Real Life Robotics

Pages 1-3 Real Life Robotics with Easton LaChappelle
Watch the Video Here

Materials Required for This Lesson/Activity	
Quantity	**Description**
Per team	Scissors
Per team	Dissection kit
Per team	Dissecting tray/plate
1 pair per student	Plastic/latex gloves
1 per team	Chicken wings (full)
Per team	Ruler/measuring tape
5 per team	Straws
5 per team	Popsicle sticks
1 box per class	Paper Clips
5 per team	Rubber bands
1 meter per team	String/Twine
Per team	Plastic/latex gloves
	Molding clay
20	Cardboard tube
1 roll per class	Duct Tape
2 per class	Small sponges (students can cut)
	Bubble Wrap (optional)
	Fishing Wire (optional)
	electric motors with circuit wires (battery or solar operated) (optional)

Pages 4-6 Real Life Robotics with Jasmine Lawrence
Watch the Video Here

Materials Required for This Lesson/Activity	
Quantity	**Description**
Per student	Laptops
	Cardboard (collected from staff and students)
Per team of 4	Scissors
Per team of 4	Glue
2 m per team	String

4 per team	Pipe cleaners
4 per team	Dowels
2 rolls per class	Tape
	Plastic bottles (collected from staff and students)
	A *Crash Course in Forces and Motion with Max Axiom* by Emily Sohn

Real Life Robotics with Easton LaChappelle

Grade/ Grade Band: 6-12	**Topic:** Engineering Design	

Brief Lesson Description: Students will meet Easton LaChappelle, an entrepreneur and tech designer who started a business that creates robotic prosthetics. During this lesson students will be able to demonstrate their understanding of the interaction between body systems (muscular and skeletal systems) and the engineering design process to create their own model of a prosthetic limb.

In advance of the lesson, you should gather structural material resources. Take the time to collect as many resources as you can, the more resources available the more creative students will be.

(Possible materials: ruler/measuring tape, straws, paper clips, clay, rubber bands, string, fishing wire, twine, cardboard tube (like discarded paper towel roll), cardstock, sponges, bubble wrap, duct tape, popsicle sticks, plastic/latex gloves, electric motors with circuit wires (battery or solar operated)

Performance Expectation(s):
NGSS HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

Specific Learning Outcomes:

1. Students will explain interactions between the skeletal and the muscular systems during movement.
2. Students will design and build a prosthetic hand with the ability to grasp

Narrative / Background Information

Prior Student Knowledge:
Students should be able to describe the structures that make up the skeletal, muscular, and nervous systems and explain the functions of each structure and the overall system.

Science & Engineering Practices: **Developing and Using Models**	**Disciplinary Core Ideas:** **Structure and Function**	**Crosscutting Concepts:** **Systems and System Models**
Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world. ● Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2)	● Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS-1)	● Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions— including energy, matter, and information flows—within and between systems at different scales. (HS-LS-1)

Possible Preconceptions/Misconceptions: Some students may believe that bones move the body independent of the other body systems, however, bones provide the structure to interact with muscles for movement.

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:
Prior to starting this activity, you will need the following items:

- Whole chicken wings (1 per team of 4)
- Dissecting kits, basic (1 per team)
- Dissecting trays or reusable plates (1 per team of 4)
- Disposable latex/plastic gloves
- Safety goggles
- Clorox Wipes

Students will carefully observe a chicken wing. They will record initial observations of the wing. Then students will manipulate the wing to investigate movement and record observations of how the wing moves. Finally, students will sketch and label a diagram of the wing.

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:
Prior to exploring, students will need a dissecting kit (scalpel, probe, and scissors) and the materials listed in the "Engage" activity.

