Introduction to LEGO WeDo Robotics

GRADE LEVELS:
Grades 3rd – 5th

OBJECTIVES:
- Participants will work in small groups to construct and program a LEGO WeDo robot to complete a specific task.
- Students will gain a greater understanding of the presence of robots and simple machines in their everyday lives as well as their usefulness and limitations.

ACADEMIC CONTENT STANDARDS:
- Physical Sciences K-2 A: Discover that many objects are made of parts that have different characteristics. Describe these characteristics and recognize ways an object may change.
    - K.1: Demonstrate that objects are made of parts (e.g., toys, chairs).
- Physical Science K-2 B: Recognize that light, sound and objects move in different ways.
    - 1.6: Investigate a variety of ways to make things move and what causes them to change speed, direction and/or stop.
- Physical Sciences 3-5 C: Describe the forces that directly affect objects and their motion.
    - 3.2: Describe an objects motion by tracing and measuring its position over time.
    - 3.4: Predict the changes when an object experiences a force (e.g., a push or pull, weight and friction).
- Science and Technology K-2 B: Explain that to construct something requires planning, communication, problem solving and tools.
    - 1.2: Explain that when trying to build something or get something to work better, it helps to follow directions and ask someone who has done it before.
    - 1.6: Investigate that tools are used to help make things and some things cannot be made without tools.
- Science and Technology 3-5 A: Describe how technology affects human life.
    - 3.1: Describe how technology can extend human abilities (e.g., to move things and to extend senses).
    - 3.3: Investigate ways that the results of technology may affect the individual, family and community.
    - 4.1: Explain how technology from different areas (e.g., transportation, communication, nutrition, healthcare, agriculture, entertainment and manufacturing) has improved human lives.
    - 4.2: Investigate how technology and inventions change to meet peoples' needs and wants.
- Science and Technology 3-5 B: Describe and illustrate the design process.
    - 3.4: Use a simple design process to solve a problem (e.g., identify a problem, identify possible solutions and design a solution).
    - 4.3: Describe, illustrate and evaluate the design process used to solve a problem.
    - 5.2: Revise an existing design used to solve a problem based on peer review.

VOCABULARY WORDS:

Application Program - A sequence of steps that specifies what jobs the robots will perform. The program can be personalized by the owner to fit specific designs.

Gear Motor - Unique internally geared motor that makes your robots move.

Light Sensor - Input device that registers light from 0.6 through 760 Lux.

EXTENSIONS AT COSI:

Gadgets Exhibition Area

- Spend some time with COSI's robots at the entrance to the Gadgets Exhibition Area. Can you identify the various programs which they are capable of performing? What types of work would these mechanical arms be useful for?

ADDITIONAL RESOURCES:

http://spark.irobot.com/index.php
http://www.fi.edu/pieces/knox/automaton/simple.htm
www.robots.com (Presenting Sponsor of COSI's Robots)
http://www.legoeducation.us/global.aspx

SAMPLE TEST QUESTIONS:

1. _____ is a sequence of steps that specifies what jobs the robots will perform.
    a. Project
    b. Input
    c. Program
    d. None of the Above

2. _____ is a device that receives information about the body and the surrounding environment.
    a. Sensor
    b. Adaptor
    c. Engineer
    d. Program

3. _____ robots, are robots which can perform desired tasks in unstructured environments without continuous human guidance.
    a. Remotely Operated
    b. Autonomous
    c. Free-Thinking
    d. Fictional

Introduction to Robotics WeDo Pre Visit Activities

Keeping It Simple

Primary Audience: K – 5th grade

Description: Participants will explore and use simple machines to understand how they make "work" easier.

Keywords: Slope, gravity, inclined plane, friction, lever, pulley

Concepts: Simple machines are any of various elementary devices considered as the elements of which all machines are composed. They include the lever, the wheel and axle, the pulley, the inclined plane, the wedge, and the screw.

Materials:

- Refer to each activity.

Instructions:

This activity is divided into six stations where six small groups will rotate through each station to explore and use simple machines.

To set-up the activity:

1. Gather and set up materials for each station as listed.
2. Number the stations.
3. Divide participants into six groups.
4. Assign each group a station and explain how to rotate through the stations. Station 1 will move to Station 2, and so on.
5. It may be helpful to set a timer so that participants will all rotate at the same time.
6. At the end of the activity, discuss the questions and the various simple machines.

