STEM TOOLKIT ACTIVITY

Robotic Hand

SOCIAL-EMOTIONAL CONNECTION: Social Awareness GRADES: 5th TIME: 90 Minutes INSTRUCTOR

EXPERIENCE: Intermediate

OBJECTIVES: Obtain, evaluate, and communicate information about the relationship between tension and engineering engagement.

ESSENTIAL QUESTION: How can a prosthetic (fake) hand be used as a metaphor for understanding complex systems and processes in the real world?

MATERIALS:

- Book- Noticing by Kobi Yamada
- Construction paper
- A pen or pencil
- Scissors
- Tape
- Drinking Straws
- Jumbo Straw

STANDARDS: VA STEM
5.1a-f;5.3c and e

SCIENTIFIC AND ENGINEERING PRACTICES:

plan and conduct an investigation related to tension and the movement of an object

plan and conduct an investigation to determine the effect of tension on moving objects

Lesson delivery note: This lesson is designed to take approximately 90 minutes. Adapt the lesson to fit the amount of available time.

INSTRUCTIONS

1. Ask (5 minutes)

- **True or false?** There are 27 individual bones in the human hands? True! Those bones help us raise out hands in class, grab candy, do handstands, an so much more. Our hands were the inspiration behind the robotic claw.
- **True of False?** There are no muscles in your fingers? True! Yout fingers don't have muscles, but they can still flex because they're connected to muscle groups in your arm and hand. When you make large hand movements- like throwing a ball- you're using muscles in your forearm. When you use fine motor control - like flipping a coin- you're using muscles inside the hand itself.

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- Did you know humans are the only animals that can make tehri thumbs touch their ring finger and pinky?
- Encourage students to feel how their arm muscles connect to their fingers with the little trick: Hold out your left arm with your hand relaxed. Then press your right thumb into your left forearm. When you press down, your fingers will curl up! (Hint: If it doesn't work the first time, move your thumb and try a different spot until you find one that works.)

2. Research (15 minutes)

• Read the book *Noticing* by Kobi Yamada.

• Hold up the book and ask students to join you for a whole group read aloud.

★ Preview the book by showing the cover and the images.
★ Read the story aloud, pausing periodically to ask students:
  - Why is noticing your surroundings important?
  - How does the child's perspective towards the idea of noticing the mundane change throughout the story? What does that convey about creativity?
  - In what ways can the message of the book be applied to our own lives?
★ Now, we are going to connect this powerful message to our upcoming robotic hand challenge. Your challenge is not just to build a robotic hand; it's to bring an idea to life. The robotic hand is your idea, and it's your task to nurture it, refine it, and use it to pick up items successfully.
★ Today, we are going to build a robotic hand. Can you find some examples online?

Video : Robotic Hand Science Project | Simple Paper Robot Hand for Kids | STEM Activity

• How does tension affect a robotic hand?

3. Connect to Careers (2 minutes) Industrial Engineers: video

➔ What do industrial engineers focus on?
  ◆ Data sciences
➔ What skills mentioned would make someone a good fit for industrial engineering?
  ◆ Broad range of interests, enjoys working with data, and caring about people
➔ What kind of career options are available for industrial engineers?
  ◆ So many options are available, such as manufacturing technicians, industrial mechanics, and electricians, to name a few!

4. Tinker to Discover (10 minutes)

1. Divide the students into small groups and distribute materials.

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2. Instruct students to brainstorm and sketch out their designs for a robotic hand using paper and straws. Encourage students to think about how they can mimic the movements of a real hand.

3. Remind students to consider factors such as flexibility, grip strength, and the range of motion in their designs.

5. Build a Prototype (15 minutes)

1. Emphasize the importance of planning and sketching a design before starting to build. Do this by introducing the key vocabulary terms below.

- Force: a push or pull
- Prosthetics: the science of making artificial body parts
- Joint: A connection between two points
- Friction: A force that fights slipping and sliding when two surfaces rub against each other
- Tension: the force transmitted through a rope, string or wire when pulled by forces acting from opposite sides.

2. Using the materials provided, each group should design and build their robotic hand. Guide students as they begin constructing, based on their designs. Remind them to use scissors carefully and to cooperate with their group members. Encourage students to experiment with different arrangements and combinations of paper and straws to achieve the desired movements and functionalities.

DIRECTIONS:

Step 1: Create the Hand Outline

- Start by placing your hand flat on a piece of paper.
- Use a marker or pen to trace around your hand, leaving some space around the edges for the prosthetic hand.
- Once you've traced your hand, carefully cut out the hand shape using scissors. This will be the base of your prosthetic hand.

Step 2: Make Finger Straws

- Cut several drinking straws into smaller pieces, each about the length of your fingers.
- These will serve as the bones of your prosthetic fingers.

Step 3: Attach Fingers to Hand Base

- Arrange the cut straws along the fingers of the paper hand base.
- Use tape to securely attach the straws to the hand base, lining them up with each finger outline.

Step 4: Create Joints

- To allow movement in the fingers, you'll need to create joints.
- Cut smaller pieces of straw to act as joints and attach them to the finger segments using tape.

- Ensure that the joints are positioned where your natural finger joints would be for realistic movement.

Step 5: Add Tendons

- If you want to add more realism and functionality to your prosthetic hand, you can create tendons using string or thin elastic.
- Cut small pieces of string or elastic and attach them from the base of each finger to the joints using tape.
- This will allow the fingers to move when the tendons are pulled.

Step 6: Reinforce and Adjust

- Once you've attached all the fingers and joints, reinforce any weak spots with additional tape.
- Test the movement of your prosthetic hand by gently bending the fingers.
- If any adjustments are needed, trim or reposition the straws and tape as necessary.

Step 7: Final Touches

- Once you're satisfied with the movement and stability of your prosthetic hand, you can add any additional decorations or details.
- You can paint the hand, add fingernail shapes using colored paper, or decorate it in any way you like.

6. Test & Improve (25 minutes)

• Once students have completed their robotic hands, allow time to test their creations.
• Have students explore the range of motion and functionality of their robotic hands by picking up objects or performing simple tasks. Observe any problem areas where the robotic hand doesn't work.
• Make adjustments and improvements based on observations and feedback from peers.

7. Discuss and Reflect (10 minutes)

• What challenges did you face when building your robotic hand?
• How did you overcome these challenges?
• What would you do differently next time?
• What principles of engineering did you see in action?

EXTENSION ACTIVITIES

- Robotic Hand Competition: Create criteria for scoring (who can hold the heaviest object, etc.)
- Storytelling: Have students tell a story or narrative using their robotic hand as a key piece of the story.
- Challenge students to further enhance their robotic hands by adding additional features or improving upon existing functionalities.
- Have students research famous inventors or engineers who have made significant contributions to the field of prosthetics and robotics, and present their findings to the class.

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