Empowering Design Solutions

Companion Lesson to X-STEM All Access Episode "Next Gen STEM"

Grade/ Grade Band: 6-8	**Topic:** Chemical Reactions	

Brief Lesson Description: Next Gen STEM inventor and student Dasia Taylor marries her interests between diversity, equity, and inclusion (DEI) work and science to develop more equitable sutures that are affordable and improve the quality of life for post-surgical patients. Dasia researched and read articles as part of her ideation process. In this lesson students will develop their own solution to a design problem.

Performance Expectation(s):
NGSS MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions by defining precise criteria and constraints and analyze data to assess solution effectiveness.

Specific Learning Outcomes:
Students will be able to define the constraints of a design problem
Students will be able to analyze data from tests to determine the effectiveness of a solution

Narrative / Background Information

Prior Student Knowledge:
Students should be familiar with chemical reactions and be able to describe oxidation as a chemical reaction.
Students should be able to use the design process to solve a problem.
Students should be able to design a test.

Science & Engineering Practices: **Asking Questions and Defining Problems** Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables and clarifying arguments and models. ● Define a design problem that can be solved through the development of an object, tool, process, or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1)	**Disciplinary Core Ideas:** **Defining and Delimiting Engineering Problems** ● The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1)	**Crosscutting Concepts:** **Influence of Science, Engineering, and Technology on Society and the Natural World** ● All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1)

Possible Preconceptions/Misconceptions:
Students may think that because reduction means to lose something, then it must mean that we lose electrons and therefore oxidation is the gaining of electrons. It is in fact the opposite. Try using the mnemonic device OIL RIG (Oxidation Is Losing and Reduction Is Gaining of electrons).

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:
Students are going to view Next Gen STEM with Dasia Taylor and record notes about her ideation process.
(Ans: reading articles (Science News for Students), analyzing data from existing experiments to draw new conclusion (Big Data), identified problem, conduct the experiment, speak with your mentor).

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: Provide students with 2-3 fresh apple slices (sliced in front of students so they can hear the crispness and see the juiciness) and a bag of sliced apples (in ascorbic acid) like they serve in the cafeteria. Ask students to observe for 5 mins noting any changes (i.e., color, odor, texture). Students share observations as a class. Then ask students which apples they prefer to eat and why. Finally ask students what the color change indicates to them?

You may need to point out that the pre-sliced apples in the bag didn't brown or didn't brown as quickly. Be sure to ask the students why these apple slices did not change as much. Also ask students to describe any differences between the freshly cut apples and the pre-sliced apples.

EXPLAIN: Concepts Explained and Vocabulary Defined:
Ask students to think about what keeps apples from browning? To help students understand why the apples turned brown explain it is a chemical reaction with the oxygen in the air and an enzyme in the apples. When an apple is injured (or cut into pieces), the plant tissue is exposed to oxygen. This triggers an enzyme known as **polyphenol oxidase (PPO)** to oxidize polyphenols in the apple's flesh. This chemical reaction is known as **oxidation**. This oxidation process is very sensitive to the ambient temperature; cooler temperatures can slow down the process, warmer temperatures will accelerate it.
(Optional ELA related activity CCSS.ELA-LITERACY.RST.6-8.1)

Making a connection to Dasia's ideation process by sharing a few articles with students about oxidation and food before they design an experiment preventing sliced apples from turning brown. Students record any notes of interest and use their findings to explain how they intend to prevent their apple slices from turning brown.

Possible Articles for Research
Effects of Oxidation on Foods
Oxidized oils in food may be harmful to health from The Detroit News
How to Prevent Cut Fruit from Turning Brown, University of Nebraska-Lincoln
How do I stop my apples from turning brown?, University of Illinois Urbana-Champaign
How to Keep Apples From Browning, Epicurious

Have students design a solution to the problem: **how to stop the apple slices from turning brown so people will enjoy a nice crisp apple**. The design solution can be anything from a substance added to the apples or a container to prevent the oxidation process, based on whatever the students can come up with using the material provided or brought from home.

Vocabulary:
Oxidation- a biological process that involves the loss of electrons in a chemical reaction; a process in which a chemical substance changes because of the addition of oxygen

ELABORATE: Applications and Extensions:
Students will create their designs using the materials available (see suggested materials list) and then test the design.

EVALUATE:

Formative Monitoring (Questioning / Discussion): Ask the students the following questions as they complete their experiment:
a) What is your hypothesis?
b) Is the objective of your design to prevent or to slow down the oxidation process?
c) What data are you collecting?
d) Who does this process benefit?

Summative Assessment (Quiz / Project / Report): Students write a conclusion explaining their results, sources of errors there might have been in the experiment and any changes they would do when performing the experiment again and address the constraints within their experiment.

Elaborate Further / Reflect: Enrichment: Students can make modifications to their designs and retest. Students can share data and identify the best characteristics of each solution to combine and create a new solution.

SOCIAL EMOTIONAL LEARNING ACTIVITY

CASEL Competency: SELF- AWARENESS, SOCIAL AWARENESS
Dasia discusses the importance of remaining curious. Curiosity is a quality related to inquisitive thinking such as exploration, investigation, and learning, evident by observation in humans and other animals. When we consider human development, curiosity is a desire for learning and to acquire knowledge and skills. It is no coincidence a cornerstone of team development is the ability to cultivate natural wonder. This activity is a fun way for students to practice their inquisitive skills. In this version of 21 Questions, students create a list of 20 questions they would like someone to ask them. Collect the questions and then group students in pairs. Randomly handout the sets of questions to each pair. Students take turns asking and answering the questions. Then you pose the 21st question: What did you learn from this activity?

Note: creating the list of questions can be very difficult and students may struggle, remind them this is an exercise to develop their curiosity while simultaneously working on self-awareness and social awareness. You may also provide a few examples i.e.: What is your favorite photo that you took? What do you do when you are feeling sad? What is your favorite thing about hanging out with your best friend? What is one thing you want to accomplish in your life? Remember to be mindful of the pairings and the question lists you assign.

INTERDISCIPLINARY CONNECTIONS/IDEAS

ELA
Completing the optional activity, students read articles related to oxidation cite specific textual evidence to support analysis of experiment.
CCSS.ELA-LITERACY.RST.6-8.1

Materials Required for This Lesson/Activity	
Quantity	**Description**
4 bags per class	Pre-sliced apples (in ascorbic or citric acid)
1 per group	Whole apples
1 per group	Plate or dissecting tray
1 per group	Scalpel or plastic knife
4 per group	Glass beakers or clear plastic cups
2 per group	Clear plastic baggies
100 ml	Alcohol
100 ml	Vinegar
100 ml	Lemons/ Lemon Juice
100 ml	Honey
100 ml	Vegetable Oil
50 cubes	Sugar
1 liter	Water
	Baking Soda
	Salt
	Vitamin C tablets
	Aluminum foil
10 per class	Rubber bands

Lesson Created by Stacy Douglas
For questions, please contact info@usasciencefestival.org