Possible Interactive Questions:

- Each activity has a list of questions.

Further Exploration:

1. Explore each activity and revisit your favorites.

Relevant Ohio Science Content Standards:

- Physical Sciences K-2 A: Discover that many objects are made of parts that have different characteristics. Describe these characteristics and recognize ways an object may change.
  - K.1: Demonstrate that objects are made of parts (e.g., toys, chairs).
  - 1.6: Investigate a variety of ways to make things move and what causes them to change speed, direction and/or stop.
- Science and Technology K-2 B: Explain that to construct something requires planning, communication, problem solving and tools.
  - 1.8: Investigate that when parts are put together they can do things that they could not do by themselves (e.g. blocks, gears, and wheels).

Keeping It Simple–Six Simple Machines

Problem To explore and use simple machines to understand how they make "work" easier

Teacher Note This activity is divided into six stations where six small groups will rotate through each station to explore and use simple machines. This exploration may be completed over 2-3 days. To set-up the activity:

1. Gather and set up materials for each station as listed.
2. Number the stations.
3. Copy student procedure directions for each station and place on appropriate table.
4. Divide students into six groups and pass out Simple Machines Data charts 1 and 2 (pp. 34 and 35).
5. Assign each group a station and explain how to rotate through the stations. Station 1 will move to Station 2, and so on.
6. It may be helpful to set a timer so that students will all rotate at the same time.
7. At the end of the activity, discuss the questions and the various simple machines.

1) Inclined Plane

Problem Which ramp will make moving a large piece of furniture the easiest?

Procedure

1. Attach the spring scale to the string around the paperback books.
2. Lift the books with the spring scale.
3. Read and record on the data sheet the number of grams it took to lift the books.
4. Use the wooden plank or cardboard and the protractor to construct a ramp that has a 60-degree angle. Put one end of the inclined plane on a stack of books. Pull the books up the inclined plane, keeping the spring scale parallel to the ramp.
5. Read and record in the Data Chart 1 (p. 34) the number of grams needed to move the books up the ramp.
6. Repeat steps 4-5 using a 30-degree inclined plane

Ramp with 60-degree angle

Materials

Inclined Plane

- wooden plank or sturdy piece of cardboard
- stack of books
- protractor
- 2 paperback books tied together with string
- spring scale

Questions

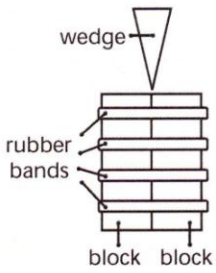
1. Did the ramp make the work easier?
2. Which ramp made the work easiest? Why?
3. What happened to the length of the inclined plane as the angle became smaller?
4. How can you use an inclined plane to help you in everyday life?

2) Wedge

Problem How can a wedge help separate two objects?

Procedure

1. Use the rubber bands to band the two same sized blocks of wood together. If you can easily pull them apart, add more rubber bands.
2. Use the smaller third block of wood to pry the banded blocks apart. Record your observations in Data Chart 1.
3. Use the wedge to pry apart the banded blocks. Record your observations in Data Chart 1.



Materials

Wedge

- blocks of wood the same size
- one smaller block
- rubber bands
- wedge of wood

Questions

1. What happened when you tried to separate the banded blocks with the smaller block of wood?
2. Compare what happened when you used the block and then the wedge to separate the banded blocks? Explain why there was a difference.
3. How can you use a wedge to help you in everyday life?

Keeping It Simple (continued) Six Simple Machines

3) Wheel and Axle

Problem

Does a larger handle on a screwdriver make work easier?

Procedure

1. Observe the screwdrivers and determine which part of the screwdriver is the wheel and which part is the axle. Discuss and record in Data Chart 1 (p. 34).
2. First, use the screwdriver with the smaller handle. Turn the screwdriver until about half the screw is inserted into the wood. Observe and rate the amount of force needed to turn the screw into the wood.
3. Use the second screwdriver to finish inserting the screw into the wood. Observe and rate the amount of force used. Record.
4. Compare the amount of force used in steps 2 and 3.

Materials

Wheel and Axle

two screwdrivers that are the same length but have different sized handles
piece of wood
6 screws (1 for each group)

Questions

1. Which screwdriver made it easier to insert the screw into the wood?
2. Explain you answer.
3. How can you use a wheel and axle in everyday life?

