concerns, and findings into appropriate and responsible individual or collaborative actions to improve conditions.

STANDARDS ADDRESSED		
Career/Technical Knowledge and Skills	Academic Knowledge and Skills	21 <sup>st</sup> Century Skills
<p><b>Common Career Technical Core</b> <b>Career Ready Practices</b></p> <p>4. Communicate clearly and effectively and with reason. 5. Consider the environmental, social, and economic impacts of decisions. 6. Demonstrate creativity and innovation. 7. Employ valid and reliable research strategies. 8. Utilize critical thinking to make sense of problems and persevere in solving them. 12. Work productively in teams while using cultural global competence.</p> <p><b>Manufacturing Career Cluster</b></p> <ul style="list-style-type: none"> <li>• <b>MN 1.3</b> Describe how changes outside the manufacturing business impact the manufacturing business.</li> <li>• <b>MN 2.3</b> Explain how planning is used to improve all business performance</li> <li>• <b>MN-HSE 4.4</b> Benchmark health, safety, and environmental or sustainability practices</li> </ul>	<p><b>Next Generation Science Standards</b></p> <p>Engineering Design:</p> <ul style="list-style-type: none"> <li>• <b>HS-ETS1-1.</b> A major global challenge is analyzed to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</li> <li>• <b>HS-ETS1-2.</b> A solution to a complex real-world problem is designed by breaking it down into smaller, more manageable problems that can be solved through engineering.</li> <li>• <b>HS-ETS1-3.</b> A solution to a complex real-world problem is evaluated based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.</li> </ul>	<p><b>Learning and Innovation Skills:</b></p> <ul style="list-style-type: none"> <li>• Creativity and Innovation</li> <li>• Critical Thinking &amp; Problem Solving</li> <li>• Communication</li> <li>• Collaboration</li> </ul>

## PROJECT DEFINITION & GOALS/OBJECTIVES

This project stems from the United Nations Sustainable Development Goals (SDGs) initiative. The SDGs are a set of 17 goals that aim to end poverty, fight inequality, and stop climate change. Specifically, this project focuses on Global Goal #14: Conserve and sustainably use the oceans, seas, and marine resources for sustainable development. Students will learn about the causes and effects of their actions, and those actions globally that affect our marine environments in a negative way. They will then design, manufacture, and market a board game where the game pieces are made from sustainable materials that could potentially reduce our reliance on plastic, or are made entirely from recycled plastic collected from a marine environment of their choice, or a combination of both. This process will also include a plan to obtain the sustainable materials and/or the plastics from their selected marine locale. Students finish the project by marketing their games and making sure to feature their sustainability efforts.

### Goals:

- Students will gain understanding of the United Nations Sustainable Development Goals (SDG).
- Students will learn about the top issues negatively affecting marine environments, especially oceans.
- Students will evaluate the sustainability practices of manufacturing businesses.
- Students will learn how manufacturing businesses can respond to social, economic, and technological changes.
- Students will use critical thinking to create a product from sustainable materials and/or various plastic refuse found in the ocean.
- Students will use a design process to develop solutions to a complex real-world problem, specifically through the creation of a collection plan and then production of a prototype.
- Students will communicate their proposed solution to the general population.

### Objectives:

- Investigate scientific evidence that reveals the greatest threats to oceans.
- Research targets selected from SDG #14, and review the progress over the past few years.
- Explain the impact of social changes on manufacturing.
- Brainstorm possible manufacturing solutions to halt and/or reverse the negative effects on marine environments.
- Describe how improvements to a product are identified.
- Using CAD/CAM software, design a product that positively impacts oceanic conservation and sustainability.
- Read prints and use the information to play, lay out, and produce parts or products using machining or forming equipment (e.g., CNC machine, plastic injection molding, 3D printing, etc.).
- Evaluate the potential impact of the proposed solution.
- Communicate the solution and persuade the audience to use/purchase the product.

## SCENARIO OR PROBLEM: What scenario or problem will you use to engage students in this project?

[Adidas](#) has made a commitment to selling shoes made of upcycled plastics — meaning plastic waste taken from the oceans is turned into yarn and used in shoes. More than 5 million pairs of shoes were produced with this recycled material in 2018, and clothes are also being produced. By [2024](#), the company plans to only use recycled plastics. You work for a company that manufactures board games — and many of the game pieces are plastic. You must design and manufacture a board game with pieces from a sustainable material (i.e., bamboo, metal, etc.) and/or from recycled plastic.

