STEM Lesson - Hydraulic Machine

STEM Challenge – Hydraulic Powered Robot Arm Challenge

Each group in a class is challenged to build a hydraulic machine suitable to lift the materials given.

Grade/Level: 7

Overview: Constructing Hydraulic machines by understanding and applying mechanical and hydraulic systems using EDP Process.

Learning standards:

Students demonstrate an understanding of the process and phenomena of fluid mechanisms.

Students demonstrate applying scientific concepts in daily life and solving problems

Students demonstrate an exhibition of creativity in designing models using eco-friendly resources.

Problem Statement: How to build a machine to lift the provided material?

Learning Outcomes:

- Use and understand the Engineering Design Process when designing and building hydraulic systems.
- Understand the science behind hydraulic and pneumatics systems.
- Research and discuss terms used in hydraulic and pneumatics systems.
- Discuss operational principles of hydraulic and pneumatics systems.
- Describe the basic principle of Pascal's law.

STEM Connect:

Science inquiry: Pascal law, multiplication of force
Technical Literacy: Fluid Mechanism
Engineering Process: Hydraulic & pneumatics
Mathematical thinking: Measurement & Exponents

Materials Required:

1. Cardboard – 10
2. Tubes
3. Syringes – 8
4. Screws – 20
5. Simple machines – cutter, scissors, drill
6. Ruler, pencil

Background Information:

Hydraulic systems are used in many different types of machines: control surfaces on airplanes, elevators, automobile lifts, and backhoes. The idea behind a hydraulic system is very simple: a force that is applied at one point is transmitted to the second point using an incompressible fluid. The fluid may be some sort of oil. The force is almost always multiplied in the process. Hydraulic machines' working is based on the pascal law.

Students will design the hydraulic machine applying pascal law using the EDP process.

Engineering Design Process:

Identify - Define the problem of building a machine to lift the provided material.
Brainstorm - possible solutions to the problem: what mechanism can we use to build the design to lift the materials?
Select - Sketch the ideas(design) for the lifting mechanism on the paper.
Prototype - Build the Hydraulic Powered Robot Arm.
Iterate - Test your design by lifting the weightless big objects and checking how it is functioning. If required improvise the working model.
Communicate - Write down step-by-step instructions that explain how to build the Hydraulic Powered Robot Arm and its mechanism.

Implementation Procedure:

Pre-session:

- Discuss with other teachers to understand the cross-curricular connection.
- Prepare the materials required for the prerequisite and challenge session.
- Equip students with the prerequisite knowledge for the challenge session through the instruction process.
- Divide the class into teams of 4-5 students.
- Prepare the materials required for each group to construct the model.

Process:

- Answer the questionnaire on pascal's law & Fluid Mechanics and multiplication and variation of force. (5 minutes)
- Teacher will provide the problem statement and students will understand the problem connecting with real life. (2 minutes)
- Students will brainstorm and do research on possible solutions to the challenge. They will look for pictures of other mechanical arms (or parts of arms) that perform functions similar to the ones that they must perform. Understand the connection and choose the best mechanism to lift the provided material. (3 minutes)
- Sketch the designs of their working model and discuss the pros and cons of each design and go for the best. (8 minutes)

- Constructs the simple Hydraulic Powered Robot Arm according to the final design. (20 minutes)
- Test the prototype.
- Redesign or reconstruct the model if required.
- Retest
- Plot the data found.
- Demonstrate the functioning of Arm to the class

Post session:

Make a portfolio of your sketch designs, a picture of your demonstration and findings.

Assessment: Demonstration of Hydraulic Powered Robot Arm assessed by peer group and the teacher.