Grade 4, Lesson 15 ✦ Recommended time, 3 hours

A KIBO Rover

Parts Needed	CS Topics	Cross-Curricular Connections
None	Program Development, Control Structures, Models & Visualization, Parts & Functions, Artificial Intelligence	Science: NGSS 3-5-ETS1–3 (engineering design process). English Language Arts: CCSS.ELA-Literacy.W.4.7-9 (research)

Overview

A robot or AI system experiences the world through sensors and input. Most AI systems can only sense certain kinds of things. Limited input can make the world simpler for AI to understand (abstraction), but it can lead AI systems to make mistakes. Students will model more complex explorer robots with their KIBOs, to engage with the question of how a robot's sensors allow it to perceive some aspects of the environment but not others.

Learning Goals

Students will:

- Understand that robots and AI take in information using sensor input.
- Understand that AI can use abstraction to organize information based on simple criteria.
- Understand that AI can learn from information it receives, but simple robots cannot.
- Be able to create a program to organize information taken in by KIBO's sensors.

Preparation and Materials

This is a **3-hour** project lesson. Suggested schedule:

Meeting 1:

» 30 mins: Introduction to the project including the INSPIRE and CONNECT steps

» 25 mins: ENGAGE Phase 1: Research

» 5 mins: Closing share-out

Meeting 2:

» 5 mins: Class discussion to remind groups of the project goals

» 50 mins: ENGAGE step Phase 2: Building the KIBO Rover

» 5 mins: Closing class discussion to share challenges and successes

Meeting 3:

» 5 mins: Class discussion to remind groups of the project goals

» 25 mins: ENGAGE step final phase (testing, preparing to share)

» 30 mins: REFLECT step, to showcase the project and reflect on the process

Ensure the students have access to research materials about extreme environments on Earth such as the deep sea, polar regions, jungles, and mountains; and/or other planets in our solar system. You may also use Internet research resources, if appropriate.

INSPIRE: Sense – Think – Act

"Today we will create KIBO Rovers to explore a new environment. We'll use what we know about KIBO's sensors and programming to make KIBO operate on its own."

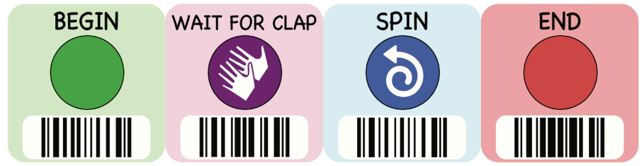
"Rovers and explorers are real-world robots that sometimes have to operate far away from people, so they need to be able to act on their own." Ask students to share ideas for places that would be interesting to explore but difficult for humans to go to. This could include other planets like Mars or Venus, difficult to reach places like dark caves, or environments like the deep sea where humans can't survive. What about these places make robots more suited for exploration?

"Sometimes scientists can remote-control these explorer machines, like they were driving a car. But other times they use artificial intelligence to let these explorer robots make decisions themselves about what to do next. Robots can use their sensors and their programs to decide what to do. We call this the 'sense – think – act' cycle."

Talk to the students about each of these steps:

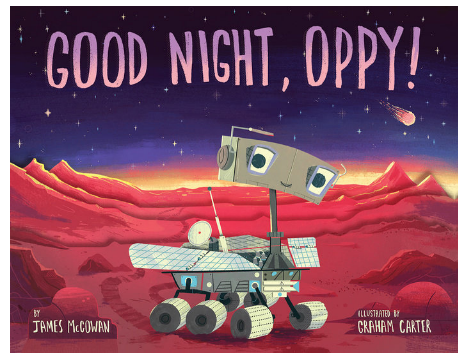
- **Sense:** Robots use their sensors to gather information. Ask the students to recall examples of KIBO's sensors and what they can detect.
- **Think:** Robots use their programs to make decisions based on what their sensors tell them. Ask the students to recall examples of KIBO's conditional programming blocks (WAIT FOR CLAP, IF/END IF) and how they represent decision-making.
- **Act:** Robots act (such as by moving) based on their decision. The actions they can take are also determined by their program.