4) Screw

Problem

To understand that the pitch of a screw determines the difficulty of turning the screw

Procedure

Each group should use a new set of predrilled holes.

1. Observe each screw and nail and note any differences in Data Chart 2 (p. 35).
2. Place screw A in one of the predrilled holes.
3. Use the line drawn on top of the screw to count the number of turns it takes using the screwdriver to insert the screw entirely into the block of wood.
4. Record the number of turns in your data chart. Observe the amount of force used and record.
5. Repeat steps 2-4 with screw B.
6. Using just your hands, try to insert the nail into the wood. Use the line drawn on top of the nail to help you count the number of turns.
7. Record the number of turns and your observations in the data chart.
8. Compare and contrast inserting the nail, Screw A, and Screw B.

Materials

Screw

block of soft wood with 12 predrilled holes
6 nails (1 for each group)
6 sets of 2 wood screws with different pitch but equal length (pitch is the distance between the treads or ridges)
1. use permanent marker and draw a line across the top of each screw and nail
2. use tape to label screws A (larger pitch) and B (smaller pitch)

screwdriver
goggles

Questions

1. How did the nail work in relation to the two screws?
2. Did you find one screw works better than the other?
3. What was the difference between the screws?
4. Which one needed more turns? Why?
5. How can screws make a difference in everyday life?

Keeping It Simple (concluded) Six Simple Machines

5) Lever

Problem

How does moving the fulcrum affect the amount of force needed in a lever system?

Materials

Lever
30-cm ruler
dictionary
small object such as a pencil or base 10 block for fulcrum
spring scale

Procedure

1. Place the dictionary 26 cm from the edge of the table.
2. Place one end of the ruler under the dictionary so that the 1-cm mark is covered.
3. Place the fulcrum under the ruler at the 24 cm mark.
4. Attach the spring scale to the ruler so that it is hanging downward. Gently pull on the spring scale until you just begin to lift the dictionary. See diagram 1.
5. Read and record in Data Chart 2 (p. 35) the number of grams used.
6. Keeping the 1-cm side of the ruler underneath the dictionary, move the fulcrum to the 15-cm mark. Repeat steps 4-5.
7. Repeat step 6, using 6 cm as the fulcrum's position.

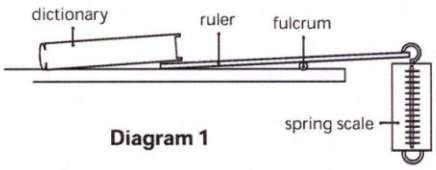


Diagram 1

Questions

1. Did the number of grams used to lift the dictionary change when you moved the fulcrum? How?
2. If you wanted to lift a heavy load, where should you place the fulcrum?
3. How can you use levers to help you in everyday life?

6) Pulley

Problem

How do pulleys make work easier?

Materials

Pulley
two single pulleys
ring stand
500 g weight
80 cm of string
spring scale

Procedure

1. Use the spring scale to lift the weight off the floor or desk. Read and record the number of grams.
2. Attach the pulley to the ring stand.
3. Attach one end of the string to the weight.
4. Loop the other end through the pulley and attach the spring scale to the end of the string. See diagram 1.
5. Pull down on the spring scale to measure how many grams are needed to lift the weight and record in Data Chart 2 (p. 35).
6. Using a second pulley, construct the pulley system below. See diagram 2.
7. Pull up on the spring scale to lift the weight. Read and record grams in the data chart.

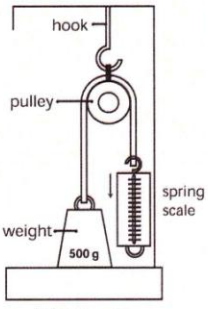


Diagram 1

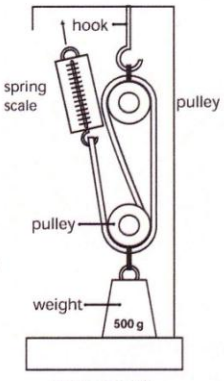


Diagram 2

Questions

1. Was there a difference between not using a pulley and using one pulley?
2. What was the difference between using one pulley and using two pulleys?
3. Why would anyone want to use just one pulley?
4. How can pulleys help you in everyday life?

