

AUTHENTIC SCIENCE CURRICULUM IN AN ALTERNATIVE HIGH SCHOOL SETTING

by Julia Brunner

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in Education.

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PROJECT DESCRIPTION

This project was created to provide an authentic inquiry-based science curriculum for a 9-12 grade Alternative Education setting. The purpose was to incorporate multiple standards and scientific skills and techniques to engage students who can be challenging to motivate and expose them to skills that are needed for scientific inquiry. My research question is: *How can science curriculum surrounding authentic tasks be created for nontraditional high school students to increase motivation and rigor?* The project is focussed on not only helping students learn the science of photosynthesis and cellular respiration, but to also show students the value of the scientific method. To help students start to think scientifically and ask their own questions.

Much of this project was inspired by my work in an alternative setting and my experiences there. I have seen so many students struggle to see a value in their education which leads to students failing courses and some not graduating. Biology can be a very difficult subject for many students. The amount of content that the Minnesota science standards require does not allow for the time to explore science concepts indepthly enough to appreciate them in my opinion. Also, as I have stated in my literature review, many alternative students have endured traumatic experiences and may live very adult lives. School comes after survival. This curriculum is rigorous and incorporates collaboration, technology, inquiry, and presentations to push students and help them gain confidence in their own abilities. Many students whom I have taught are capable and very intelligent, but they are lacking confidence and skills that they may have missed in previous grades. There is not lacking of ability in most cases just a lack of motivation and confidence.

Attendance and students moving schools is an issue that needs to be addressed in alternative programs. Students can have large gaps in their learning, so multiple standards can be taught together and give students content they may missed in the past. This unit has embedded

concepts into standards that are often taught isolated from one another in the traditional setting. I wanted to integrate them. I wanted to help students see that science is not isolated, that it is all connected.

This unit plan covers the following Minnesota State Standards:

- 9.1.3.3.2 Communicate, justify, and defend the procedures and results of a scientific inquiry or engineering design project using verbal, graphic, quantitative, virtual, or written means.
- 9.1.1.2.1 Formulate a testable hypothesis, design and conduct an experiment to test the hypothesis, analyze the data, consider alternative explanations, and draw conclusions supported by evidence from the investigation.
- 9.1.1.2.2 Evaluate the explanations proposed by others by examining and comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the scientifically acceptable evidence, and suggesting alternative scientific
- 9.4.2.2.2 Explain how matter and energy is transformed and transferred among organisms in an ecosystem, and how energy is dissipated as heat into the environment.
- 9.4.1.2.4 Explain the function and importance of cell organelles for prokaryotic and/or eukaryotic cells as related to the basic cell processes of respiration, photosynthesis, protein synthesis and cell reproduction.
- 9.4.2.2.1 Use words and equations to differentiate between the processes of photosynthesis and respiration in terms of energy flow, beginning reactants and end products
- 9.4.4.1.2 Describe the social, economic and ecological risks and benefits of changing a natural ecosystem as a result of human activity. For example: Changing the temperature

or composition of water, air or soil; altering the populations and communities, developing artificial (MDE, 2009).

This is a lot of material to cover and practice. I think that this six week unit will allow for students to be engaged, become curious, and develop a scientific way of thinking about their world.

I am following the Understanding by Design curriculum model developed by Wiggins and McTighe (2011). This model designs lessons by starting with the end goal. There are three stages that I have followed I create the unit, which are the following:

1. Desired Results, where I state which standards and outcomes I want my students to master.
2. Evidence of Learning, where I state what student mastery will look like.
3. Learning Plan, where I design my lessons around the first two stages (2011).

This curriculum model allowed me to design lessons that allow for student learning in multiple ways. It utilizes different teaching strategies that include, lecture and note taking, video, discussion, inquiry, hands-on experimentation, and collaborative learning.

I recommend teaching this lesson earlier in the year as it allows for students to practice the scientific method and develop their “science thinking.” Also, I believe that understanding the interconnections between photosynthesis and cellular respiration is a foundation for biology concepts that include ecology, evolution, and homeostasis.

One aspect of Alternative Education Programs is small class sizes. This allows opportunity for one-on-one discussion and assessment between a teacher and the students. It is integral that the teacher makes a connection with each student. I have often found that many alternative students know and understand the content but will refuse to complete traditional assessments. Giving students multiple opportunities to convey what they learn is one of the most

important aspects of alternative education and one-on-one attention from a teacher can give students the confidence and support they need to be successful.

