Science that Saves Lives

Pages 1-4 Science that Saves Lives with Dr. Mika Sovak

Watch the Video Here

Materials Required for This Lesson/Activity	
Quantity	**Description**
Per group (4-6 students)	Blindfolds
Per group (4-6 students)	Ruler
Per group (4-6 students)	Balance/ Scale
Per group (4-6 students)	Thermometer
Per group (4-6 students)	Graduated Cylinder
Per group (4-6 students)	Metal water bottle
Per group (4-6 students)	Plastic water bottle
Per group (4-6 students)	Soda can
	Collection of rocks
	Vegetables or fruits (frozen and fresh)
	Balls (soccer, basketball, football, baseball, tennis ball)
	Shoe box/cardboard box

Pages 5-7 Science that Saves Lives with Dr. Greg Gage

Watch the Video Here

Materials Required for This Lesson/Activity	
Quantity	**Description**
	Dominos
3 rolls	String
3 rolls	Tape
100	Rubber bands (various sizes)
6-8	Clamp stands
	Recyclable materials (from the cafeteria like paper towel tubes, milk containers (crates or cartons), paper bags, cardboard boxes)

2	Buckets
20	Marbles
	Legos
3	Tennis ball/ baseball/ golf ball
20	Dixie Cups
15-30	Balloons
5	Matchbox cars
10	Wooden dowels
Per student	laptops

Science That Saves Lives featuring Dr. Mika Sovak

Grade/ Grade Band 6-12	**Topic:** Communication and Team Building	

Brief Lesson Description: It is important for scientists to be able to communicate their results to a variety of people. In this video Dr. Sovak describes the benefits of having a diverse team. This lesson is designed to teach students why it is important to collaborate with others that don't always think like them.

Performance Expectation(s):

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.

HS-ETS1-2- Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Specific Learning Outcomes:

Students will be able to design a protocol that is inclusive for different types of learners.
Students will be able to explain why working with a diverse team is beneficial to communicating with others.

Narrative / Background Information

Prior Student Knowledge:

Students can define protocol.
Students understand how to design a protocol.

Science & Engineering Practices:

Analyzing and Interpreting Data-Analyzing data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Analyze and interpret data to determine similarities and differences in findings (MS-ETS1-3)

Constructing Explanations and Designing Solutions- Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanation and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2)

Disciplinary Core Ideas:

ETS1.B-Developing Possible Solutions-There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-3)

Sometimes parts of different solutions can be combined to create solution that is better than any of its predecessors. (MS-ETS1-3)

When evaluating solutions, it is important to the into account a range of constraints including cost, safety, reliability, and aesthetics and to consider social, cultural, and environmental impacts. (HS-ETS1-3)

Crosscutting Concepts:

Influence of Science, Engineering, and Technology on Society and the Natural World

- The uses of technologies and any limitations 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. (MS-ETS1-1)

Possible Preconceptions/Misconceptions:

Students may believe that the process of science is purely analytical and does not involve creativity. This may be in part due to the fact that the Scientific Method is often presented as a linear and rigid representation of the process of science, yet many scientists recognize that creative thinking is one of the most important skills.

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:

Today's lesson begins with viewing Dr. Mika Sovak's video Science That Saves Lives. Pose the following question: Why is diversity important to scientific investigation? After viewing the clip, ask students to come up with one word or phrase that summarizes Dr. Mika Sovak's journey. (Possible answers.: teamwork, diversity, respect, multiple intelligence, creativity, communication). Lead a short discussion about the purpose of Dr. Sovak's story to studying STEM.

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:
Procure the following materials prior to the lesson.

- Blindfolds
- Ruler
- Balance/ Scale
- Thermometer
- Graduated Cylinder
- Metal water bottle
- Plastic water bottle
- Soda can
- Rocks
- Vegetables or fruits (frozen and fresh)
- Balls (soccer, basketball, football, baseball, tennis ball)
- Shoe box/cardboard box

Before the investigation ask students: "have you ever been able to identify what was for dinner just by the smell, have you ever reached out to touch something you've never felt before, why did you do that?" Explain to students that there are multiple ways of knowing something and people have different strengths when it comes to learning.

