

**CODE/MOE/UOIT Makerspaces Project**

**Lesson Plan: Grade 4 Science:**

**LEGO Robotic EV3 Pulleys and Gears Exploration**

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| **BIG IDEAS:**  Pulleys and gears change the speed, direction, and motion of, and force exerted on, moving objects.  Gears are specialized wheels and axles that are used daily in many machines.  **Overall Expectations – Science and Technology**  Investigate ways in which pulleys and gears modify the speed and direction of, and the force exerted on, moving objects;  Demonstrate an understanding of the basic principles and functions of pulley systems and gear systems.  **Specific Expectations**  **2.2** use scientific inquiry/experimentation skills (see page 12) to investigate changes in force, distance, speed, and direction in pulley and gear systems  **2.3** use technological problem-solving skills (see page 16) to design, build, and test a pulley or gear system that performs a specific task  **3.1** describe the purposes of pulley systems and gear systems ***(e.g., to facilitate changes in direction, speed, or force)***  **3.2** describe how rotary motion in one system or its components ***(e.g., a system of pulleys of different sizes)*** is transferred to another system or component ***(e.g., a system of various gears)*** in the same structure  **3.3** describe how one type of motion can be transformed into another type of motion using pulleys or gears ***(e.g., rotary to linear in a rack and pinion system, rotary to oscillating in a clock pendulum)*** | |
| **Learning Goals:**  Understand how pulleys and gears change the direction of force applied to a mechanical system. | **Success Criteria:**  We can create a machine that uses a combination of pulleys to perform a simple task. |
| **Lesson Overview:**  Students are introduced to the purpose of pulleys and gears through a series of simple mechanical aptitude diagrams, and some demonstrations and examples using pulleys and gears. Students sketch a variety of simple machines, using a two-colour code system to classify input force and output force for a variety of machines.  Students are then given access to a variety of Technic LEGO gears, pulleys, axles, wheels and frames / pins. Their initial goal is to re-create one of the mechanical aptitude diagrams, and if they can do that successfully, modify their machine so it can be driven using an electric motor, and write a simple program using LEGO EV3 software to apply the initial force to the machine. | |
| **Materials and Technology:**  Mechanical Aptitude (Complex pulley and gear example) schematics  EV3 and EV3 Extension LEGO Robotics Kits  Laptop computer with EV3 Software installed for extension activities  Pencil, Pencil Crayons, Sketch Paper | |
| **Student Accommodations/Modifications:**  **Extra Time**  **Simplified Pulley/Gear Diagrams (single or double wheel)** | **Lesson will be differentiated by:**   * **Content, specifically:** * **Process, specifically:** * **Product, specifically: Flexibility in the complexity of the machine designed, interfacing the pulley / gear system with the electric motor** * **Environment, specifically:** |
| **MINDS ON: Getting Started** | |
| During this phase, the teacher may:  • activate students’ prior knowledge;  • engage students by posing thought-provoking questions;  • gather diagnostic and/or formative assessment data through observation and questioning;  • discuss and clarify the task(s). | During this phase, students may:  • participate in discussions;  • propose strategies;  • question the teacher and their classmates;  • make connections to and reflect on prior learning. |
| - Identify a pulley and a gear  - Describe their motion and how they modify the direction and amplitude of force applied to them  - List examples of everyday devices that utilize pulleys and gears  - Attempt to modify their design so that the system can be driven by a computer controlled electric motor  - Design and construct the model using the LEGO EV3 Mindstorms kit  - Create a program using the Mindstorms software to replicate the motion and direction of the system  - Challenge - use a gearing system to make a robot that travels as slowly as possible based on the gearing only  Diagnostic Data: Everyday examples, explanatory sketch of simple machine with input and output directions, completion of mechanical aptitude diagram.  Summative Data: Ability to re-create a mechanical diagram using LEGO manipulatives.  Student Grouping: Individuals, or small (2-3) groups for the construction phase.  Material Distribution: Available at the completion of the mechanical diagram, to be checked with teacher before materials are released. | |
| **ACTION: Working on it** | |
| During this phase, the teacher may:  • ask probing questions;  • clarify misconceptions, as needed, by redirecting students through questioning;  • answer students’ questions (but avoid providing a solution to the problem);  • observe and assess;  • encourage students to represent their thinking concretely and/or pictorially;  • encourage students to clarify ideas and to pose questions to other students. | During this phase, students may:  • represent their thinking (using numbers, pictures, words, manipulatives, actions, etc.);  • participate actively in whole group, small group, or independent settings;  • explain their thinking to the teacher and their classmates;  • explore and develop strategies and concepts. |
| Task: Demonstrate how to complete a mechanical aptitude diagram using a color-coded system for input / output.  Extension: Have the students attempt to re-create one of the diagrams using LEGO Technic parts to check their logic.  Misconceptions: Direction of output force with a given input force, tension of cable on a pulley, alignment of teeth in gears, variable output forces of different sized gears.  Demonstration of Understanding: Create a re-creation of a mechanical schematic, and have it modify force in an identical manner to their description on their solution sketch.  Assessment Data: Checklist of summative tasks, Rubric applied to success criteria for final product. | |
| **CONSOLIDATION: Reflecting and Connecting** | |
| During this phase, the teacher may:  • bring students back together to share and analyse strategies;  • encourage students to explain a variety of learning strategies;  • ask students to defend their procedures and justify their answers;  • clarify misunderstandings;  • relate strategies and solutions to similar types of problems in order to help students generalize concepts;  • summarize the discussion and emphasize key points or concepts. | During this phase, students may:  • share their findings;  • use a variety of concrete, pictorial, and numerical representations to demonstrate their understandings;  • justify and explain their thinking;  • reflect on their learning. |
| Groups will be selected to share their results based on what their simple machines can demonstrate, and how accurately they were able to re-create their mechanical schematic.  Questions asked: Did your machine do what you thought it would? What was the same as the diagram? What was different? What was difficult to recreate? What was easy? Were you able to adapt your system so that it could be used with an electric motor? What purpose could your device be used for? How could you make one of your chores easier? | |