Unit Summary

Unit Title: Cell Energy and the Carbon Cycle Subject: Biology/Life Science Grade: 9-12 Alternative Education Program	Teacher: Julia Brunner Duration: 6 weeks
<p>Summary of unit: This unit will explore how plant and animal cells acquire energy utilizing inquiry-based learning experiences. Students design and conduct experiments about what affects the rate of photosynthesis and cellular respiration. After discovering the connections between photosynthesis and cellular respiration students will be presented with an issue of climate change and how the carbon cycle is affected by human interactions. Students will use their new knowledge of connections between plants and the carbon cycle to explore how they could reduce carbon in the atmosphere in their own communities and globally. The goal of the unit for students to come to their own conclusions about if there are ways to remove carbon from the atmosphere or should we stop relying on fossil fuels as energy sources due to their CO₂ emissions into the atmosphere. This unit should come before a more in-depth unit on human interactions with living systems. So often there is an idea that humanity will clean up after itself or that someone else can take care of a problem for us. This unit will help students understand the urgency for a change in the way humans obtain and use energy.</p> <p>Link to Resources: https://drive.google.com/drive/folders/1osvvlm2GH3inf-AnNjkd996KZsXT6gtU?usp=sharing</p>	
Stage 1 – Desired Results	
<p>Objectives/Standards: 9.4.2.2 Matter cycles and energy flows through different levels of organization of living systems and the physical environment, as chemical elements are combined in different ways. 9.4.1.2 Cells and cell structures have specific functions that allow an organism to grow, survive and reproduce.</p> <ul style="list-style-type: none"> ● Use words and equations to differentiate between the processes of photosynthesis and respiration in terms of energy flow, beginning reactants and end products. ● Explain how matter and energy is transformed and transferred among organisms in an ecosystem, and how energy is 	<p>Essential Questions:</p> <ol style="list-style-type: none"> 1. Where does the mass that makes up organisms come from? 2. Where does the energy that organisms need to grow and live come from? 3. Where and how does photosynthesis occur? 4. What affects the rate of photosynthesis? 5. Where and how does cellular respiration occur? 6. What are the reactants and products of photosynthesis and cellular respiration? 7. How are photosynthesis and cellular respiration connected? 8. What affects the rates of cellular respiration and photosynthesis? 9. What is carbon’s role in the environment? 10. What are sources of carbon in the environment? 11. How do human interactions with the environment affect the carbon cycle?

<p>dissipated as heat into the environment.</p> <ul style="list-style-type: none"> ● Explain the function and importance of cell organelles for prokaryotic and/or eukaryotic cells as related to the basic cell processes of respiration, photosynthesis, protein synthesis and cell reproduction. 	<p>12. How are human interactions with the carbon cycle causing climate change?</p> <p>13. What can people do to help stop the effects of climate change?</p> <p>14. How can knowledge of cellular processes be valuable to your everyday life? Where can this knowledge be used?</p>	
<p>Factual Knowledge Students will know:</p> <p>In photosynthesis plants need Carbon Dioxide CO₂, Water H₂O, and Sunlight energy to create Glucose C₆H₁₂O₆, and Oxygen O₂.</p> <p>In cellular respiration plants and animals use Oxygen O₂ and Glucose C₆H₁₂O₆ to create Carbon Dioxide, ATP energy, heat and Water H₂O.</p>	<p>Procedural Knowledge Students will be able to:</p> <p>Design and carry-out an experiment.</p> <p>Collect and analyze data</p> <p>Collaborate with peers</p> <p>Present information</p>	<p>Conceptual Knowledge Students will understand:</p> <p>The interdependence of humans and plants and the impacts of climate change on that interdependence.</p> <p>The connections between organisms on earth and the environment.</p> <p>Their actions have impacts on the environment.</p>
<p>Stage 2 – Assessment Evidence</p>		
<p>Performance Tasks:</p> <ul style="list-style-type: none"> ● Experimental design and data analysis for photosynthesis lab. ● Cellular Respiration Lab ● Presentations about photosynthesis and cellular respiration connections and experimental design and findings. ● Climate change public service announcement projects. 	<p>Unit Pre-Assessment:</p> <ul style="list-style-type: none"> ● Giant Sequoia Tree Questioning: Where do trees get their mass? Pair and Share and class discussion. ● Concept mapping of where their favorite foods comes from. ● Photosynthesis and Cellular Respiration PreTest <p>Other Evidence/Assessments:</p> <ul style="list-style-type: none"> ● Discussion and check-ins with students one-on-one or in their groups. ● Presentations of finding from experiments. 	

