MODULAR ROBOTICS EDUCATION

Robotics & Scientific Investigation

Cubelets SIX and Additional Think Cubelets,

45-60 minute activity

By snapping together magnetic Sense and Act Cubelets in different configurations students make working robots while using the inputs and outputs in their robots to craft investigations and work with claims and evidence.

For each class/group, this lesson plan includes 4 parts, 15 minutes each :

1. A hands on exploration of how robots get input and produce corresponding output
2. An opportunity to design and build more complicated robots.
3. Hands-on exploration of the Think function of a robot
4. Optional free-play and special challenge for an additional 15 minutes

This lesson plan is ideal for beginning robotics students as young as 5 and up to 11 and older because Cubelets allow students to quickly snap together components and understand sensors and actuators. Students can immerse themselves quickly in robotics by immediately assembling and testing working robots. These activities start at the least advanced level but offer suggestions for more advanced groups of students by scaling from level 1 to level 3 for each segment of the lesson plan.

Let's define robots first - *What do these three things have in common?*


"Who knows what a robot is?"

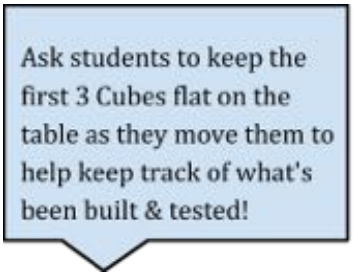
Possible Answer	**Response**
It's a machine that can do things (or, it's a machine with a computer inside of it.)	A toaster is a machine that does things - is it a robot? what makes robots different than other machines
It's a machine that looks like a person and can do things like walking and talking.	Are their robots that don't look like people but can still do people jobs? (Roomba, Drone planes, etc.)
Robots are independent agents that carry out tasks by sensing and computing that data into a reaction.	**Another way to say this is robots are machines that SENSE - THINK - ACT!**

Dictionary.com defnes robots: any machine or device that operates automatically with human like skill.

Part 1: Hands-on with the Sense and Act components

Materials: KT06 kits with Passive Cubes set aside, groups of 1-4 students using each kit.

A hands-on opportunity for students to understand how how robot senses are inputs that inform their actions/outputs. *It's best if all students start using just one sense and one action Cubelet in order to understand the robotics components and their relationship.*



"Robots are automatic agents that can sense, think, and act. Our robot senses are in these black cubes. Our robot action parts are in these clear cubes. Also, all robots need power, and the gray blocks are the battery or power cubes. We'll use the Brightness sense first and the Flashlight to see how input and output work together"

Suggested age variations/progression:

- **Level 1(ages 4-6)**: Students use the Battery, Brightness and Flashlight. "At first, build robots using just this sense and this action. How many different ways can you build with just these three blocks? Try to keep all the blocks on the table as you move and rebuild. Try to make the light shine more or less by changing the input to the sense. Let's practice claims and evidence - I claim this robot will be bright when it is _____ and dim/dark when it is _____."
- **Level 2 (ages 7-10)**: Secret Sense Challenge! Once students have mastered the above, have them switch to the Distance sense but don't tell them what the input to this sense is. " Can you test out how this robot reacts to its environment by trying different inputs to this sense? *What do you think this robot is sensing?* " Once they have a theory prompt them to practice changing how much information this Distance Cubelet gets by controlling the light to shine more or less by showing the Distance Cubelet objects close and far. Let's practice claims and evidence - I claim this robot will be bright when it is _____ and dim/dark when it is _____." "What do you notice about how to control making the light be brighter or dimmer? " **This is an opportunity to talk about magnitude of input -** a big value (objects close to the Distance Sensor) will produce a big reaction (Flashlight at full brightness). A small value (objects far away from the Distance Sensor) will produce dimmer light/less action.
- **Level 3 (ages 11+)**: Now, have students now switch action Cubelets to use the Drive with the Battery and the Distance Cubelets. "Test your theory about what input this sense uses and build a robot that drives. Can you use the Distance sense to control the Drive action. There are many ways to put these three Cubelets together - does configuration change how the input and output produce a sense-act relationship? Can you control it by using inputs to this sense? Can you drive it across this table?"

Concepts Presented: Sensing and input, action, output, actuator, magnitude
Vocabulary: Sense/input, reaction/output, actuator, magnitude

Part 2: More complicated robots

Materials: KT06 kits with Passive Cubelets set aside, groups of 1-4 students using each kit.

This is an opportunity for students to add more excitement to their small robots while also exploring robots that have more than one sense and more than one action.