Now ask students to divide into diverse teams of 4. Students should select their own teammates. Be mindful of collaborations by circulating and listening out for comments that may indicate frustration. Lead a discussion asking students what makes their team diverse and how will it lead to successfully completing the investigation.

Give students a blindfold, ruler, balance/scale, thermometer, graduated cylinder and the metal water bottle, plastic water bottle and a soda can. Ask students to design a protocol (a set of rules and guidelines for communicating data) for explaining an object to a person who cannot see the object. Suggest that students create multiple protocols: one using measurements and the instruments for measuring, one using prose and detailed descriptions, and another of their choosing like charades or Pictionary or one that combines the two.

Students will test their protocols: blindfold one teammate, use the protocol to describe the object and have their teammate guess what the object is. Students revise their protocols based on the findings and by answering the following questions:

1. Which objects were the easiest to describe? And why?
2. Which objects were the easiest to identify? And why?
3. Which objects were the most difficult to describe? And why?
4. Which objects were the most difficult to identify? And why?

EXPLAIN: Concepts Explained and Vocabulary Defined:
Diversity in STEM is extremely important. But what is diversity? Why would it be useful in science and engineering? (Ask students to brainstorm). Then share one of the following articles:

- Diversity in STEM: What It Is and Why It Matters, Sept 2014 Scientific American
- Why is Diversity Important for Science?, Fall 2014 Society of Physics Students
- Why Diversity in STEM Matters Nov 2021 Packard Fellowships for Science and Engineering
- Why Diversity In Science Is So Important May 2022 Forbes

Ask students to use evidence from the article(s) to write an answer to *why diversity in science and engineering is important*. (Possible answers: broaden perspectives on research questions, more inclusive data, leading to better results) and *how could diversity improve their protocols*?

Vocabulary:
Diversity- a range of different things, variety

ELABORATE: Applications and Extensions:
Prior to starting the elaboration section of this lesson, you will need to gather the following materials (per group):

- Collection of rocks

- Vegetables or fruits (frozen and fresh)
- Balls (soccer, basketball, football, baseball, tennis ball)
- Shoe box/cardboard box

Explain to students they are going to compete to identify the items in the box using another team's protocol for identifying objects. The winner is the team whose protocol allows the most items to be identified.

Have teams identify the person who will identify the objects and blindfold* them and make sure their backs are turned away from the box. Using the protocol teammates select one item from the assigned box and describe the object without saying the name of the item. Continue selecting items until they are all identified, or time is called (15-18 minutes max).

Students then reflect on the following questions:

1. Which objects were the easiest to describe? And why?
2. Which objects were the easiest to identify? And why?
3. Which objects were the most difficult to describe? And why?
4. Which objects were the most difficult to identify? And why?
5. What did you notice about your ability to describe the objects? What was your strength when it comes to communication?
6. What did you notice about your ability to identify objects? What was your strength when it comes to listening?
7. Did you improve with practice?
8. What were the strengths and weaknesses of the protocol you used?
9. If you had to create a new team, what skills would you be looking for and why?

*Blindfold unless a protocol requires looking at sketches

EVALUATE:

Formative Monitoring (Questioning / Discussion): Students identifying the objects and responses to questions asked during the lesson

Summative Assessment (Quiz / Project / Report): Protocols, written report and answers to the question will determine if students understand how to create an inclusive protocol and why it is important

Elaborate Further / Reflect: Enrichment: Students identify their strengths as learners using this Multiple Intelligences Survey then they recreate a more diverse team to repeat the experiment by creating a new protocol and comparing it with the winning one.

SOCIAL EMOTIONAL LEARNING ACTIVITY

CASEL Competency: Self- Management
The ability to manage one's emotions, thoughts, and behaviors can be tricky in stressful situations. Ask students to think about a stressful situation when their emotions get the best of them. Then have students pair up and share that stressful situation and describe how they behaved. Ask for volunteers to share out loud with the class. Then tell students they are going to learn a quick and easy strategy for managing their emotions and behaviors in stressful situations. Introduce mountain breathing as a mindful breathing technique. Students visualize 5 mountain peaks, they inhale through the nose as they move up the mountain, hold at the peak, then exhale through the mouth visualizing moving down the mountain, and repeat four more times.