	<ul style="list-style-type: none"> ● Extension and transfer of knowledge to climate change projects.
<p>Extensions:</p> <ul style="list-style-type: none"> ● Students can take what they learn about carbon use and climate change and develop a way to help their community lessen its carbon footprint. ● BBC How to Grow a Planet documentary and video questions 	<p>Differentiation Considerations:</p> <ul style="list-style-type: none"> ● Students should be allowed to work individually or with groups on everything. ● Tasks can be chunked into smaller bits of students are struggling. ● Templates for experimental design instead of students creating their own write-up. ● Students can be given more guidance from the teacher in order to start their climate change projects. A list of possible questions could be posted for students to choose from.
Stage 3 – Learning Plan	
<p>Learning Activities:</p> <ul style="list-style-type: none"> ● Giant Sequoia Tree formative assessment questions and discussion. ● Experimental design and lab for variables that affect the rate of photosynthesis. ● Cellular respiration inquiry lab. ● Presentations of experimental design and lab findings. ● Carbon intake of Trees Lab ● Student-led climate change and the carbon cycle public service announcement projects. 	
Lesson Descriptions	
<p>Lesson 1: After reviewing the laws of conservation of energy and matter, lesson 1 introduces students to the concept of photosynthesis using a formative assessment question of “Where does the mass of plants come from?” Students will think about what they know about plants and how they can apply that to how they obtain and use energy.</p>	
<p>Lesson 2: Students will be given a variety of materials and equipment and are asked the questions of how can they design an experiment to help the class uncover the best variables for growing plants. They will all be given radish seeds because they are fast growing. While students collect data on their growing plants they will be asked the question, “How do people and animals, consumers, obtain and use energy?” Students will be asked to think about their favorite food and trace it back to where it came from, what energy and matter was needed for its creation. Students should come to the realization that everything gets its energy from the sun and plants are what allows other organisms to use that energy.</p>	

Lesson 3: Students will continue to collect data on their radish plants and will start to look more in depth at cellular respiration using yeast. They will be able to see the effects of different energy sources (protein, lipids, carbohydrates, and a control) on the rate of cellular respiration of yeast.

Lesson 4: Students will use the data that they collected from the radish seed photosynthesis experiments and the yeast experiments to make digital presentations about their findings. They will describe their experiments in detail, their data, and their analysis. They should be able to make a connection between the two cellular processes and see the connections between producers and consumers.

Lesson 5: Students will use measurements of local tree circumference and identify trees to calculate how much carbon their tree has taken from the environment. This lesson can be found at the Earth Labs website developed by Science Education Resource Center at Carleton College.

<https://serc.carleton.edu/eslabs/carbon/1b.html>

Lesson 6: Students will watch a documentary about climate change. *Chasing Coral*, *Chasing Ice*, or *An Inconvenient Truth* are great documentaries. Students will then brainstorm questions they now have. They can work in groups or independently to focus on a question and how they can make it testable or researchable. They will begin to complete research that can help them answer their own question. They should then create a public service announcement to help combat climate change based on their research. They should show what the problem is, background research on their subject, and what people can do to help. Students should see connections between the carbon cycle, human activity, and climate change.

Lesson 1

Lesson Topic: Conservation of Matter and Energy Grade level: 9-12

Length of lesson: 2 days or 2 55 min. class periods

Stage 1 - Desired Results

Content Standard(s):

9.4.2.2 Matter cycles and energy flows through different levels of organization of living systems and the physical environment, as chemical elements are combined in different ways.

