MODULAR ROBOTICS EDUCATION

Robot Creatures & Their Behavior, Part II

Cubelets SIX kits , 40 minute activity

This class activity can be used as a longer unit and second day of students building scientific observation skills using Cubelets. As students delve further into practicing behavioral observation they also continue to advance their deductive investigations as to what inputs produce robot reactions, why, and what this means about the robot sense. Students practice skills gained in the previous class (Part I) again, this time with a different robot sense and action, strengthening their understanding of using observations to make a theory, test it, and refine it using different inputs. While students observe and understand behavior they build scientific skills relevant to biology, psychology, robotics and artificial intelligence.

For each class/group, this lesson plan includes 2 segments:

Each segment is suggested to last 20 minutes in order to comprise one class of about 40 minutes.

1. An extension of the previous class using Cubelets to consider observation of behavior
2. A group wrap-up exercise or capstone challenge with the Cubelets

These activities are intended as a continuation of Robot Creatures and their Behavior, Part I. Each segment is suggested to last for 20 minutes, with two segments comprising a 40 minute class. Where a class period affords less than 40 minutes, we suggest increasing time for each segment and using Part 1 as a single class and Part 2 as a single class activity the next day.

While these lesson plans have suggested age levels, it is also possible to use the younger student activities as a ramp up to older students; e.g. use the 4 years old - 8 years old activities to ramp up and extend a lesson plan for a group of 9 year olds to last for more than one class. Similarly, the activities suggested for older students can become a way to expand on challenges presented to younger learners if there is time and interest.

Remind each group of their previous robot investigations

“Yesterday you worked on seeing robot behaviors, and then using those observations to see what they could be sensing. Does everyone remember the sense we investigated? Today we will continue working on using behavior we see to understand a sense we might not be able to see. We’ll practice noticing how the robot is reacting while considering what different inputs and outputs mean about what the robots sense.“

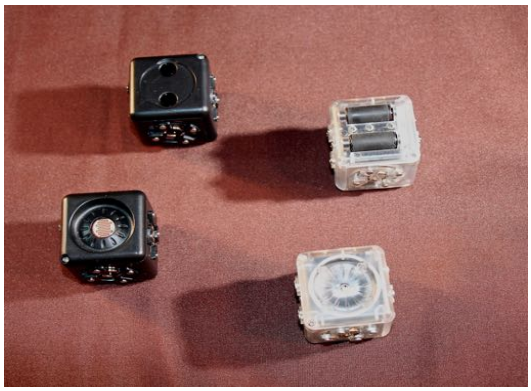
Part 1: Sensing and Magnitude

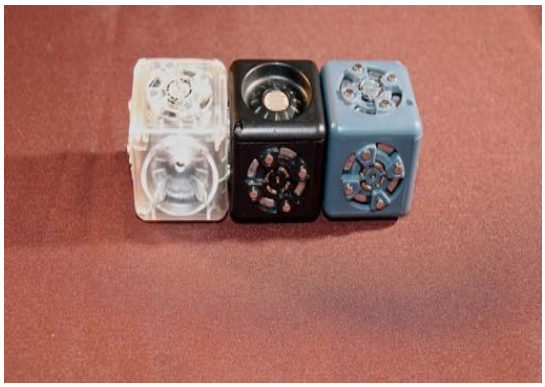
Materials: Cubelets SIX kits, groups of 1-4 students using each kit.

This is an opportunity for students to investigate how to observe behavior and input with more precision - what kind of stimuli? How much? What changes does this produce and how are they related to the changes in sensory information and stimuli? As students progress to adding more than one sense and more than one action students will experience behavior variations and emergent behavior within even very small robots.

Suggested age variations/progression:

- **4 years old to 8 years old**: Swap the Distance and Brightness Sense Cubelets. “Investigate what the robot is sensing now? What input have you given it? What makes it move and what makes it stop? ” Have students form a theory, make a plan to test it, and carry it out deciding what inputs might help them determine if their theory is explanatory of the robot behavior. Once students carry this out, swapping the Drive and Flashlight Cubelets is useful as students realize they can make the light brighter or dimmer in lighter and darker areas.
- **8 years old to 11 years old**: Swap the Sense Cubelets and document what stimuli produces reactions. Then swap the Action Cubelets and investigate magnitude of stimuli and its correlation with response, asking, “What does this reaction tell us? Can you modulate how MUCH response there is? What causes there to be more or less response (speed/light)? Predict how to make the biggest and smallest response and then test it.” Once students have discovered how to produce greater and lesser reactions with the Brightness Sense and Flashlight Action Cubelet, have them test this with different combinations of Battery - Sense - Action Cubelets. Prompt by saying, “Robots might react more or less depending on the magnitude of input or stimuli they sense. How can we measure or keep track of how much stimuli the robot is sensing?”
- **11 years old and up**: As above with 8 to 11 year olds. As investigations continue suggest that students increase the specificity of the stimuli they use to test senses. “Have you used objects other than your hands? Can you test whether different surfaces or conditions make a difference? Keep track of your observations.”





Concepts Presented: measurement/magnitude, sensing, behavioral observation, theory
Vocabulary: sense/input, reaction/output, theory

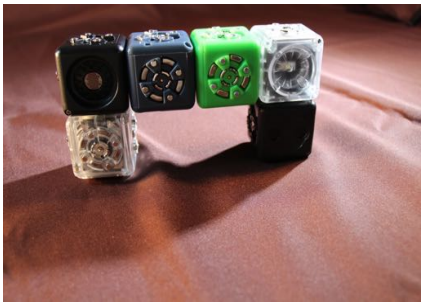
Part 2: Group Wrap-up or Capstone Challenge

Materials: Cubelets SIX kits, groups of 1-4 students using each kit. For group builds, separate into 3 piles of Action (clear), Sense (black), and Think (green, Passive)

This final challenge is an opportunity for students to continue playing, learning, and discovering while testing their understanding of the Cubelets senses and actions and how that leads to different reactions. Although each game is slightly different, they all give students an experiential lesson on how complex behaviors can arise out of simple, discrete functions they've already been manipulating.

Suggested age variations/progression:

- **4 years old to 8 years old:** Group Robot build! Each child may pick one Cubelet to add to a group robot (Instructor holds battery, makes sure there is at least one sense and action Cubelet.) "What does our robot do? Let's all test what it's sensing and responding to." *With extra time this can be repeated multiple times to show that even with all the same Cubelets/functions different robots and different behaviors emerge. Adding Passive Cubelets is another element to the group build if this activity is repeated.*
- **8 years old to 11 years old:** Use all 6! Each team/child is asked to use all 6 Cubelets to build their own robot. (Leave 5 minutes for each group to show their robot.) Each robot may be different. Comment on how the same functions can combine to produce different constructions and behaviors.
- **11 years old and up:** Bigger Robots! Using two senses and/or two actions have students plan and execute a robot build. Ask them to record their design and predict what the robot will do, then build and test it. "Can you predict what will happen if you add two senses? Two actions? Plan where they will go, predict what you think your robot will do. Now make it, test it, and record its response to various stimuli. Did your prediction come true? What parts were right and what unexpected things happened? Now use all 6 Cubelets - what will your robot do? What can it do? Try different configurations and see what surprising reactions you might find. " Each robot they make may be different. Comment on how the same functions can combine to produce different constructions and behaviors and how this is an example of emergent behavior.



Concepts presented: emergent behavior, prediction
Vocabulary: prediction, properties/characteristics, emergent behavior