Introduction to Robotics WeDo Post Visit Activities

Beach Ball Bytes

Primary Audience: All Ages

Description: Students will discover that robots and computers must be given explicit information to do a task. Computers store information in chunks called "bytes." Many tasks that human do would require massive instructions and "storage space" if a robot were programmed to do the same task. This is a classroom demonstration with one volunteer.

Keywords: Robot, computer, programming

Materials:

- 10-12 full size beach balls or play balls
- Chalkboard

Instructions:

Ask a student to be a volunteer robot. Ask the class what task they want the robot to perform.

Use the chalkboard to write your "program." A "program" is a list of instructions that tell the robot what to do. List all the steps the robot would have to do or know in order to complete the task. For each task listed, hand the students a ball. The balls represent "data" or bytes of information. After several steps you will discover that the student (robot) may have trouble handling and storing the data. The students will find it humorous when the robot experiences an information overload and blows a "circuit."

For instance, if the task was washing dished, your list may look similar to the following:

Task: Wash Dishes

1. Instruct robot where kitchen is located.
2. Instruct robot where sink is located.
3. Instruct robot how to turn on the water.
4. Instruct robot on how to plug the sink.
5. Instruct robot on how to add detergent to the sink.
6. Instruct robot on what a plate feels like.
7. Instruct robot on what a cup feels like.
8. Instruct robot on the proper way to wash a plate.
9. Instruct robot on the proper way to wash a cup.
10. Any other instructions.

Depending on the age group, you can make your list more or less detailed.

What's Going On?

Even with the microchip, computers cannot possibly compare with the memory of the human brain. Each one of us has the information needed to process huge amounts of information about our environment and make decisions.

Further Exploration:

1. Discuss with your students the ways humans store information and compare them to the way computers store information.
2. Create illustrations (frames of the steps of a procedure/ process) and see if your students can put the pictures in proper sequential order. Example: shooting a basketball or baking a cake. Note: if you have a hard time drawing, ask a student to try it!

Relevant Ohio Science Content Standards:

- Science and Technology K-2 B: Explain that to construct something requires planning, communication, problem solving and tools.
    - 1.7: Explore that several steps are usually needed to make things (e.g., building with blocks).
    - 2.4. Communicate orally, pictorially, or in written form the design process used to make something.

ROV Races Primary Audience: All Ages

Description: Participants will learn the challenges of operating a remotely operated vehicle (ROV) and problem solve solutions by using a hands-on simulation. They will also have the ROV pilot design and execute a series of commands that will guide a human ROV through a simulated underwater environment, allowing the ROV team to experience some of the challenges of tele-operating a robotic vehicle underwater.

Keywords: Robot, programming

Materials:

- Per Room:
  - Blindfolds
  - Obstacles (ramps, cones, etc.)
  - Stopwatch

Instructions:

1. Choose or draw names of students to form teams of six. One student will be designated as "the ROV pilot", one will be the "team timer", and another will be the "team judge". The remaining three students will become the ROV by hooking together in a line (both hands to the shoulders in front of them (O=O=O). The ROV will be guided by the driver through an obstacle course (simulated underwater environment).
2. The pilots will proceed through the course first, writing down the instructions that will guide the ROV through the course (i.e. 3 steps forward, stop, 1 step left, stop, etc.)
3. Once the pilots have recorded their upload sequences on their navigational sheets, the ROV races can begin. The ROV teams line up at the starling line. The three ROV members are blindfolded, as to not aid the pilot in executing their commands. The ROV members link up (to form the 3 sets of propulsion fans like the real ROV designs) with their hands on the shoulders of the person in front of them (it is fun to choose different-sized students to form a ROV, as the different sizes of steps taken by each is more evident). The judges will keep a tally of the number of foot faults that their ROV team makes by counting each time the front ROV person's footsteps on a red tile (artifact). The timer of each team will record the time it takes for their ROV team to make it through the course. (NOTE: remind the teams that accuracy, not speed is more important when piloting a robotic vehicle in an unfamiliar environment.)
4. The teams will all start at the same time, with the timers starting the team stopwatches when the facilitator indicates. The pilot may stand near their team to give the command sequences, but may not physically touch their ROV to help guide it (this is, after all, tele-operations!). They must guide their ROV by voice only. The ROV driver may not deviate from the commands that have been written in their previous trip through the course, even

if the ROV is going off course. Many times in robotic missions, sequences of commands are sent all at once. Changes have to be added later.