9.4.1.2 Cells and cell structures have specific functions that allow an organism to grow, survive and reproduce.

<p>Understanding (s)/goals</p> <p>Students will understand:</p> <ul style="list-style-type: none"> • That 85% of the mass of a tree comes from CO₂ in the air. • Plants utilize the energy from the sun to turn water and carbon dioxide into glucose and wood. • Photosynthesis occurs in the chloroplasts of plant cells. 	<p>Essential Question(s):</p> <ol style="list-style-type: none"> 1. Where does the mass that makes up organisms come from? 2. Where does the energy that organisms need to grow and live come from? 3. Where and how does photosynthesis occur?
<p>Student objectives (outcomes):</p> <p>Students will be able to:</p> <ul style="list-style-type: none"> • Explain the chemical reaction of photosynthesis with its reactants and products. • Explain how plants utilize energy from the sun to turn a gas into their own mass. 	
<p>Stage 2 – Assessment Evidence</p>	
<p>Performance Task(s):</p> <ul style="list-style-type: none"> • Students will be given the handout from Life Science Assessment Probes “Giant Sequoia Tree.” • Small group discussion • Large group discussion • Exit Ticket 	<p>Other Evidence:</p> <ul style="list-style-type: none"> • Student discussion one-on-one with teacher. • Answered questions in note packet.
<p>Stage 3 – Learning Plan</p>	

Learning Activities:

- Students will be given the handout called, Giant Sequoia Tree from NSTA Uncovering Student Misconceptions: Life Science Assessment Probes book. Allow them 5 minutes to think about the question and answer it.
- Tell students to share their answer with a partner and discuss how they decided on their answer. (3 min)
- Open the discussion to the whole group and write key words on the board. (5 min).
- Give students the Cellular Respiration and Photosynthesis Pretest
- Show students the video: Where Do Trees Get Their Mass From (4:09 min) https://www.youtube.com/watch?v=2KZb2_vcNTg
- Lecture using a powerpoint on cell energy, have students complete guided notes, that describes where and how photosynthesis takes place. (15 min.)
- Students complete an exit ticket that asks:
What do plants need to grow?
What are the products and reactants of photosynthesis?
Where does photosynthesis take place

Lesson 2**Lesson Topic: Photosynthesis Grade level: 9-12****Length of lesson: 1 week or 5 55 min. class periods to collect data.****Stage 1 - Desired Results****Content Standard(s):****9.4.1.2 Cells and cell structures have specific functions that allow an organism to grow, survive and reproduce.****9.4.2.2 Matter cycles and energy flows through different levels of organization of living systems and the physical environment, as chemical elements are combined in different ways.****9.1.3.3.2 Communicate, justify, and defend the procedures and results of a scientific inquiry or engineering design project using verbal, graphic, quantitative, virtual, or written means.**

<p>9.1.1.2.1 Formulate a testable hypothesis, design and conduct an experiment to test the hypothesis, analyze the data, consider alternative explanations, and draw conclusions supported by evidence from the investigation.</p>	
<p>Understanding (s)/goals Students will understand:</p> <ul style="list-style-type: none"> • How to design and implement an experiment. • Temperature, light intensity, and amount of water affect the rate of photosynthesis. 	<p>Essential Question(s):</p> <ol style="list-style-type: none"> 1. Why is it important to only change one variable at a time when designing an experiment? 2. What affects the rate of photosynthesis? 3. What do plants need to grow?
<p>Student objectives (outcomes): Students will be able to:</p> <ul style="list-style-type: none"> • Ask a question about photosynthesis and design an experiment around that question. • Collect and analyze data from plants they have grown. • Determine which variables had the greatest effect on the rate of photosynthesis of their radish seeds. 	
<p>Stage 2 – Assessment Evidence</p>	
<p>Performance Task(s):</p> <ul style="list-style-type: none"> • Experimental Design • Data collection and analysis • Explain what plants need to grow 	<p>Other Evidence:</p> <ul style="list-style-type: none"> • Discussion with teacher about experimental design and data collection. • Students individual answers to post-lab questions.
<p>Stage 3 – Learning Plan</p>	

Learning Activities:**Materials:**

- Radish Seeds (or other fast growing plant)
- Potting Soil
- Gravel, wood chips, compost, other soil medium
- Growing light
- Access to a window
- Seed starting pots
- Heat pads
- Water
- Fertilizer
- Plastic covering, cling-wrap or some sort of cover for the plants
- Lab template write-up template (optional)
- Student handout #1 Focusing Preliminary Research Ideas (see folder)
- Student handout #2 Research Design Table (see folder)

Day 1:

- Have all of the materials set out on a table and ask students to come and observe them.
- Have students rank with ones they think are most important for growing plants.
- Explain to students that they are going to be designing their own experiment to see what variables have the greatest effect on plant growth.
- As a review of experimental design show students the video called Controlled Experiments on Youtube (2:34 min)
<https://www.youtube.com/watch?v=VhZyXmgIFAo>
- Give students the Focusing Preliminary Research Ideas handout and ask them to complete the worksheet. They should be given at least 20 minutes to brainstorm and discuss what variables they are going to be manipulating. They can work alone or with a group (2 to 3 works best)

