Next Gen STEM

Pages 1-3 Next Gen STEM with Dasia Taylor NGSS & CASEL lesson

Watch the Video Here

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

Pages 4-8 Next Gen STEM with Catherine Kim NGSS & CASEL lesson

Watch the Video Here

Materials Required for This Lesson/Activity	
Quantity	**Description**
6/ team of 4	Resealable plastic sandwich bags
12/team of 4	Paper napkins
6/team of 4	50 ml beakers
Per team of 4	25 ml graduated cylinder

60/team of 4	Radish seeds (in a bag or cup)
1/team of 4	Permanent marker
1	Masking tape
Per student	Latex disposable gloves
Per student	Safety goggles
50 ml	Carbonated soft drink
50 ml	Coffee or tea
50 ml	Fruit & Vegetable cleaner
50 ml	All-purpose disinfectant
50 ml	Filtered water

Next Gen STEM with Dasia Taylor

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.		
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 21^{st} 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

Next Gen STEM with Catherine Kim

Grade/ Grade Band: 6-8	**Topic:** Toxicity-Chemical Interactions	

Brief Lesson Description: One morning Next Gen STEM, bioinformatics researcher, and recent high school graduate Catherine Kim noticed her father taking multiple medications and asked him how they interacted. She went on to investigate the beneficial and harmful effects that a chemical has on an organism. This lesson plan looks at the dosing of a chemical and its effects on a living organism to address why scientists use models to test for toxicity of chemicals. It is based on a curriculum supplement from the National Institutes of Health Office of Science Education and Biological Sciences Curriculum Study.

Performance Expectation(s):
NGSS-MS-PS1-3 Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

Specific Learning Outcomes:
1. Students will use models to establish relationships based on evidence from observations.
2. Students will demonstrate the effects of a chemical on an organism as related to the dose and the resulting concentration of chemical in the organism.
3. Students will demonstrate how toxicity tests enable toxicologists to learn about the responses of living organisms to doses of chemicals (dose-response relationship).

Narrative / Background Information

Prior Student Knowledge:
Students should understand precision and accuracy to make the various concentrated solutions.
Students should be able to define solute, solvent, and solution.
Students should be able to identify if a physical or chemical change has occurred.

Science & Engineering Practices: Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas: PS1.B: Chemical Reactions**	**Crosscutting Concepts: Influence of Science, Engineering and Technology on Society and the Natural World**
Obtaining, evaluating, and communicating information in 6–8 builds on K–5 and progresses to evaluating the merit and validity of ideas and methods. ● Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-PS1-3)	● Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-3)	● The uses of technologies and any limitation on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-PS1-3)

Possible Preconceptions/Misconceptions:
Chemical changes are perceived as additive and not the result of interaction. Sometimes it is difficult to tell if a chemical reaction has taken place but there are basic indicators that chemists use such as a change in temperature or color, development of an odor, formation of a precipitate or gas.

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:
Ask students to record any similarities between their lives and Catherine's as they view Next Gen STEM with Catherine Kim. (Possible ans.: likes to visit science museums, asks a lot of questions/really wants to know the answer to the question why, parents take multiple medications, likes science and math classes).

Ask students if they know what bioinformatic means? This is what Catherine is studying. Tell students bioinformatic is the science of collecting and analyzing complex biological data. Let students know the essential question: Why do scientists use models to test dose-response impact of chemicals?

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: Prior to the lesson the teacher will need to prepare the following materials per team of 4 students:
- 6 resealable plastic sandwich bags
- 12 paper napkins
- 6 50ml beakers

- 1 25ml graduated cylinder
- 60 radish seeds (in a bag or cup)
- 1 permanent marker
- Masking tape
- Latex gloves
- Safety goggles
- Access to the following liquids: carbonated soft drinks, coffee/tea, fruit and vegetable cleaner, all-purpose disinfectant, filtered water, fruit juice

Part 1: Concentrations
Explain that concentration refers to the amount of solute that is dissolved in a solvent. Concentration can be expressed as volume percent when preparing solutions of liquids. [(volume of solute)/(volume of solution)]x 100%= volume percent of the volume of the solution. For example, a 70% rubbing alcohol means when preparing the solution, we added30 ml of water to 70 ml of isopropyl alcohol making 100 ml rubbing alcohol. Out of the total volume 70% is alcohol.

