Wizards of Wright

Lesson: Cube-lets, Introduction to the Engineering Design Process

Use WOW! Lesson Intro to begin.

Background Info for Wizards:	Students should already have had the Cube-lets 1 Lesson, or some other introduction to Cube-lets. Students do not need to understand the Engineering Design Process (or have had our EDP Lesson) for this lesson to be educational. If you haven't taught the Cube-lets 1 or 2 Lessonss, you will want to become familiar with the Sensor Cubes (black) and the Action Cubes (clear). Students may use the logic cubes more in this lesson, than they have in others. See below to learn about what the Logic Cubes do.  *https://www.modrobotics.com/shop-cubelets/#individual-cubelets* The **Passive** (light green) Cube-let transmits power and data just like a wire, but doesn't do anything. It carries power and data from its neighbors, but it basically acts like a smart brick. It doesn't move, sense, or change the data in any way.  The **Blocker** (dark green) Cube-let is a data barrier. It "blocks" data from its neighbors. It still passes power, but effectively stops communication and can insulate one side of a robot from another.  The **Inverse** (red) Cube-let flips the value. It calculates a value that is the opposite of the values it receives. The Inverse Cube-let will (weighted) average its inputs and then output a value of one minus that average.  The **Maximum** (dark brown) Cube-let will filter out the highest value. It accepts many different inputs but only passes along the one with the greatest value. With a maximum block, you could easily build a robot that performs an action only when a sensor reads a value over a certain threshold (set by a Knob Cubelet, perhaps).  The **Minimum** (light brown) Cube-let outputs the minimum input value that it receives. It can accept any amount of data but only outputs the smallest value that it receives. It can be handy for creating an on-off switch for a robot and also for using with a Distance Cube-let to build robots that avoid falling off the edge of a table.  The **Threshold** (orange) Cube-let is a THINK Cube-let with a knob to alter the behavior of your robots. It will output a value of zero until its inputs exceed the threshold set by the knob. Above this threshold data will flow normally. Use this Cube-let to create robots that react suddenly, gate data flow, or exhibit binary behavior.

Materials:	Student Boxes of Cube-lets (cubes should match the picture) Battery Cube-lets Intro to Engineering Worksheet Explanation Sheets Cube-lets, Introduction to the Engineering Design Process Worksheets Charger (if sent)
Lesson Time: ***45-60 minutes***	Introduction: 3-5 minutes Guided Lesson #1: 2 minutes Student Activity #1: 10-15 minutes Guided Lesson #2: 5 minutes Wizard Demonstration: 5 minutes Student Activity #2: 15-20 minutes Conclusion: 5 minutes
Learning Targets:	
Introduction for Students: 3-5 minutes	Review with students what they learned during the Cube-lets 1 Lesson: - electricity, electrical current, potential and kinetic energy, electrical circuits - robots and what they can do - controlling or changing what it senses, they can change the action/behavior - how cube-lets use electrical currents and potential and kinetic energy
Guided Lesson #1: 2 minutes	Let's talk about Engineering. Engineers are scientists that study and understand how things work and solve problems by designing or creating something new. There are all kinds of different engineers - some engineers design products and machines like cars, airplanes, and computers while some engineers build structures like roads, buildings, and bridges. Engineers start by asking: 1. What is the problem? Does something need to be changed? 2. What would make this better? What needs to be changed? 3. How well does our new solution work? How do we know that we succeeded?
Student Activity #1: 10-15 minutes	Have students work in groups (2-4 people) to complete the Intro to Engineering worksheet. Pass out the worksheets and explain that they need to answer the questions after hearing each story. Read each scenario aloud (some students will read it on their own, but some students will need to hear you read it) and then give each group time to discuss it and fill in the blanks.

	You don't have to go over their answers, this is an opportunity to get them thinking. All answers are acceptable.
Guided Lesson #2: 5 minutes	Explain to students that the activity they just finished, and the questions they are learning to ask themselves (and each other) is all a part of the Engineering Design Process. They will now use those same ideas (and questions) to define a problem, build a potential solution, and test their innovation and creativity with Cube-lets. Lead a discussion on why it is important to do all 3 components.
Wizard Demonstration: 5 minutes	Remind students what they have learned about Cube-lets. - they sense and act (today we will see that some of them "think") - black cube-lets are sensors, they act like our eyes and ears - clear cube-lets are the action cubes, they react to what the other cube senses - they must have a sense cube, and act cube, and a battery cube at all times They may not have used colored cube-lets yet. Introduce the colored cubes as the thinking or logic parts of the robot. Put together a simple robot as an example. Use the Brightness sensor cube and the Flashlight action cube (and a battery).   Show them that when the sense cube senses light in the room, the flashlight comes on. We can make it work the other way, by having it sense less light (cover the sensor face). What happens? Did the light go out? What happens when we add a logic cube? Let's add the Passive cube-let.  It should extend the response. What happens when we move the pieces around? Explain to students that by using colored cubes, they can change the information between senses and actions.

	Show them an example. Use the Knob Cube and the Bar Graph Cube.   After reminding student what they do, add the Inverse Cube between the sense and action.  This should turn a big input into a small action, and a small input into a big action.
Student Activity #2: 15-20 minutes	Tell students they have 4 challenges to work through. They may not have time to complete all of the challenges, so they should start with whichever one they want. They are to practice the Engineering Design cycle by defining the problem, building a potential solution, and then testing their innovation. *Explanation Sheets* are available if you think the students need to use them. It has a picture of the cube, its name, and a brief description. The Logic sheet may be the most beneficial. The rest of the cubes are fairly easy to figure out. Pass out Student Sheets, boxes of Cube-lets, and a Battery Cube to each group (4 to a group is best). *Hint: The Passive Cube may be needed for Challenge #3, and the Inverse Cube for Challenge #4.*
Conclusion: 5 minutes	Have students share their inventions, and the answer to their Engineering questions.

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