Day 2:

- Have the following warm-up question on the board, or something similar:
The plants in the pot on my patio are dying. How can I figure out what is making them sick using the scientific method?
- Allow students 5 minutes to come up with a plan. Then have them share with a partner for another 3 minutes.
- Call on a few students to share their ideas.
- Give students the [Research Design Table](#) worksheet and have them start working on designing their own experiments to see what variables affect the

rate of photosynthesis.

- Check-in with each group to make sure they have a solid plan for the next day.
- Students should turn in their Research Design Tables for assessment by the teacher. Feedback is very important for the next step.

Day 3:

- Students will set-up their experiments and start writing their lab reports with the following information on a google doc:
 1. Question/Problem
 2. Hypothesis
 3. Independent Variable
 4. Dependent Variable
 5. Controls
 6. Experimental Group(s)
 7. Materials
 8. Procedure
 9. Data Table
 10. Graph
 11. Conclusion
 12. Analysis

(Students can also be given a template for this)
- Students should begin setting up their experiments with time for clean-up at the end.
- Students should be ready to start collecting data the next day and for the next 5 days at least to see the effects of their experiments on the plant growth. Giving 10 minutes at the beginning of each class to care for the plants and collect data.

Lesson 3

Lesson Topic: Cellular Respiration Grade level: 9-12

Length of lesson: 120 min. or 2 55 min. class periods

Stage 1 - Desired Results

<p>Content Standard(s): 9.4.1.2 Cells and cell structures have specific functions that allow an organism to grow, survive and reproduce. 9.4.2.2 Matter cycles and energy flows through different levels of organization of living systems and the physical environment, as chemical elements are combined in different ways.</p>	
<p>Understanding (s)/goals Students will understand:</p> <ul style="list-style-type: none"> • Organisms, including single-celled yeast fungus, need glucose for cellular respiration to occur. • Cellular respiration occurs in the mitochondria of cells. • Temperature and beginning reactants affect the rate of cellular respiration 	<p>Essential Question(s):</p> <ol style="list-style-type: none"> 1. What are the products and reactants for cellular respiration? 2. What affects the rate of cellular respiration? 3. What is yeast? 4. What is the difference between aerobic and anaerobic respiration? 5. How do people use these processes in their everyday lives?
<p>Student objectives (outcomes): Students will be able to:</p> <ul style="list-style-type: none"> • Follow a lab procedure to see the effects of different reactants in the cellular respiration reaction using yeast. • Collect and analyze data from a lab experiment. • Make a conclusive statement about what reactants give the highest rate of cellular respiration thus giving an organism the most energy. 	
<p>Stage 2 – Assessment Evidence</p>	

<p>Performance Task(s):</p> <ul style="list-style-type: none"> • Cellular Respiration Lab 	<p>Other Evidence:</p> <ul style="list-style-type: none"> • Small group discussion • One-on-one teacher-student discussion. • Questions answered in note packet
<p>Stage 3 – Learning Plan</p>	
<p>Learning Activities:</p> <p>Materials:</p> <ul style="list-style-type: none"> • Cell Energy powerpoint and note packet • Cellular Respiration Using Yeast Lab Packet • Plastic water bottles (enough for each group to have 4) • Balloons (each group will need 7) • Sugar • Yeast • Distilled Water • Protein Milk or Powder • Vegetable Oil • A way to warm water or a heating pad • Ice Cubes <ul style="list-style-type: none"> • Finish the powerpoint presentation on cell energy and have students finish their note packet. • Help students get ready for this by asking students to write the equations for Cellular respiration and photosynthesis on the board. Give students 5 minutes and then ask volunteers to write their answers on the board. • Arrange students into groups randomly or allow them to choose their own groups and handout lab packet. • Have students read through the lab and procedure and have them highlight important information. Check-in with each group and ask them to explain how to complete the lab so there isn't any confusion with the procedure. • Allow 2 days for the students to complete the lab. 	

Lesson 4

Lesson Topic: Connections Between Cellular Respiration and Photosynthesis

Grade level:9-12

Length of lesson: 3-5 Days that includes a day for presentations.