With a KIBO equipped with the **sound sensor** (ear), demonstrate this program:



Discuss with the students how KIBO's sensors and program illustrate each element of **sense – think – act**. Ask students to share ideas for more complicated programs that use this cycle. We will explore their ideas in the group activity.

CONNECT: Read *Good Night, Oppy!*



Read *Good Night, Oppy!* by James McGowan. This book follows the NASA Opportunity rover on its mission to Mars. Several AI and robotics related themes are included, such as what sensors Opportunity used to explore its environment and how the Earth team communicated with the rover across long distances. For older students, the book includes optional side passages with additional material about space exploration.

Afterward, reflect with the students on the way the author represented the communication between Opportunity and the NASA team on Earth. What decisions was Opportunity making using the sense – think – act cycle?

ENGAGE: Exploring a Remote Environment

"Now it's time to create our own robotic rovers!" Each group will design a KIBO program to explore an environment using the sense – think – act structure.

Phase 1: Research

Divide the class into groups and ask each group to choose an environment their rover will explore. They might choose a challenging environment on Earth — a deep cave system, the ocean floor, icy polar mountains — or another planet or moon in the Solar System.

Tip: if the students are studying environments, ecosystems, or planets in science class, you may want to ask students to choose a particular exploration destination that aligns with these topics.

Provide research materials and time for groups to gather information about their chosen environments or locations. Have them identify the challenges that an explorer would face there. What makes this environment well suited to exploration by a robotic rover? What could we learn from exploring it? What sorts of sensors or scientific devices might a rover need to work effectively there?

Groups should record the answers to these prompts, and some key facts about their environment, in their journals.

Close this phase with a brief share-out to ensure groups are on track.

Phase 2: Building the KIBO Rover

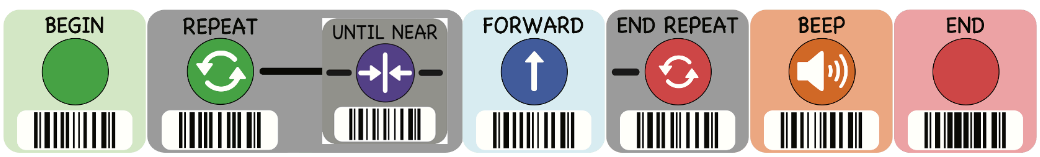
Working from their journals to remember the specific challenges of their target environment, groups should now design their KIBO Rovers. Ask them to consider how the robot will move, gather information, and stay safe.

Their robots and programs should include the following elements:

- Wheels and motors to allow KIBO to explore the environment;
- At least one sensor to gather data about the environment;
- Conditional program elements such as REPEAT: UNTIL..., IF/END IF or WAIT FOR CLAP driven by the sensor;
- An action to take based on the sensor input.

Here are examples of programs the students might create, drawing on prior work they've done with sensor programming. Share these examples if students need guidance:

KIBO will travel forward once, then check if the environment is dark.
If so, it will turn on its light to make the environment safer for human explorers later.



KIBO will keep rolling forward, checking to see if an obstacle is near.
When it reaches an obstacle, it will beep to let the scientists know it found something!

Students can use art and craft materials to transform KIBO into their imagined rover. What features might be useful in navigating the environment they're exploring: fins and tanks for an undersea robot, or big wheels and solar panels for a Mars explorer? Let the students be inspired by their imaginations when decorating their KIBO rovers!

Allow groups plenty of time to test and improve their programs and rovers. Check in with groups individually or via class-wide share-outs to ensure they are on track. When you wrap up the class meeting, ask groups to record their plans, programs, and designs in their engineering journals.

Prior to ending the ENGAGE step, give students time to perform final testing and to reassemble their rovers and re-scan their programs prior to sharing.

REFLECT: Advantages and Disadvantages of AI Explorers

Allow each group to demonstrate their rover robot. They should explain how their robot engages in the sense – think – act cycle. They should also describe the environment their robot is exploring, and how the independent action of the AI program allows the robot to perform its task.

Discuss with the students: Compared to humans exploring dangerous or challenging environments, what are the advantages of AI-driven robotic explorers? What are the problems or limitations? What if a robot encountered something completely unexpected?