Students will dissect their chicken wings to expose the skeletal and muscular systems. The teacher should model the skin removal using the scissors from the dissection kits to create an incision and carefully remove only the skin and not damage the muscles and tendons. Once the

skin has been removed, students will observe the muscles. To prevent cross contamination, one student should be assigned to record observations and sketch and label what happens as the muscles are moved. Be sure to point out the biceps and triceps and any visible tendons.
Next students will carefully remove the muscles so not to damage the ligaments and bones. Once the muscles have been removed, students will observe the skeletal system of the wing. One student should be assigned to record observations and sketch. The team can label the bones, ligaments, and joints. The teacher may need to highlight the shoulder, so students are able to identify the type of joint.

Students carefully dispose of waste and wipe down dissection kits and any surfaces they worked on before thoroughly washing their hands.

EXPLAIN: Concepts Explained and Vocabulary Defined:

Begin with a KWL. chart. Ask students to record what they know about and any questions they have about prosthetics. Watching the video, Real-Life Robotics with Easton LaChappelle, students should add to their KWL.

After viewing Real-Life Robotics with Easton LaChappelle, ask students to share what they recorded in their KWL notes.

Let students know their task is to design and build a working prosthetic hand that can grasp an item. Have students brainstorm what are some important features required for a good prosthetic hand. (possible ans.: strength, flexibility, comfort, lifelikeness)

Vocabulary:
prosthetic-denoting an artificial body part, such as a limb

ELABORATE: Applications and Extensions:
Prior to starting the elaboration section of this lesson, you will need to gather as many building materials as possible (see lesson description for suggested materials list).

Define the design process as a series of steps that guides engineering teams to solving problems. The steps are 1) identify a need/problem, 2) research the problem, 3) sketch possible solutions/designs, 4) select the best solution/design, 5) make a model/prototype of solution, 6) test and evaluate the effectiveness of the solution/design, 7) communicate findings and reflections, and 8) redesign the solution based on the evaluation and reflections.

Group students into teams of 4-5.

Remind the teams that the problem is to design and build a prototype of a prosthetic hand with the ability to grasp an object. Have students independently sketch their design solution(s) for 3-5 mins before meeting as a team to discuss and select the best design solution. Once teams have selected their design solution, they should begin creating the prototype which illustrates how the skeletal and muscular systems interact.

Note: the research portion of the design process should be based on the chicken wing observations and the Easton LeChappelle video.

EVALUATE:

Formative Monitoring (Questioning / Discussion): Students demonstrate their working prototype, explaining how the two (or three) body systems work together.

Summative Assessment (Quiz / Project / Report): Written Design Process report including the redesign ideas and a conclusion answering the following questions:

- □ What improvements would you make to your prototype?
- □ What other materials and fasteners would help improve your design?
- □ What would be different if you had to make the entire arm up to the shoulder?

Elaborate Further / Reflect: Enrichment: Redesign the device and test the improvements.

SOCIAL EMOTIONAL LEARNING ACTIVITY
Self-Awareness and Self-Management At the end of Easton Chappelle's presentation (20:50), he discusses pushing boundaries and creating the future. The first bit of advice he offers is "Take a step back and look at things differently". This is a key step to building resilience. **Learning From My Work** is an activity from PositivePsychology.com. In this activity students develop resilience by setting realistic goals, striving towards them, learning from their mistakes, and trying again. The activity presents nine (9) dichotomous pairs of statements and asks students to indicate how they feel about an assignment regarding the statements. The objective is to have a strategy for looking back and reflecting on their work, in order to make adjustments on future assignments helping students to discover when they are satisfied with their work and where they might need to devote a little more time and attention. One set of statements is not better than the other; it's a balancing act and their feeling should change depending on the goals they set and the assignment they are reflecting on.
INTERDISCIPLINARY CONNECTIONS/IDEAS
Math- Ask students to calculate the cost of building their prosthesis before and after improvements. Then ask students how they could make the prosthetic more cost efficient if it was designed for a growing child. **ELA**- During this lesson, students conduct a short research project to answer a question using multiple sources which aligns with Common Core Writing Standards