INTERDISCIPLINARY CONNECTIONS/IDEAS

CCSS.ELA-Literacy.WHST.9-20.8: **Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.**

CCSS.ELA-LITERACY.SL.8.1: **Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.**

Materials Required for This Lesson/Activity

Quantity	Description
Per group (4-6 students)	Blindfolds
Per group (4-6 students)	Ruler
Per group (4-6 students)	Balance/ Scale
Per group (4-6 students)	Thermometer

Per group (4-6 students)	Graduated Cylinder
Per group (4-6 students)	Metal water bottle
Per group (4-6 students)	Plastic water bottle
Per group (4-6 students)	Soda can
	Collection of rocks
	Vegetables or fruits (frozen and fresh)
	Balls (soccer, basketball, football, baseball, tennis ball)
	Shoe box/cardboard box

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

Science That Saves Lives with Dr. Greg Gage

Grade/ Grade Band 6-12	**Topic:** Neuroscience	

Brief Lesson Description: Dr. Greg Gage is a neuroscientist, and he believes that neuroscience is for everyone. In this lesson, students create a model of a neuron to illustrate how the nervous system sends messages around the body.

Performance Expectation(s):
MS-LS1-2 Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.

MS-ETS1-4 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved

Specific Learning Outcomes:
Students will create a model of a neuron to illustrate how the cell transmits messages in one direction and that one neuron can activate the next.

Narrative / Background Information

Prior Student Knowledge:
Students should know the structures of the nervous system.
Students should be able to describe simple machines and how they are used to modify motion.

Science & Engineering Practices:	**Disciplinary Core Ideas:**	**Crosscutting Concepts:**
Developing and Using Models Constructing explanations and designing Modeling in 6-8 builds on K-5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ● Develop a model to describe phenomena. (MS-LS1-2) ● Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4)	**LS1.A: Structure and Function** Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2) **ETS1.C: Optimizing the Design Solution** The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)	**Structure and Function** Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS1-2)

Possible Preconceptions/Misconceptions: The brain being " hard-wired" is a misconception most people have. We are illustrating with the model that the brain is organized in a way with neurons creating neural pathways like wires and they communicate by releasing a pulse of electricity through ions. And while that is a true description of how neurons function, we need to emphasize that the nervous system is less rigid and more plastic and can change its wiring. An example is when someone is practicing a new skill, like learning to play the violin, the system "rewires" parts of the brain that are responsible for fine motor control. Or how people with brain injuries can recruit other parts of the brain to compensate for the damage. This would not be possible if the nervous system was "hard-wired". This activity does not dispel the misconception. As the educator, you need to highlight how change and adjustments are possible in the nervous system such as learning something new or recovering from an injury.

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:
Ask the students to organize themselves to complete the wave like they were at a sporting event. After the organize themselves have them write down what happened and was their role in making sure the wave was executed accurately.

Show the students the video: Science That Saves Lives with Dr. Greg Gage and ask them to record 2-3 facts that they believe would relate to the wave.

Lead a discussion about the experiment Dr. Gage shared about how you know to turn around when someone taps you on the shoulder. Highlight: using an animal model (similar nervous system to humans), neuron cell structure and function (axon transmits communication, note he mentions electricity), and ethics of experimenting with animals or on yourself, and the brain machine interface.

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:
Prior to the lesson procure as much as you can of the following materials:

- Dominos
- String
- Tape

- Rubber bands
- Clamp stands
- Recyclable materials (from the cafeteria like paper towel tubes, milk containers (crates or cartons), paper bags, cardboard boxes)
- Buckets
- Marbles
- Legos
- Tennis ball/ baseball/ golf ball
- Dixie Cups
- Balloons
- Matchbox cars

You need an assortment of materials that will allow students to get creative. Ask students to bring in items from home.
Students are going to build a Rube Goldberg machine /mousetrap machine to model how neurons send messages.

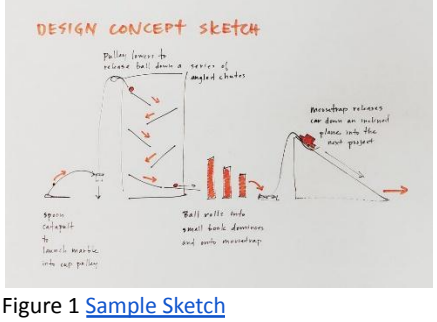

Figure 1 Sample Sketch

In teams of 4, ask students to sketch a plan to create a machine that will pop a balloon in no more than 5 steps.
Once the sketch has been approved (you're looking for 5 or less steps, realistic use of materials based on simple machines: levers, pulleys, inclined plane, wedge, wheel and axle, and screw) the team can build their machine and test it.

