

Introduction to the Teacher

| Timeline and Discipline  | Big Idea and Essential Questions  | Lesson Overview   | Eliciting and Engaging the Student  | Developing the Ideas | Checking for Understanding   |
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| <p><u>Timeline:</u> ~1 day<br/><u>Discipline:</u> Any</p>            | <p><b><u>BIG IDEA 1:</u></b> How the case study may be different than what students are used to, and what the expectations are.</p> <p><u>Essential Questions:</u></p> <ol style="list-style-type: none"> <li>1. How does the case study differ from what I (a student) may be used to in the classroom?</li> <li>2. What will I (a student) be expected to do?</li> <li>3. How and why do people work in teams?</li> </ol> | <p>In these three lessons students are introduced to the case study approach.</p> <p>Lesson 1-1 asks students to discuss how they prefer to learn. Lesson 1-2 is a description of the what the students should expect. Lesson 1-3 is a discussion the challenges, strategies, and benefits of working in teams.</p> | <p>Lesson 1-1: Introduction to learning styles</p> <p>Lesson 1-2: Expectations for the case study</p> <p>Lesson 1-3: Working in teams</p> |                      | <p>Ask the Questions:</p> <ol style="list-style-type: none"> <li>1. What concerns do you have about the upcoming case study? What are you excited about?</li> <li>2. Have you worked in teams before? What was it like?</li> </ol> |
| <p><u>Timeline:</u> ~1 day<br/><u>Discipline:</u> Social Studies</p> | <p><b><u>Inception</u></b><br/><b><u>BIG IDEA 2:</u></b> Choosing paper or plastic has societal, environmental, and economic repercussions</p> <p><u>Essential Questions:</u></p> <ol style="list-style-type: none"> <li>1. Is a plastic bag ban good or bad for</li> </ol>   | <p>In these lessons, students are introduced to the topic of the case study and become invested in it.</p> <p>Students are polled on environmental sustainability, watch</p>  | <p>Lesson 2-1: Polling the students' knowledge</p> <p>Lesson 2-2: Inception video</p>   |                      | <p>Ask the question:</p> <ol style="list-style-type: none"> <li>1. Who does the plastic ban impact?</li> <li>2. Which statements in the video were true? Which were untrue?</li> </ol>   |

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|  | <p>communities?</p> <p>2. What is the impact of choosing paper or plastic?</p>  | <p>an inception video on a plastic bag ban, and discuss the impact of a plastic bag ban.</p>   |  |  |  |
| <p><u>Timeline:</u> ~3 days</p> <p><u>Discipline:</u> Social Studies, Environmental Studies, Science</p> | <p><b>Engagement</b></p> <p><b>BIG IDEA 3:</b> Defining environmental sustainability and recognizing its scope</p> <p><u>Essential Questions:</u></p> <p>1. What is environmental sustainability?</p> <p>2. What are the three pillars of sustainability?</p> <p>3. How is the debate over “paper vs. plastic” an environmental sustainability issue?</p> <p>4. What are other environmental sustainability issues?</p> | <p>Through these lessons students become engaged in the topic of environmental sustainability.</p> <p>Students will research and debate over the question paper vs. plastic, will participate in a sticky-note activity to determine the 3 pillars of sustainability, and will create a class list of environmental sustainability issues. Each team will pick an issue.</p> |  | <p>Lesson 3-1: Engagement question</p> <p>Lesson 3-2: Sticky note activity</p> <p>Lesson 3-3: Sustainability issues list</p> | <p>Ask the question:</p> <p>1. Which of the following issues are related to environmental sustainability? Which are not? How do you know?</p> <p>War on drugs<br/>Obesity<br/>Climate change<br/>Zika<br/>Littering<br/>Oil spills<br/>Vaccines<br/>Factory farming<br/>Etc.</p> |
| <p><u>Timeline:</u> ~1 week</p> <p><u>Discipline:</u> Science</p>  | <p><b>Research</b></p> <p><b>BIG IDEA 4:</b> Scientific inquiry skills can be used to address issues in environmental sustainability</p>  | <p>In these lessons, students collect background information on their topic, write a research question, and collect data</p>   | <p>Lesson 4-1: Topic diagram</p> <p>Lesson 4-3: Form a hypothesis</p> <p>Lesson 4-4:</p> | <p>Lesson 4-2: Writing a research question</p> <p>Lesson 4-5: Conducting the research</p>                                    | <p>Discuss with each team whether they have gathered enough information to answer their research question. Do they have the</p>  |

