Innovations in Prosthetics

Companion Lesson to X-STEM All Access Lesson "Real- Life Robotics"

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:	**Disciplinary Core Ideas:**	**Crosscutting Concepts:**
Developing and Using 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)	**Structure and Function** ● 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)	**Systems and System Models** ● 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)

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