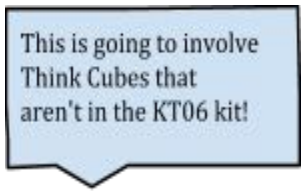
Suggested age variations/progression:

- **Level 1 (ages 4-6):** Have students use both sense Cubelets - Distance and Brightness with the Drive Cubelet. "If your robot is responding to two senses now, what's happening? Is it easier or harder to control? Can you make it drive faster and slower? Are there ways to build your robot that make it easier? Can you drive your robot across the table now?"
- **Level 2 (ages 7-10)**: Now try using two senses AND two actions. "Is your robot acting in any surprising ways? What is happening now? Can you build it and predict what it will do?"
- **Level 3 (ages 11+)**: As above.

Concepts presented: Multiple inputs, prediction, critical thinking
Vocabulary: Sensing, inputs, response, reaction, action, predict

Part 3: Robot Thinking

Materials: KT06 kits , now with Passive Cubes included, as well as Blocker, and Inverse Cubelets groups of 1-4 students using each kit.



A hands-on opportunity for students to understand how how the Think component of a robot changes information sent from the sense to the act component.

" In the last activity, we used Sense Cubelets and Action Cubelets to build robots that drove and lit up. Now we're going to make our robots a little smarter by using Think Cubelets with the senses and actions. Let's see how this changes our robots"

Suggested age variations/progression:

- **Level 1**: Students use the Battery, Brightness, Passive and Flashlight. "We built this robot before, but without the green Think Cubelet. Test out this Think component by putting it between the sense and the action - what do you think this Cube is doing to the information going from the Brightness sense to the Flashlight Action? Is getting the light to be brighter or dimmer any different? Has this Think component changed how information goes from this sense to this action - when does the light get bright? When there's a lot of light on the black Cubelet or a little light? What does that mean? Let's practice using our claims and evidence to explain your robot's reactions"
- **Level 2:** Swap the Passive for the Inverse Cubelet. "I'm passing out a Think Cubelet that sees information from the Sense Cubelet and then can change information before it goes to the Act Cubelet. Can you build robots with this Think Cubelet and test out what it does?" **What happens with the Inverse Cubelet?** Ask Students, **"**Before, the light came on when it was bright out. What happens now? What does it mean?" Have students practice using these two Think Cubelets by swapping senses and swapping actions.
- **Level 3:** Pass out the dark-green blocker Cubelet. Now, ask students now to consider what this might do when they build two small sense-action robots and use this Think function **between them**. Prompt them by reminding them, "You'll need to build a small sense-act robot with one black Cube and one clear cube and put it on one side of this Think Cube. And then build another small sense-act robot with one black Cube and one clear cube and put it on the other side. Use what you know about how these sense act robots take input and turn them into action and see how this Think cube in the middle is changing how these two small robots make one bigger robot."



Concepts presented: Multiple inputs, prediction, critical thinking
Vocabulary: Sensing, inputs, response, reaction, action, predict

Part 4: Special Challenges

Materials: KT06 kits , now with Passive Cubes included, as well as Blocker, and Inverse Cubelets. Groups of 1-4 students using each kit.

Students now get to choose and master their own robotics challenges! In some groups it may work to offer all of these challenges and let student choose which one they'd like to work on, while in others it may be best to start with the Level 1 challenge and then work up to the Level 2 and 3 and Bonus challenges.

"Now that you've built small robots with just one sense and one action, practiced giving robots inputs and outputs that make it react more and less, built robots with multiple senses and multiple actions, and used the Think blocks to make your robot smarter, let's see if you can build robots that can do these tasks! "

Suggested age variations/progression:

- **Level 1**: Using just the Battery, Distance, and Drive, make it go straight, and then change it to go in a circle. How many different robots can you build with just these three Cubelets? Now, add the Passive Cube and see how this changes what configurations you can build. What is the coolest robot you can build with just these Cubelets?
- **Level 2:** Using the 6 cubes in your box, what is the coolest robot you can make? What does it do? Can it be used for anything?
- **Level 3:** Plan a robot with 2 senses and 2 actions and 1 Think Cube (inverse, blocker, or passive). engineer, design and build it with a purpose for how it would be used in mind. Test it and see if it will meet that purpose and make design changes if need be.
- **Bonus!** Using the 6 Cubes in your box, can you build a robot that will follow a wall? How does it work? Can you explain it to other groups? Why might robots need to know how to do this?

Concepts presented: Engineering and design, critical thinking
Vocabulary: Purpose, engineering, design