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|  | <p><u>Essential Questions:</u></p> <ol style="list-style-type: none"> <li>1. What is known about this topic? What is not known?</li> <li>2. How do you write a research question?</li> <li>3. How should I collect my information?</li> <li>4. Which sources are reliable and reputable?</li> </ol>  | and information to answer their research question.   | Designing the study                 |  | evidence to support their position? Are they missing a piece of information?  |
| <p><u>Time:</u> ~1-2 days<br/><u>Discipline:</u> Science, Social Studies</p> | <p><b>Create</b><br/><b>BIG IDEA 5:</b> Scientific communication can be used to address issues in environmental sustainability</p> <p><u>Essential Questions:</u></p> <ol style="list-style-type: none"> <li>1. How do you draw conclusions from research and data?</li> <li>2. Who would benefit most from hearing your conclusion?</li> <li>3. How do you articulate your conclusion clearly and scientifically?</li> <li>4. How could your research impacted environmental sustainability?</li> </ol> | In these lessons, students will draw a conclusion based on their research, communicate their conclusion to an audience outside the classroom, and present their team's project to the class. | Lesson 5-1:<br>Drawing a conclusion | <p>Lesson 5-2:<br/>Communicating your findings</p> <p>Lesson 5-3: Peer-editing</p> <p>Lesson 5-4:<br/>Presenting</p> | <p>Ask the following questions:</p> <p>Compare and contrast yours and your classmates communication pieces. What do you think these communication pieces will accomplish?</p> |
| <p><u>Time:</u> ~1 day<br/><u>Discipline:</u> Any</p>                        | <p><b>Reflect</b><br/><b>BIG IDEA 6:</b> Reflection is a tool for improving</p>  | In this lesson students will reflect on their process  | Lesson 6-1: Reflect                 |  | N/A   |

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|  | <p>your scientific inquiry skills and for identifying the next steps for addressing environmental sustainability</p> <p><u>Essential Questions:</u></p> <ol style="list-style-type: none"><li>1. What have I learned?</li><li>2. What have I done well?</li><li>3. How can I improve?</li></ol> | <p>recognize their strengths, their opportunities for growth, and what they have learned and accomplished.</p> |  |  |  |
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## Introduction to Teacher

Case studies are a student-driven, situation-based approach to learning science. Students investigate a societal problem through asking questions, researching, drawing conclusions, and communicating their findings. This case study addresses Environmental Sustainability. Environmental sustainability refers to individual, societal, and political practices that can be continued indefinitely without major repercussions on the environment, society, or the economy. Students are introduced to this topic through debate over the sustainability of paper and plastic bags. Later, student teams choose an issue related to environmental sustainability to research further. By the end of the case study each team will have moved the needle forward on an issue related to environmental sustainability.

This high-school level case study is adapted from a college-level science program called the Integrated Concentration in Science (iCons) Program at University of Massachusetts Amherst. Students in this program bring their expertise from a variety of science and engineering majors and work together on interdisciplinary societal problems in the fields of renewable energy and biomedicine. To learn more about the iCons program, you can visit our [website](#).

The case study method, which hopes to engage scientific curiosity and inquiry, works in conjunction with lecture style learning in which students focus mainly on basic scientific principles and their significance. The goals of the case study method are focused just as much on the skills students develop from the experience of self-driven learning as they are on the facts they learn. This may be a shift from the students' normal experiences, so it is important to emphasize the value of the learning process before you begin. Then you may proceed through the five steps of the iCons Case Study learning process: inception, engagement, research, create, and reflect.

