Novice Lesson 1: Let's Build KIBO

Topics: Parts and Functions

Learning goals: students will learn what a robot is and that robots are designed by humans to solve problems. They will learn about the mechanical and robotic parts of the KIBO robot and understand that parts have functions.

Background: What IS a Robot?

Robots are **machines** and they are **not alive** (though some may move or even look like real people or animals).

Robots have **automated moving parts**. (This can be wheels, but could also simply be a fan that spins, a door that moves up or down, or an internal motor.)

Robots can be **programmed**, or given instructions, by humans (not just controlled by a joystick or a remote).

Robots usually have **input** (such as a sensor or a button that takes in information) and **output** (such as light, sound, or movement).

Inspire: What is a Robot?

"Today we are all going to build special machines called robots. Have you ever heard of robots before? What do you think a robot is?" (Write children's ideas and questions on a large board for them to see).

Children may have heard of robots from popular songs or books, from TV shows or movies, or from family members who work with electronics. Their ideas may be very diverse. Try not to correct their ideas, but rather use them as a starting point to ask questions while using KIBO. Support children as they make discoveries and revisit their original ideas on their own. Feel free to ask prompting questions such as, "What are robots made of?" or "Do you think robots are alive?" or "How are robots different from animals and people?"

"We have a lot of ideas about robots, and a lot of questions also. Let's learn about the robot we will be building with today, and see if we can answer any of our questions."

Connect: Hello, KIBO!

Show the KIBO Robot, and begin a conversation saying, "This is KIBO, the robot we are going to build with. What do you see and notice about this robot?" Here are some options for presenting KIBO and its different parts.

- Present KIBO's body and parts on a tray and pass it around the circle; ask each child to add one part to KIBO.
- Ask children to each take different KIBO parts (e.g. a wheel, a motor). Go around the circle to each child so they can hold up and describe their part, like a show and tell circle.

List children's observations and questions prominently in the room. Encourage children to notice the body, the motors that connect to the top and sides, and the round wheels.

You can also flip KIBO over to look at its see-through bottom, and invite conversation about the parts inside KIBO as well. They may recognize parts like the batteries and the wires. You can compare KIBO's computer chip to a brain, and the wires inside to the veins and nerves in our human bodies that connect the brain to moving parts. KIBO's wheels help it move around, just like our legs help us move.

Finally, practice scanning a short program for the students. You can tell children that soon they will be sequencing their own instructions for KIBO, but for now they can watch how you scan a simple test program, such as BEGIN – SHAKE – BEEP – END. Show them how KIBO moves after you scan the program by pushing the flashing triangle button on the top of KIBO. That tells you that you connected all your robotic parts correctly!

Engage: Build and test KIBO

Allow groups to build their own KIBO robot using the bodies, 2 motors, and 2 wheels. Invite children to try to build a robot that looks like the one you demonstrated, with wheels and motors attached to sides and green dots facing down on all motors. Ask them to notice the shapes, colors, and materials. How many different ways can the parts fit together?

When children have built their KIBOs, invite them to come to a "testing station" where you can facilitate scanning the sample code from your demonstration. Allow them to test their programmed robot. Does it move the way your robotic demo did?

After scanning their program, allow children to re-attach KIBOs wheels and motors in new ways. Encourage children to press the triangle button on top of KIBO to run the demo program again after each new build. Does the way KIBO is built change how it moves? How many new ways can they build KIBO?

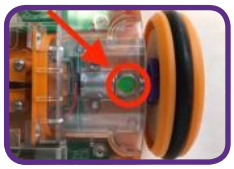
If children finish building quickly, allow them time to freely explore a small set of the programming blocks to create new programs. Limit these to the blue motion blocks plus BEGIN and END.

Reflect: Share Observations of KIBO

Ask children to bring their robots to the circle with them to show what they have learned. You can have children demonstrate and share one fact about their robot, run all robots at the same time for a fun "robot party," or do a combination of both. Return to the list of their ideas and questions, and see if they learned anything new that they did not know before. You can also ask children to share something that was hard for them while building or testing their robots, and see if others had the same problem. Sharing problems is an important part of the Engineering Design Process, which children will learn about later, and it helps children feel comfortable with the "hard fun" of working with robotics!

Tips for the Teacher:

Make sure the green dot is visible on the motors: KIBO's motors can be installed "right side up" or "upside down." When the motors are installed right side up, you'll be able to see a green dot on the motor through KIBO's clear bottom. If the motors are installed upside-down, KIBO will not move as expected.



Novice Lesson 2: What is a Program?

Topics: Sequencing, Symbols

Learning goals: students will learn that a program is a sequence of instructions. They will learn about the symbols that make up KIBO's programming language.