Stage 1 - Desired Results	
<p>Content Standard(s):</p> <p>9.4.1.2 Cells and cell structures have specific functions that allow an organism to grow, survive and reproduce.</p> <p>9.4.2.2 Matter cycles and energy flows through different levels of organization of living systems and the physical environment, as chemical elements are combined in different ways.</p> <p>9.1.3.3.2 Communicate, justify, and defend the procedures and results of a scientific inquiry or engineering design project using verbal, graphic, quantitative, virtual, or written means.</p> <p>9.1.1.2.1 Formulate a testable hypothesis, design and conduct an experiment to test the hypothesis, analyze the data, consider alternative explanations, and draw conclusions supported by evidence from the investigation.</p>	
<p>Understanding (s)/goals</p> <p>Students will understand:</p> <ul style="list-style-type: none"> ● Plants (producers) are able to utilize energy from the sun and make their own food. ● Consumers get their energy from plants and other animals. ● If it wasn't for a plant's ability to use sunlight and CO₂ to make their own food life would not exist on earth. ● Plants create the O₂ that other organisms need to survive and take in the CO₂ that they output. ● Plants and animals are interconnected. 	<p>Essential Question(s):</p> <ol style="list-style-type: none"> 1. What is the role of plants in an ecosystem? 2. How does the law of conservation of mass and energy apply to photosynthesis and cellular respiration? 3. Do plants use cellular respiration? 4. Where and when do cellular respiration and photosynthesis take place? 5. Why is it important for scientists to communicate their results? 6. What makes an experiment valid?

<p>Student objectives (outcomes): Students will be able to:</p> <ul style="list-style-type: none"> • Communicate their findings from their photosynthesis experiments and cellular respiration lab data to the class. • Peer review groups experimental design and data analysis. • See the interconnections between photosynthesis and cellular respiration. 	
Stage 2 – Assessment Evidence	
<p>Performance Task(s):</p> <ul style="list-style-type: none"> • Students create and present digital presentations to communicate their experimental design, data, and what they have learned. • Students peer review each other’s experimental designs. 	<p>Other Evidence:</p> <ul style="list-style-type: none"> • Check-ins with the teacher • Daily reflections of how the presentations are going and goals for the next day. • Peer Evaluations
Stage 3 – Learning Plan	

Learning Activities:**Materials:**

- Chromebooks
- Internet access
- Google Slides
- Textbooks
- Peer Review Student Worksheet
- Pictures of their experiments

- Students should be given the handout with the requirements for their presentations.
- Allow students 3 days to create their presentations.
- The day of the presentations give students a peer review work
- Allow a class period for presentations
- Students should fill out a peer review worksheet for each presentation.

Lesson 5**Lesson Topic: Carbon cycle and Trees Grade level:9-12****Length of lesson: 1-2 Class Periods**

Stage 1 – Desired Results	
Content Standard(s): 9.4.2.2 Matter cycles and energy flows through different levels of organization of living systems and the physical environment, as chemical elements are combined in different ways.	
Understanding (s)/goals Students will understand: <ul style="list-style-type: none"> ● The majority of the mass of trees comes from CO₂ in the atmosphere. ● Trees take CO₂ out of the atmosphere and turn it into wood and glucose. 	Essential Question(s): <ul style="list-style-type: none"> ● Where do trees get their mass from? ● How does carbon get cycled through the environment?

<p>Student objectives (outcomes): Students will be able to:</p> <ul style="list-style-type: none"> • Take measurements for the circumference of tree trunks • Identify tree using a dichotomous key • Calculate the amount of carbon help within a tree 	
Stage 2 - Assessment Evidence	
<p>Performance Task(s):</p> <ul style="list-style-type: none"> • Carbon storage in Local Trees Lab 	<p>Other Evidence:</p> <ul style="list-style-type: none"> • Class discussions • One-on-One teacher questioning
Stage 3 - Learning Plan	
<p>Learning Activities:</p> <p>Materials:</p> <ul style="list-style-type: none"> • Dichotomous Key for Minnesota Trees • Link to SERC Earth Labs: Carbon Storage of Local Trees https://serc.carleton.edu/eslabs/carbon/1b.html • Lab Handout from SERC Website • Access to trees outside • Calculators • String • Meter sticks <ul style="list-style-type: none"> • Give students access to the link with the website for the Carbon in Local Trees Lab from SERC @Carleton.edu • Have students watch the video on the web page about where the mass of trees comes from as a review. https://serc.carleton.edu/eslabs/carbon/1b.html • Give students the lab handout and read through the directions together. • Go outside and have students choose a tree they want to work with. • Students should identify the tree species using a dichotomous key. • Give each group a string and have them wrap it around the trunk of a tree marking the circumference of the tree. • When students have all gathered the needed information they can go back into classroom. 	