**Inception** is the first step in the iCons case study method. The purpose of this step is to introduce the topic of the case study and get the students invested in it. An effective inception material draws attention to a particular time and place, brings relevancy to the societal issue, and leads students into the engagement step.

The **Engagement** step allows students to “buy in” to the case study curriculum before they begin the highly student-driven Research step. The Engagement step is when students become aware of how scientific inquiry will help them address the societal issue. They will gain confidence and motivation to address this societal problem and become curious about the scientific phenomena underlying the societal issue.

The **Research** step requires students to narrow their topic. Teams are challenged to understand one topic completely in order to answer a specific research question and to

eventually draw original conclusions. Students have the freedom to conduct an experiment, compile information from other scientists' findings, survey other's understanding and habits, calculate a cost-benefit analysis of a certain object/practice, etc. or a combination of these in order to answer their research question. It is important to give students freedom and to push them to do their best work so that they can exceed their own expectations of what they can accomplish.

In the **Create** step, the students communicate the conclusions they have drawn from their research to an audience outside the classroom and to their peers. This grounds the students' work in reality and reinforces the idea that their work is important, valid, and applicable to a real issue. Students then present their whole research process and communication product to the class.

The **Reflection** step is for students to analyze, critique, and evaluate their process and product, and recognize how they have learned and grown through the case study. It is also a data-collection tool to inform improvements of your case study curriculum design. Students will incorporate feedback from others and draw from their own experiences to answer reflection questions. Reflection questions should cover personal growth, team dynamics, engagement, and societal impact of their research.

*Journal Check-in:* These optional check-ins are interspersed throughout the case study in places we feel students would benefit from collecting their thoughts and setting goals. They are meant to be 3-5 minute reflection periods during which students respond in journals to prompts related to the previous activity. The purpose of these journal activities is to help students prepare for the reflection step of the case study, process their experiences in this new and possibly uncomfortable learning style, and become self-reflective learners.

The following Next Generation Science Standards can be addressed in this case study:

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.

\*HS-ETS1-3. Evaluate a solution to a complex real-world problem 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.

\*HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

\*HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

\*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.

HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

\*These standards may be addressed depending on what students choose to investigate for their research and create steps.

During case study days, students work in teams to address the issue of Environmental Sustainability through scientific research. Students develop research and collaboration skills throughout the process; therefore, it is not just the final product that can be used as an assessment for learning, personal growth, and team collaboration. Student participation and cooperation are required throughout, and they may need periodic feedback to guide their level of efficiency. This is different from traditional-style curriculum, in which assessment tools like tests and exams are often used to measure individual growth.

In terms of timing, this case study could take a few different forms, depending on the format and schedule of your class. This could be done in a 2-3 week stretch where the case study is the only material being addressed during this time. Another option is for the case study to be interspersed with the regular curriculum two or three days a week for multiple weeks. This is up to your discretion concerning your class structure, student preference and curriculum layout. In addition, depending on the experience and academic level of your class, you may choose to add, edit, or remove activities to this lesson plan to meet the needs of your students. It is our hope that each teacher who uses these case studies makes them their own.

This curriculum was created by Dominique Kiki Carey, Rebecca Howard, Erica Light, Corrine Losch, and Stephanie Purington. We are members of the iCons community at the University of Massachusetts Amherst. This case study was implemented in two high-school classes. It has been revised to reflect all that we learned through our teaching, and we have incorporated suggestions into the teaching plans. From our experiences, we believe student-centered, case study-based education is an extremely effective and engaging way to learn. We hope to prepare students to be leaders in solving the world's challenges through research and critical thinking.

NGSS Lead States. (2013). *Next Generation Science Standards: For States, By States*. National Academies Press.