Materials Required for This Lesson/Activity	
Quantity	**Description**
Per team	Scissors
Per team	Dissection kit
Per team	Dissecting tray/plate
1 pair per student	Plastic/latex gloves
1 per team	Chicken wings (full)
Per team	Ruler/measuring tape
5 per team	Straws
5 per team	Popsicle sticks
1 box per class	Paper Clips
5 per team	Rubber bands
1 meter per team	String/Twine
Per team	Plastic/latex gloves
	Molding clay
20	Cardboard tube
1 roll per class	Duct Tape
2 per class	Small sponges (students can cut)
	Bubble Wrap (optional)
	Fishing Wire (optional)
	electric motors with circuit wires (battery or solar operated) (optional)

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

Real Life Robotics with Jasmine Lawrence

Grade/ Grade Band 6-12	**Topic:** Engineering Design	

Brief Lesson Description: Robotics Engineer and Entrepreneur Jasmine Lawrence has combined her love of science and engineering to solve real-world problems. This lesson emphasizes the engineering design process. It can be a culminating activity to a unit on Forces and Motion with lessons on Newton's Laws of Motion. Students will use their knowledge of simple machines to design a device and make a prototype that solves a problem facing senior citizens like their grandparents and/or a person with limited mobility.

Performance Expectation(s):
NGSS 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.
NGSS MS-PS2-1 Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.

Specific Learning Outcomes:

1. Students will use the design process to solve a real-world problem creatively.
2. Students will demonstrate the use of at least 2 simple machines in their prototype.
3. Students will describe Newton's Third Law as it impacted their design.

Narrative / Background Information

Prior Student Knowledge:
Students should be able to describe and provide examples of simple machines and their uses. Students should be able to state Newton's third law and provide real-world examples. Students should also be familiar with the engineering design process.

Science & Engineering Practices:
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6-8 builds on K-5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Apply scientific ideas or principles to design an object, tool, process, or system. (MS-PS2-1)

Developing and Using Models 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 generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS-1-4)

Disciplinary Core Ideas:
ETS1.B: Developing Possible Solutions

- Models of all kinds are important for testing solutions. (MS-ETS-1-4)

PS2.A: Forces and Motions

- For any pair of interacting objects, the force exerted by the first object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law) (MS-PS2-1)

Crosscutting Concepts:
Systems and Systems Models

- Models can be used to represent systems and their interactions-such as inputs, processes, and outputs-and energy and matter flows within systems. (MS-PS2-1)

Influence of Science, Engineering, Technology and Applications of Science

- The uses of technologies and any limitations on their use are driven by individuals 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-PS2-1)

Possible Preconceptions/Misconceptions:

1. In Newton's third law, students may believe that equal force pairs cancel out resulting in no motion.
2. Simple machines decrease the amount of work being done.

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:
Explain to students before watching the video that they are to WSQ (whisk)-Watch (take notes), Summarize (write a summary), Question (write 2-3 questions about the video). Show the video Real Life Robotics with Jasmine Lawrence. Allow students 2-3 minutes to write their summary and questions before sharing as a class.

Explain to students (if they have not identified) that Jasmine was an engineer from age 8, always solving problems that impacted her directly before moving into careers where she impacts the lives of others.

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:
Prior to the lesson gather the following material(s):

- *A Crash Course in Forces and Motion with Max Axiom* by Emily Sohn (optional interdisciplinary activity)

Ask students to brainstorm what they think might be an issue faced by their grandparents or a person with limited mobility and list them all. Ask students to identify the problems that can be addressed by design.

(Optional Activity: Read aloud *A Crash Course in Forces and Motion with Max Axiom* pages 4-17, this selection discusses forces and motion. Students choose an amusement park ride and write a few sentences explaining one of the laws of motion that makes the ride work and identify the simple machines found in the design of the ride. Ask students to share their descriptions. This is an opportunity to refresh students' minds about the everyday uses of simple machines and the laws of motion. It's a great place to address any misconceptions- simple machines make work easier by changing the size/direction of the force and in terms of the 3rd law of motion, forces don't cancel but act on a different object.)