- Have students write their measurements and tree species on the board.
- Students should complete the lab and turn it in.
- Students can add up the amount of carbon all of their trees contain.
- Have a class discussion about how much carbon is emitted into the atmosphere each year from humans and how much the trees around them take in.

Lesson 6

Lesson Topic: The Carbon Cycle and Human Activity PSA Grade level: 9-12

Length of lesson: 8 days (Possibly longer depending on student ability)

Stage 1 - Desired Results	
<p>Content Standard(s): 9.4.2.2 Matter cycles and energy flows through different levels of organization of living systems and the physical environment, as chemical elements are combined in different ways.</p> <p>9.4.4.1.2 Describe the social, economic and ecological risks and benefits of changing a natural ecosystem as a result of human activity. For example: Changing the temperature or composition of water, air or soil; altering the populations and communities, developing artificial (MDE, 2009).</p>	
<p>Understanding (s)/goals Students will understand:</p> <ul style="list-style-type: none"> • Human activity has an impact on the cycling of matter throughout our planet. • Matter and energy are constantly being transformed due to human activity. • Climate change is occurring at an increasing rate due to human activity 	<p>Essential Question(s):</p> <ul style="list-style-type: none"> • What human activities are causing climate change? • How are those activities causing climate change? • What are the implications for our future due to climate change?

Student objectives (outcomes):

Students will be able to:

- Use information presented to formulate a research question.
- Conduct research and collect information from credible sources.
- Cite the information they use for their projects.
- Answer their own questions using research.
- Come up with a solution, either global or local, to combat climate change.
- Create a public service announcement to communicate their findings and their solutions.

Stage 2 - Assessment Evidence	
Performance Task(s): <ul style="list-style-type: none"> ● Project/presentation of research ● Public Service Announcement 	Other Evidence: <ul style="list-style-type: none"> ● Group discussions ● Daily reflections and goal setting exit tickets ● One-on-one teacher check-ins ● Student research notes
Stage 3 - Learning Plan	

Learning Activities:

Materials:

- Documentary about climate change
- Questions to go with documentary
- Internet Access
- Handouts #1 and 2 for student research
- Public Service Announcement Handout

Day 1-2:

- On the board have the question “What is climate change and how does it affect me?”
- Watch a documentary on climate change (*Chasing Coral*, *Chasing Ice*, or *An Inconvenient Truth* are good choices, but there are many available.)
- After the film, have a class discussion on students feelings and what they learned. Did they find it credible? (This may be time to review what credible sources are)
- Ask students to write down questions they have after watching the film on the board. (It is important for students to hear others questions)

Day 3:

- Give students 30 minutes to think about and discuss what they are still curious about and have them fill out Student Handout #1 for focusing preliminary ideas. Allow them to start forming groups of 2-4. (Students may work alone if they want to, but they need to be willing to present alone as well)
- Allow the next 20 minutes for research and have students write a reflection on what they came up with and who they are working with.

Day 4:

- Show examples of Public Service Announcements
- Give students Student Handout #2 to help them organize their research. Explain that it doesn't have to be an experiment but they need to understand gaining multiple perspectives on an issue is important to make their research credible.
- Have students make a decision on what they want to research and write-up an exit ticket and how the hour went and what their goal is for the next day.

Day 5-10

- Give the students the handout with the requirements for the PSA. This project can be a presentation, a video, a poster, etc. Students should have choice in how they want to present their work.
- Show students examples of prior student work if available.

- Students should have at least 5 days to work on this project in class.

Day 11

- Gallery walk and presentations of student work. This can a great thing to have before conferences so parents and families can see the work their students are doing.

Sample questions could be:

- Should people all be vegetarians?
- What can I do every day to decrease my carbon footprint?
- Should meat be grown in a lab?
- What are energy alternatives that I can utilize in my life?
- Can the average citizen run their homes off of solar power?
- Should all cars be electric?
- Should the government require people to recycle?

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