Give each team: 6-50ml beakers, a graduated cylinder, one of the suggested liquids listed, 6 strips of tape, and a marker. Students are going to prepare 20 ml solutions for each of the following concentrations (see table).

Ensure students are wearing the safety goggles and latex gloves. First students create labels for the beakers (0%, 6.25%, 12.5%, 25%, 50%, 100%). Then students measure out water as directed in the table into the labeled beakers. Finally, they added the amount of assigned liquid to make 20 ml of each solution.

Table 1. Percentage concentrations of chemicals to prepare

Beaker #	Amount of water	Amount of chemical	Total volume of liquid	Concentration of chemical
1	20.00 mL	0.00 mL	20 mL	0%
2	18.75 mL	1.25 mL	20 mL	6.25%
3	17.50 mL	2.50 mL	20 mL	12.5%
4	15.00 mL	5.00 mL	20 mL	25%
5	10.00 mL	10.00 mL	20 mL	50%
6	0.00 mL	20.00 mL	20 mL	100%

Ask students to write in their notebooks what they think would happen to a radish seed when exposed to the various concentrations? Then have students share their hypotheses with their team members. Allow 5 minutes for students to discuss why they think the change in concentration would affect the seed (possible ans.: increasing concentration will kill the seed, increasing concentration will make the seed germinate faster/slower, some chemicals would be good for the seed regardless of the concentration).

EXPLAIN: Concepts Explained and Vocabulary Defined:

Explain to students that chemicals can have beneficial and harmful effects on an organism, it depends on the amount of the chemical that gets into the organism. The total amount of chemical administered to, or taken by, an organism is called a **dose**, and a chemical's effect on a living organism is called the *response*. The chemical's effect is related to the dose of the chemical and the resulting concentration of chemical in the organism. **Toxicity** tests enable toxicologists to learn about responses of living organisms, especially humans, to doses of chemicals. Just as Catherine Kim was concerned for her father, it is important to study the interaction chemicals have on organisms using a model.
Part 2: Prepare the treatment bags
Students place 2 folded paper towels in each of the 6 plastic bags. Fill out the labels on the plastic bags with the appropriate information:

- Names
- Bag Number
- Date
- Chemical (the name of the test substance)
- Concentration

Students select one solution to test and measure 5 ml of each concentration into the corresponding labeled bag. Seal the bag and mix the liquid inside the bag so that the entire paper napkin is damp (if needed add more solution 2ml at a time).
Next students count out 10 radish seeds and place them on the wet paper towel in one of the bags. Make sure to spread the seeds out so they have plenty of room between them. Once again, seal the bags and remove as much air as possible. Repeat these steps until all the bags have 10 radish seeds in them.

Lay the bags on a flat surface where they will be safe for the next 3 days and leave them until tomorrow when you will count the number of seeds that germinate.

The next day, without opening the bags, count the number of seeds that have germinated (i.e., have little sprouts growing out of them).

Write the number of germinated and not germinated seeds in the "Seed Toxicity Results" Table (hint: these two numbers should add up to 10 each day).

Repeat this counting for two more days until you have counts for a total of three days and your results table is full.

TABLE 2: SEED TOXICITY RESULTS

Bag #, dose	Day 1 # seeds germinated	Day 1 # seeds not germinated	Day 2 # seeds germinated	Day 2 # seeds not germinated	Day 3 # seeds germinated	Day 3 # seeds not germinated
1 0%						
2 6.25%						
3 12.5%						
4 25%						
5 50%						
6 100%						

Students share data and complete the table for the total number of seeds germinated by day 3.

