5E Integrated STEM Lesson Plan

Lesson Title: Robotic Arm

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Topic: This lesson engages students in the design, creation, and use of a robotic arm that can pick up a pencil box. The robotic arms will be constructed using cardboard, rubber bands, string, plastic straws, duct tape, and brass tabs. The activity includes discussions, construction of a functioning arm, a rubric, and a short video clip that enhances the purpose of the activity.

Targeted Grade Level: Middle school (grades 6-8)

Time Needed: 5 (40 minutes) classes

Subject Integration: Engineering, Science, Visual Arts and History

Justification:

Engineering- Students will create a robotic arm by designing their own from square one

Science- Students will use levers, tension, and compression in the creation and operation of their robotic arm

History-Students will explore the history and evolution of the robotic arm and robotics in general.

Arts-Students will create an initial and final concept drawing of their design.

Standards:

- 3-PS2-1 Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
- MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

- 3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- VA:Cr2.1.8a Demonstrate willingness to experiment, innovate, and take risks to pursue ideas, forms, and meanings that emerge in the process of artmaking or designing

NGSS Performance Expectations

- 3-PS2-1 Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
- MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- 3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts:
• Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. ○ Students will observe the function of their designs after design and redesign. Students will identify the problem, brainstorming the design, build, test, and evaluate to complete the best use of the robotic arm as they attempt to pick up objects	• Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. ○ The success of the arm design will be if the students can lift the box. Through problem solving, students can see how different robotic arms worked and how others failed and will use that data to improve their own design.	• Substructures have shapes and parts that serve functions. ○ Reiterate to the students that each part of the robo arm (cardboard, fasteners, string and guidelines) all serve to make the arm function.

Common Core State Standards
ELA: *CCSS.ELA-LITERACY.SL.8.4*- Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.
ITEEA Standards
K 6-8 1.F- New products and systems can be developed to solve problems or to help do things that could not be done without *K 6-8 9.H- Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.*
National Art Standards
VA:Cr2.1.8a Demonstrate willingness to experiment, innovate, and take risks to pursue ideas, forms, and meanings that emerge in the process of artmaking or designing

Measurable Student Learning Objectives:

- Students will be able to design and explain how to build a robotic arm that can lift a cup off a table. (DOK 2)
- Students will be able to explain the impact the robotic arm has on the exploration of Mars. (DOK 4)
- Students will be able to explain technological advances in personal prosthetics made possible by robotics. (DOK 4)
- Students will be able to create an initial and final design of their robotic arm.(DOK 2)

Nature of STEM: This assignment addresses the Nature of Engineering through the observation, implementation, and active nature of researching designing and building the robotic arm. This assignment also covers the nature of science as it embraces the scientific method in order to find the best solution for building the robotic arm.

Nature of Technology is addressed by exploring the system of people and organizations, knowledge, processes, and devices that go into creating and operating technological artifacts, as well as the artifacts themselves. Throughout history, humans have created technology to satisfy their wants and needs, and this lesson explores why we would need such technology.

Engaging Context/Phenomena:

- *https://www.youtube.com/watch?time_continue=60&v=TQLaICxXQLk&feature=emb_logo*
- *https://www.youtube.com/watch?v=7cmJfZD5mLo*
- *https://www.youtube.com/watch?v=GgTwa3CPrIE*

Data Integration: Students will be required to design and redesign their robotic arm to improve its overall performance. Assessment questions and the rubric help to guide the progress of the students. To best monitor progress, students will record the changes made to their projects and any observations of how it performed each time they redesigned in their journals.

Differentiation of Instruction: In order to differentiate the project, I will allow this to be done individually or with a partner. I will also allow students to design and test their robotic arms in an online or cloud based software, such as a CAD program. Students will also be provided additional research assistance should they need it from the school library media teacher.

Real-life Connection: The Mars Rover is using robotic arms in order to collect data from beneath the surface of the Red Planet. Prosthetics are now using small motors and neural connectors in order to change a simple prosthetic arm into fully functioning robotic limbs. Students will be able to witness this technology through the viewing of multiple videos showcasing the advancement of prosthesis technologies.

Possible Misconceptions: Where would they need the use of a robotic arm? Unless they choose to go into skilled robotics or manufacturing, will they ever need this technology. I will link them to the simple use of a claw in an arcade claw game to draw them back should this happen.’