EXPLAIN: Concepts Explained and Vocabulary Defined:
Ask students if they've ever wondered why they feel sleepy after the sun sets? Explain that when the sun goes down the pineal gland in the brain secretes the hormone, melatonin, which makes you feel tired. This is just one example of how the brain uses chemical signals and electrical signals through the nervous system to transmit or send messages to other parts of the body. Neurons are composed of 3 parts: cell body, an axon, and dendrites. The cell body is where the nucleus is located; the axon is the long narrow appendage that extends from the cell body to send electrical impulses to the other neurons; the dendrites also extend from the cell body however they are responsible for receiving messages from other neurons at the contact point call a synapse.

Neurons work by sending neurotransmitters (chemicals) across the synapses between the axon of one neuron to the dendrite of another neuron.

Have students label their sketches with the structures of the neuron.

Vocabulary:
Neuron- the cell of the nervous system whose function is to receive sensory inputs from the external environment and sending motor commands to the muscles and transforming and relaying the electrical signals throughout the body.
Cell Body- contains the nucleus and genetic information of the neuron.
Axon- long branch that extends from the cell body carrying information via electrical impulses to the next neuron
Dendrites-short branches extending from the cell body that receives messages from other neurons.
Synapse- the space between neurons when the dendrites of one neuron meets up with the axon of another neuron.

ELABORATE: Applications and Extensions:

Tell students they are going to connect their neurons with the rest of the class to simulate the nervous system. Allow teams to align their "neuron" machines to travel through the classroom and eventually pop a balloon.

Students should be allowed to revise their design however they should not increase the number of steps in each team's design.

After 15 mins and at least 3 tests to pop the balloon, ask students to write a paragraph explaining how the model simulates the nervous system. If the signal failed to travel around the room and pop the balloon, tell students to diagnose the potential issues and propose solutions.

Lead a discussion using the following questions as a guide: What worked well? What would you do differently next time? What were some of the limitations?

EVALUATE:

Formative Monitoring (Questioning / Discussion): The sketch of the machine assesses student understanding of developing a model to generate data

Summative Assessment (Quiz / Project / Report): Students write a summary about the model and how it illustrates a neuron and the nervous system

Elaborate Further / Reflect: Enrichment: Students will investigate the nervous system of a leech in a virtual lab. They will have the opportunity to observe the response to stimuli and map how the leech's nervous systems responds to touch.

SOCIAL EMOTIONAL LEARNING ACTIVITY

CASEL Competency: Self Awareness
The abilities to understand one's own emotions, thoughts, and values and how they influence behavior is extremely valuable to understand. In this activity *Circle of Control* students discuss what things they can control (i.e. things I say, helping people) and what things they cannot control (i.e. other people's reactions, the weather). On chart paper create a graphic organizer drawing 2 large concentric circles, label the inner circle **WHAT I CAN CONTROL** and the outer circle **WHAT I CANNOT CONTROL.** Give students 4-6 Post It notes and ask them to write one example per Post It note. Encourage them to have an equal amount of can vs cannot. When they have written their statements, they can place them on the graphic organizer in the appropriate section. Read aloud the examples and challenge students to focus on the things they can control.

INTERDISCIPLINARY CONNECTIONS/IDEAS

RST.6-8.1 – Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and interest, (MS-ETS1-4)

Materials Required for This Lesson/Activity

Quantity	Description
	Dominos
3 rolls	String
3 rolls	Tape
100	Rubber bands (various sizes)
6-8	Clamp stands
	Recyclable materials (from the cafeteria like paper towel tubes, milk containers (crates or cartons), paper bags, cardboard boxes)
2	Buckets
20	Marbles
	Legos
3	Tennis ball/ baseball/ golf ball
20	Dixie Cups
15-30	Balloons
5	Matchbox cars
10	Wooden dowels
Per student	laptops

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