Background: What is a Program?

A **program** is a sequence of instructions that the robot acts out in order. Each instruction has a specific meaning, and the order of the instructions affects the robot's actions. Like a story, a program has a beginning and an ending, with a sequence of events in between.

Inspire: A Program is a Story

"Today we are going to be programmers and learn how to give KIBO instructions! A program is a list of instructions that a robot can understand. Just like people can understand languages like English, Spanish, and Chinese, KIBO has a language, too!"

"KIBO's language uses these wooden blocks with pictures on them. Each block is a different Instruction for KIBO. What do you think these blocks tell KIBO to do?" Show children a few different blocks (if you have a larger group, you can use the large KIBO Says cards, so that children can see clearly). "Each block has a symbol on it which tells KIBO to do one thing."

"We can guess what the instructions do because of the pictures and the words, but KIBO reads this black and white barcode down here." (Point to a barcode on a block). Children may recognize barcodes from the backs of library books, or foods at the grocery store. "KIBO can read the barcode with this red flashing light. This is KIBO's scanner." (Point to the flashing red light KIBO's front).

"A program is a like a story for KIBO to act out. Just like a story, a KIBO program needs a **beginning** and an **ending**." Show children the BEGIN and END blocks.

Other metaphors to explain programming include using a program to tell a story that KIBO acts out, or thinking of KIBO as a character in a play and the program as KIBO's lines.

Connect: Play KIBO Says

This activity teaches the KIBO programming language, symbols, and sequencing. You'll use the large KIBO Says cards which come with the KIBO curriculum package. For this first game, only use: BEGIN, END, BEEP, and all of the blue Movement commands.

The game is played like the traditional Simon Says game: Students repeat actions as instructed by the teacher. First, introduce each card and what it means. Have the class stand for the game. Hold

up one card at a time and say "The programmer says to _____." Then give several instructions at a time for the students to act out in order. Finally, you can introduce complete KIBO programs with the BEGIN and END cards. The Programmer should also play around with order and sequence. For example, how does BEGIN, SHAKE, BEEP, END look different from BEGIN, BEEP, SHAKE, END?

Engage: Program KIBO

Demonstrate scanning a simple program for KIBO, to remind children of the work they did in the previous lesson.

Then give children plenty of time to work in small groups to build their own programs for KIBO. Children can use any of the movement blocks along with BEEP and SING to program their KIBOs. Remind them that every program must have a BEGIN and END block!

Invite children to create a dance with their programs! When their dance is complete, children can try to dance along with their robots, or to learn another group's KIBO dance. Remind children that they can plan their sequence by acting out a dance themselves, with their bodies. Then, they can remember their actions while they build a program for KIBO using blocks.

Reflect: Demonstrate Your KIBO Program

Invite children to sit in a circle and take turns sharing their programs, and then demonstrating their robot's movements. You can invite children to say out loud the programming instructions while KIBO is moving to check against the program they made. After every group gets a chance to share their finished KIBO, you can let children all start their KIBOs and follow along standing up at the same time for a fun dance party!

Tips for the Teacher:

Scanning tips. Here are some tips for scanning KIBO's blocks:

- Keep KIBO's flashing scanner light 3-4 inches from blocks, and tilted slightly.
- If children have trouble holding KIBO steady, encourage them to try resting KIBO flat on the ground and scanning the sides of the blocks.
- You can separate the blocks slightly to make it clearer for children which block is being scanned.
- Remember to aim KIBO's light at the barcode, not at the picture or word.
- When scanning, look for KIBO's green LED to flash and listen for a single beep. This lets you know KIBO understood the command.

She, He, or It? KIBO is not a girl or a boy, but students will often make assumptions about what pronoun to use with KIBO. Engaging this question with the students at circle time can help explore their ideas - and their implicit biases.

Novice Lesson 5: Craft and Build Drop Test

Topics: EDP

Learning goals: students will learn about the steps of the engineering design process. They will create models out of craft and recycled materials, then they will test the sturdiness of their models by dropping them from ankle height. If the models don't survive, the students can follow the engineering design process to revise their designs.

Background: What is an Engineer?

An engineer is anyone who invents or improves things (for instance, just about any object you see around you) or processes (such as methods) to solve problems or meet needs. Any human-made object you encounter in your daily life was influenced by engineers.

There are many kinds of engineers, including biomedical engineers, aerospace engineers, computer engineers, and industrial engineers.

Inspire: Introducing the Engineering Design Process

"Today we will all become engineers. We will build and improve our own creations."
What is an **engineer**? An engineer is anyone who invents or improves things.