### Essential Questions

- How do culture and economics affect pollution levels in the oceans?
- Are current manufacturing practices sustainable?
- What is the value of changing the way goods are manufactured to support oceanic conservation and sustainment?
- How can manufacturing support global efforts of oceanic conservation and sustainability?
- Are the trade-offs of sustainable manufacturing practices worth the investment?
- What are optimal manufacturing strategies to reverse the pollution that is currently in the marine environments around the world?

### Grade Level Adaptations

Younger students could engage in a STEM challenge to build a prototype of a machine designed to collect plastic from marine environments. They could construct their prototypes from Legos, cardboard, modeling clay, paper mâché, etc.

**ASSESSMENT: How will you determine what students have learned? (Check all that apply.)**

FORMATIVE		SUMMATIVE	
Quizzes/Tests		Multiple Choice/Short Answer Test	
Notes/Graphic Representations	X	Essay Test	
Rough Draft		Written Product with Rubric	
Practice Presentation	X	Oral Presentation with Rubric	X
Preliminary Plans/Goals/Checklists of Progress	X	Self-Evaluation or Reflection	
Journal/Learning Log	X	Evaluation by Authentic Audience	X
Other:		3D model	X
		Other:	

**MATERIALS, RESOURCES, or CONSTRAINTS: What materials and resources will be needed? Are there any perceived challenges?**

**Materials:**

- Computers with internet access
- Presentation rubrics (team and individual)
- CAD/CAM software
- Fabrication equipment (e.g., CNC machine, plastic injection molding machine, 3D printer, etc.)
- Projectors/smart boards to deliver presentations

**Internet Resources:**

- [U.N. Sustainable Development Goals](#)
  - [Goal #14: Life Below Water](#)
- [Blue the Film](#)
- [Plastic Not So Fantastic Experiment](#)
- [NOAA](#)
- [The Ocean Cleanup](#)
- Ellen Macarthur Foundation’s article, “[What is a circular economy?](#)”
- Video resources:
  - TED’s video, “[The surprising solution to ocean plastic](#)” (11:46) David Katz discusses The Plastic Bank.
  - TEDEd’s video, “[The seas of plastic](#)” (7:24) Captain Charles Moore draws attention to the growing, choking problem of plastic debris in our seas.
  - TEDEd’s video, “[The business logic of sustainability](#)” (15:52) Ray Anderson shares a powerful vision for sustainable commerce.

- TEDED's video, "[What really happens to the plastic you throw away?](#)" (4:07) Emma Bryce traces the life cycles of three different plastic bottles.

**Constraints:**

If using a 3D printer, make sure that the filament is an eco-friendly choice such as PLA or other plant-based filaments. Be sure all 3D printing waste is recycled.

**SUPPORT, MODIFICATIONS, AND EXTENSIONS:** What is needed to provide support for students who have difficulty learning the content, modify for students with special learning needs, or to provide enrichment for advanced students?

**Support & Modifications:**

- For students that are just beginning to learn how to use CAD/CAM software and/or fabricating machinery, you may choose to have students recreate the game pieces from games that already exist rather than create their own new and unique game and game pieces.

**Extensions:**

- Contact companies that manufacture plastic products to see if there is any interest in producing their product.
- Tour facilities that produce goods using sustainably sourced or recycled materials.
- Visit a recycling center to discuss how the plastics are recycled.
- Create an educational campaign for the general public on the detrimental effects of single-use plastics.
- Explore the concept of social license and how it relates to the manufacturing industry.

**CALENDAR OF MAJOR LEARNING ACTIVITIES:** What are the learning activities or tasks for each day? Are there any project milestones? When will formal assessment activities occur?