Now ask students to create their own engineering team of four (4) to create a solution to one of the problems that was identified as having a design solution.

EXPLAIN: Concepts Explained and Vocabulary Defined:
Teacher will explain the design process. Define the design process as a series of steps that guides engineering teams to solve problems. The steps are 1) identify a need/problem, 2) research the problem, 3) sketch possible solutions/designs, 4) select the best solution/design, 5) make a model/prototype of solution, 6) test and evaluate the effectiveness of the solution/design, 7) communicate findings and reflections, and 8) redesign the solution based on the evaluation and reflections.

Vocabulary: design process- a series of steps that guides engineering teams to solve problems

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

- Cardboard
- String or flexible wire (like pipe cleaners)
- Plastic bottles
- Dowels (various sizes)
- Scissors
- Tape
- Glue
- Marbles (for testing prototypes)

First ensure each team has selected a problem that has a design solution. Once the team has recorded the problem, allow 5-10 mins to research the problem online (you may want to have a folder with specific websites). Tell students to independently sketch their design solution(s) for 5-8 mins before meeting as a team to discuss and select the best design solution. Once teams have selected their design solution, they should begin creating the prototype which includes a simple machine and test it 3 times before writing their presentation.

EVALUATE:

Formative Monitoring (Questioning / Discussion): Students demonstrate their working prototype, explaining how the laws of motions and the simple machines work to solve the problem. (The test could be transporting marble(s) from one point to another either vertically, horizontally, or both)

Summative Assessment (Quiz Project / Report): Written Design Process report including the redesign ideas.

Elaborate Further / Reflect: Enrichment: Redesign the device and test the improvements.

SOCIAL EMOTIONAL LEARNING ACTIVITY

Relationship Skills
When Jasmine Lawrence shares her top takeaway she says, "Our job is to love people" (53:21). The ability to establish and maintain healthy and supportive relationships requires work and practice. Students need time to practice communicating effectively, working in teams, standing up for each other and seeking support and help when needed. Here are two activities that support the development of positive relationships.
First activity is called **Fishing for Compliments**. This is an opportunity for students to reflect on their interactions with peers and write something nice about them/give a compliment. All you need is a sheet of paper with each student's name on it, then pass the paper around the class. When students receive the page, they provide a compliment (*a polite statement of praise or admiration*). Once the sheets of paper have circulated to at least 10 students, collect them (you may want to read over them before) then return to the student's whose name is on top to read through.
The second activity is called **Overcoming Problems- Breakthrough not Breakdown**. With this activity students practice seeking support and

helping when needed. Explain to students that problems can often seem hard to solve, for some people it's like facing a brick wall. Ask students, without taking the problem on, what problems could they help solve and who would they be able to help. Students create a list of the names of the people they believe they could help and the problem they would help remove. Then students share privately with the individual they can help or students, without saying the names, share the kinds of problems that need solving. If sharing as a whole class, students should make broad statements, like making new friends, studying for math tests, or talking with adults/teachers.
INTERDISCIPLINARY CONNECTIONS/IDEAS
English Language Arts: Students use the graphic novel, A *Crash Course in Forces and Motion with Max Axiom* by Emily Sohn and cite specific textual evidence to support the analysis of the laws of motion in amusement park rides. (See optional activity) During this lesson, students conduct a short research project to answer a question using multiple sources which aligns with Common Core Standard WHST.6-8.7

Materials Required for This Lesson/Activity	
Quantity	**Description**
Per student	Laptops
	Cardboard (collected from staff and students)
Per team of 4	Scissors
Per team of 4	Glue
2 m per team	String
4 per team	Pipe cleaners
4 per team	Dowels
2 rolls per class	Tape
	Plastic bottles (collected from staff and students)
	A *Crash Course in Forces and Motion with Max Axiom* by Emily Sohn

Lesson Created by Stacy Douglass
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