5. Allow time for all teams to complete the course. Gather the groups to debrief how the piloting went - the challenges and what they might change to do a better job the next time.
6. The participants might observe that their steps and those of the ROV people might need some type of calibration (i.e. "take baby steps" or "take giant steps"). Turns might be more accurate by saying, "turn 45 or 90 degrees". Flying a ROV with 3 axles is also different than walking a course singularly.
7. Repeat the activity as time permits, allowing the changes the participants brainstormed to be tested

Possible Interactive Questions:

- Was the course easier or harder to complete then expected? Why or why not?

What's Going On?

Many participants think that remotely operated vehicles can be flown much like they drive their toy radio-controlled cars. They imagine a ROV pilot watching a computer screen showing the ROV in an underwater environment and moving a joystick to make it go. The reality isn't quite that simple! For some ROVs, the time it takes for a command to reach the ROV deep below the surface varies with the distance between the control panel and the ROV involved. This can prevent "joy-stick" driving in real time.

In most cases, the distance between the ROV and control panel is fairly short (few hundred feet) and, as a result, pilots can rely on "joy-stick" like controls.

Further Exploration:

1. Safety cones can be added to the course as return sample artifacts to be collected. When the ROV is in the proper position for the last person on in the ROV team to bend down (blindfolded) and pick up the cone, the pilot can command, "retrieve artifact sample". Once the cone has been retrieved, the cone can be passed to the middle ROV person to be carried.
2. A video camera and monitor could be set up, so that the pilot is in another room, allowing for a closer simulation to tele-operation. The pilot would have to interpret the images and piloting pathway with only the camera images (camera being held by the lead ROV person) to guide them. Commands could be sent via a "runner" student, simulating the wait time that occurs in long distance communication.
3. The tiles can be arranged in any design to make the course easier or more difficult (according to grade level or participant's ability.) If course is set up outside you might want to tape the underside of the tiles, to prevent the course being disturbed by any wind.
4. Talk about the time differences the teams took to complete the course. Are there advantages to taking it slower (more careful moves, less crashes) or perhaps the power supply are getting low and more territory needs to be covered (faster).

Relevant Ohio Science Content Standards:

- Science and Technology 3-5: Describe how technology affects human life.
    - 3.1: Describe how technology can extend human abilities (e.g. to move things, extend senses).

Research Activity Primary Audience: All Ages

Description: Research is a part of science. It involves collecting information to increase your understanding of the topic you're studying. Research also includes communicating that information to others. In this activity, participants will work on their own or in small groups to research their topic in further detail.

Research Materials:

- Paper, pens and pencils
- A computer with Internet access
- Books, journals, magazines or newspaper articles on the topic
- If available, access to experts on the topic to interview

Instructions:

Using whatever research materials are available to the students, encourage them to further explore an aspect of the given topic that they find interesting. As with any research project, they should not make it too broad in scope. Rather, they should pick a specific area of the topic that excites them.

For example, they might research a specific person who was influential in the advancement of their topic. They could choose to do a project involving a timeline of important events in the history of their topic. Or they could identify an issue, question, or problem related to their topic. The key is finding that thing about the topic that grabs their attention.

The final part of a research project is to share the results of the research with others. If time permits, have the students present their research to other classmates who participated in the workshop.

Possible Interactive Questions:

- What is it about this topic that is interesting to you?
- Is there a particular question about this topic that you could answer?
- How could you share the results of your research with your classmates?

Relevant Ohio Science Content Standards:

- Scientific Ways of Knowing 3-5 A: Distinguish between fact and opinion and explain how ideas and conclusions change as new knowledge is gained.
    - 5.1: Summarize how conclusions and ideas change as new knowledge is gained.
- Scientific Inquiry 3-5 B: Organize and evaluate observations, measurements and other data to formulate inferences and conclusions.
    - 3.2: Discuss observations and measurements made by other people.
    - 3.6: Communicate scientific findings to others through a variety of methods (e.g.,

pictures, written, oral and recorded observations).

- Scientific Inquiry 6-8 B: Analyze and interpret data from scientific investigations using appropriate mathematical skills in order to draw valid conclusions.
    - 8.3: Read, construct and interpret data in various forms produced by self and others in both written and oral form (e.g., tables, charts, maps, graphs, diagrams and symbols).