Week 1				
Monday	Tuesday	Wednesday	Thursday	Friday
<p><b>Initiating:</b> Introduce students to SDG #14. Research the issue from both a local and global lens. Discuss how manufacturing can support global efforts.</p>	<p><b>Initiating:</b> Continue research on plastic pollution and issues facing our oceans.</p>	<p><b>Initiating:</b> Investigate current manufacturing practices and discuss how production can change to be more sustainable. Explore businesses that demonstrate sustainability. A few examples are listed below:</p> <ul style="list-style-type: none"> <li>• <a href="#">Patagonia</a></li> <li>• <a href="#">Green Toys</a></li> <li>• <a href="#">Bureo</a></li> </ul>	<p><b>Initiating:</b> Launch the scenario. Form project teams. Students create scope statement, identify deliverables, name stakeholders, and assign project managers. (Use free resources from the <a href="#">PMIEF Toolkit for Teachers</a>)</p>	<p><b>Planning:</b> Students brainstorm and analyze solutions, and select the best possible final solution.</p>

Week 2				
<p><b>Planning:</b> Students plan success measures and develop task sequence and schedule.</p>	<p><b>Planning:</b> Students identify resources and create a plan for monitoring and controlling progress. They propose their solution and plan to class.</p> <p><i>Formative assessment opportunity</i></p>	<p><b>Executing:</b> Students build, test, and improve game boards and pieces using CAD/CAM software and fabricating machinery.</p>	<p><b>Executing:</b> Students build, test, and improve game boards and pieces using CAD/CAM software and fabricating machinery.</p>	<p><b>Executing:</b> Students build, test, and improve game boards and pieces using CAD/CAM software and fabricating machinery.</p>
Week 3				
<p><b>Executing:</b> Students build, test, and improve game boards and pieces using CAD/CAM software and fabricating machinery.</p>	<p><b>Executing:</b> Students build, test, and improve game boards and pieces using CAD/CAM software and fabricating machinery.</p>	<p><b>Executing:</b> Students build, test, and improve game boards and pieces using CAD/CAM software and fabricating machinery.</p>	<p><b>Executing:</b> Students prepare product presentations.</p>	<p><b>Executing:</b> Students prepare product presentations.</p>
Week 4				
<p><b>Executing:</b> Students finalize and rehearse product presentations.</p> <p><i>Formative assessment opportunity</i></p>	<p><b>Executing:</b> Students finalize and rehearse product presentations.</p> <p><i>Formative assessment opportunity</i></p>	<p><b>Closing:</b> Students deliver products and presentations to an authentic audience gather feedback, and discuss. The authentic audience could be students in other classes who could play the games and give feedback.</p>	<p><b>Closing:</b> Students deliver products and presentations to an authentic audience gather feedback, and discuss. The authentic audience could be students in other classes who could play the games and give feedback.</p>	<p><b>Closing:</b> Students review the projects and evaluate team member effectiveness. Reflection activities below.</p> <p>Don't forget to celebrate their success!</p> <p><i>Summative Assessment</i></p>

**STUDENT REFLECTION ACTIVITIES:** How will students reflect on their work? Add reflection questions and/or activities here.

- Require each student to complete an “Exit Ticket” where, at the end of each day, students provide a quick answer to a prompt you provide.
- Students can create a “sustainability” journal and share their thoughts and things they have learned throughout the project. Questions: What are the trade-offs of using sustainable/recycled materials? What might result from these manufacturing changes? What constraints exist in implementing sustainable manufacturing processes?
- At the end of the project reflect on how it went, what would they do differently next time, what feedback did they receive?

Adapted from:

- “Sustainable Development Goals: Goal 14: Conserve and Sustainably use the Oceans, Seas, and Marine Resources for Sustainable Development,” 2018, New York: The United Nations. Retrieved from <https://sustainabledevelopment.un.org/sdg14>
- “The Universal Declaration of Human Rights,” by The United Nations, 1948, Paris: The United Nations. Retrieved from <http://www.un.org/en/universal-declaration-human-rights/>
- “Unit Planning Template” by the Southern Regional Education Board, n.d., Atlanta: Southern Regional Education Board.

Works Cited:

- McCauley, D. (2018). *Here are 5 of the biggest threats to our oceans, and how we can solve them*. New York: World Economic Forum. Retrieved from <https://www.weforum.org/agenda/2018/06/5-ways-we-can-improve-ocean-health/>
- National Oceanic and Atmospheric Administration (NOAA). (2018). *Why should we care about the ocean?* D.C.: U.S. Department of Commerce. Retrieved from <https://oceanservice.noaa.gov/facts/why-care-about-ocean.html>