Lesson Procedure

5E Model	5E Objectives
Engage *Introduce the lesson with an anchoring phenomenon. Facilitate student questions, discussion, etc. as appropriate. Learn about what students already know and want to know.*	**Procedure:** Students will watch videos on the use of a robotic arm by the Mars rover, as well as the technology presented in robotic replacement limbs, or prosthetics. Students will document their “KWL’s” (Know, Wanna Know, Learned) in their classroom journals based on simply the video presentations. On the board, I will provide questions for the students to answer about the videos. **Modifications:** The instructor will provide a transcript of the videos used in the classroom. **Standards Addressed:** MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **Formative/Summative Assessments:** Students will be recording their answers as well as their KWL chart in their journal. The instructor will review the journals to decide the level of understanding by the students. **Resources:** • *https://www.youtube.com/watch?time_continue=60&v=TQLalCxXQLk&feature=emb_logo* *(Inside InSight - Ghanaian Engineer Works on Robotic Arms for Mars)* • *https://www.youtube.com/watch?v=7cmJfZD5mLo* *(Real World: Robotic Arms)*

	• https://www.youtube.com/watch?v=GgTwa3CPrIE *(Beyond bionics: how the future of prosthetics is redefining humanity)*
Explore *Plan for students to engage in hands-on activities that are designed to facilitate conceptual change.*	**Procedure:** Students will create a robotic arm that can pick up a pencil box off of a table. They will be creating an initial drawn design of a robotic arm they wish to create. They will be designing their arms to perform the task and will create a journal documenting any changes they make to their designs. The teacher will be walking around giving limited guidance and supporting students with critical thinking answers and questions. Once the students have a final engineered project, they will complete their finalized drawn design. **Modifications** Additional one-on-one support will be provided during the practical, or project based, side of the lesson. The instructor will be walking around the room and the workstations to assess the level of interaction needed by students. **Standards Addressed:** VA:Cr2.1.8a Demonstrate willingness to experiment, innovate, and take risks to pursue ideas, forms, and meanings that emerge in the process of artmaking or designing 3-PS2-1 Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. **Formative/Summative Assessments:** Students will create a journal documenting any changes they make to their designs and observations of how it performed each time they redesigned in their journals. Students will create a drawn initial and final design of their robotic arm. **Resources:** Project worksheet “See Appendix A”

Explain *Facilitate opportunities for students to explain their understanding of concepts and processes and make sense of new concepts.*	**Procedure:** Students will give a presentation of their solution to the challenge and demonstrate their robotic arm. The teacher will be grading the students based on a rubric. Both the student peers and the instructor will provide feedback and overall scores for the projects. **Modifications:** Students will be given the option to either present one-on-one with the instructor or to record their presentation using Flipgrid, to accommodate those who struggle speaking in large groups. **Standards Addressed:** 3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. **Formative/Summative Assessments:** Students will be graded based on a rubric **Resources:** Rubric "See Appendix B"
Elaborate *Provide applications of concepts and opportunities to challenge and deep ideas; build on or extend understanding and skills.*	**Procedure:** Using MESA guidelines,students will create a more elaborate prosthetic arm capable of grasping and throwing a bean bag. **Standards Addressed:** MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **Formative/Summative Assessments:** Students will participate in the MESA competition **Resources:** MESA guidelines "See Appendix C".
Evaluate *Assess students knowledge, skills and abilities.*	**Procedure:** *Using the MESA guidelines, the students will compete with their prosthetic arm against 30 other middle schools. The students will have to operate their prosthetic arm and throw as many bean bags into the Target Zone as fast as possible.* **Standards Addressed:** *MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.*

	Formative/Summative Assessments: *Together as a class, we will review the judges comments and scores. We will discuss how we could fix the robotic arms to receive full points next time.* **Resources:** *Competition Judges comments and score cards*

Teacher Background:

The teacher should have the basic knowledge of the Curiosity Rover as well as the basic knowledge of simple machines that use levers, compression and decompression.

Teacher Resources

Mars Curiosity Rover : https://mars.nasa.gov/msl/home/

Simple Machines: https://www.teachengineering.org/lessons/view/cub_simple_lesson01