TABLE 3: RESPONSE OF RADISH SEEDS TO SOLUTIONS OF DIFFERENT CONCENTRATION

Bag #, dose	Day 3 # seeds germinated in CARBONATED SOFT DRINK	Day 3 # seeds germinated in COFFEE	Day 3 # seeds germinated in FRUIT&VEG CLEANER	Day 3 # seeds germinated in DISINFECTANT	Day 3 # seeds germinated in FRUIT JUICE	Day 3 # seeds germinated in FILTERED WATER
1 0%						
2 6.25%						

3 **12.5%**						
4 **25%**						
5 **50%**						
6 **100%**						

Students create a graph to illustrate the data completed on Day 3.

Vocabulary:
Concentration- the measure of how much of a given substance there is mixed with another substance
Dose- the amount of chemical administered or taken
Toxicity- the degree to which a chemical substance or a particular mixture of substances can damage an organism
Chemical Change- a changes that occurs when the composition of a substances is changed

ELABORATE: Applications and Extensions:
Students answer the following questions on their notebooks:

- What was your chemical? Describe what you know about it?
- Do you consider the chemical beneficial, harmful, or neither? Explain your answer using the data collected.
- In which bag was the concentration of the chemical in the solution highest? Describe how you know.
- Was there a difference in the effect on seeds of a small dose of chemical compared with the effect of the larger dose? Explain why you think there was or wasn't a difference.
- What could the chemical be used for?

Students write a conclusion that addresses the essential question: Why do scientists use models to test the impact of the dose-response relationship of chemicals, analyze the data, and make suggestions for further experiments.

EVALUATE:
Formative Monitoring (Questioning / Discussion): Ask the students the following questions after they complete their graphs:

- What impact did you initially expect the substances to have on the seeds? Were your expectations correct?
- How did the setup of the experiment and recording observations go? Did you run into any issues?
- Identify conditions that may not have been consistent across different students (ex. light, temperature). How might this have impacted the seeds? Why might control variables be important?

Summative Assessment (Quiz / Project / Report): Students write a conclusion explaining the graphed 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 essential question: why do scientists use models to test the dose-response relationship impact of chemicals.

Elaborate Further / Reflect: Enrichment: Students research examples of environmental factors that influence the growth of an organism (ex. air/water pollution, floods/droughts, extreme temperatures).

SOCIAL EMOTIONAL LEARNING ACTIVITY

CASEL Competency: SELF-AWARENESS
Catherine Kim talks about being curious in the Next Gen STEM video. Being curious is about being equally inquisitive and creative; it's about putting dreams/ideas into action.

Explain to students that curiosity is a way of developing your self-identity; being curious and investigating your ideas and dreams helps you to define who you are in the world and who you want to be. This activity has students starting a *My Wild Ideas* notebook where they capture imaginative ideas before they get away. Sketches, word clouds, poems, or prose, it's totally however the student feels moved. Every once in a while have students read through their *My Wild Ideas* notebook and make a plan to get the idea into action. It's a wonderful way for students to learn more about themselves.

INTERDISCIPLINARY CONNECTIONS/IDEAS

Math-Students can create scatter plots of the data
CCSS.MATH.CONTENT.8.SP.A.1
Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.
ELA-Students are writing a conclusion for the experiment

CCSS.ELA-LITERACY.WHST.6-8.2
Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

Materials Required for This Lesson/Activity	
Quantity	**Description**
6/ team of 4	Resealable plastic sandwich bags
12/team of 4	Paper napkins
6/team of 4	50 ml beakers
Per team of 4	25 ml graduated cylinder
60/team of 4	Radish seeds (in a bag or cup)
1/team of 4	Permanent marker
1	Masking tape
Per student	Latex disposable gloves
Per student	Safety goggles
50 ml	Carbonated soft drink
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50 ml	Fruit & Vegetable cleaner
50 ml	All-purpose disinfectant
50 ml	Filtered water

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