Introduce the steps of the engineering design process using the EDP poster.

"In their projects, engineers follow a series of steps called the "**Engineering Design Process**." It has just 6 steps: ASK, IMAGINE, PLAN, CREATE, TEST & IMPROVE, and SHARE. The Engineering Design Process is a cycle — there's no official starting or ending point. We can keep going around and around as we imagine and invent our creations."

Ask the students to share examples of times they've imagined something new, and then created it. Did what they create always work the first time? Engineers don't expect things to work the first time! Engineers **test** their creations to find ways to **improve** them.

Connect: Read *The Most Magnificent Thing*

Read ***The Most Magnificent Thing*** by Ashley Spires. This book emphasizes the power and importance of persistence in an engineer's work.

Engage: Build and Drop Test

Sturdy building and the ankle-drop test. Have students think about the different things they have learned that engineers can create (i.e. rockets, cars, ladders, etc.). Each group will choose one thing and create a simple sketch to serve as their **plan**.

Based on their plan, the group should then **create** a model using crafts and recycled materials or LEGO bricks. These models need to be sturdy! Groups should **test** their models by dropping them from ankle height to see if they fall apart. If models do not survive the ankle-drop test, remind students of the "Test & Improve" stage of the Engineering Design Process. Encourage them to modify their designs. Are there loose parts that need to be better connected? Do they need a softer material to cushion the fall?

Extra challenge: If a group's model is sturdy enough to survive the ankle drop test, they can modify their design and test it from a knee-height drop.

Reflect: What Did You Change?

After finishing the task, students **share** their creations. They may explain the features of their projects, describe the features of their final design that make it sturdy, talk about what they found easy and difficult, and share anything they changed from their original plan as a result of their testing.

Novice Lesson 7: Build Dream Cars

Topics: Sequencing, EDP

Learning goals: students will use the engineering design process to design, build, and test their own robotic vehicles. They will create short sequences for their robots.

Inspire: The Engineering Design Process Song

"We have been learning about the Engineering Design Process. It has just 6 steps: ASK, IMAGINE, PLAN, CREATE, TEST & IMPROVE, and SHARE. Today we'll learn a short song to help us remember the steps."

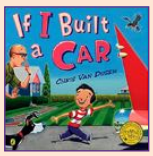
Lead the children in the Engineering Design Process song (to the tune of "Twinkle, Twinkle"):

Ask and imagine, plan and create,
Test and improve and share what we make. (Repeat)

Ask children to share their ideas about what each of the steps mean. Record their ideas on the board.

Connect: Read *If I Built a Car*

Read ***If I Built a Car*** by Chris Van Dusen. This book will get kids thinking creatively about how they might design their own dream car.



In this book, Jack has designed the ultimate fantasy car inspired by zeppelins and trains, Cadillacs and old planes, with brilliant colors and lots of shiny chrome.

Engage: Build Your Dream Car

Student groups will design and build their own "dream cars" with KIBO. Students will use a variety of arts and crafts materials like the ones used in the sturdy building challenge in the earlier lesson, but this time they will build directly onto KIBO. They can attach art materials to KIBO with masking tape, pipe cleaners, string, and other fasteners. Remind students to attach their materials in a sturdy way!

Allow the students to design creatively and build how they see fit to create a dream car like Jack's from *If I Built a Car*. When they think they have a working robot, they can bring it to a testing station to scan the program BEGIN, FORWARD, END with the help of a teacher and run it. This test is to ensure that their robot follows the instruction properly and that it is sturdy. Invite them to play with the different ways of attaching the wheels to the motor hubs and see the difference in KIBO's motion.

Some students may not connect with the notion of building a car. Allow these students to define their own creative goal for this exercise.

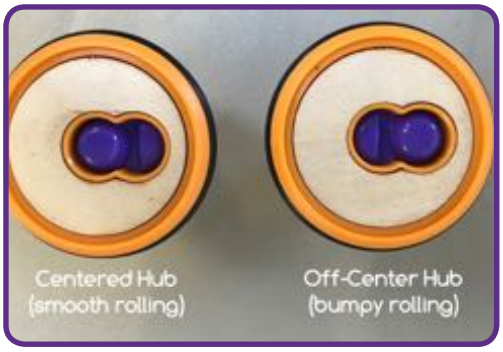
Reflect: What Does Your Car Do?

After finishing their cars, groups share their creations. Encourage them to explain the features of their dream car and what materials they used to construct it. Ask students to compare the different dream cars and see which features are similar and different. Do they think their cars could actually be built?

Tips for the Teacher:

Wobbly wheels: Is a student's robot wobbling instead of moving smoothly? Try attaching the wheel to the motor in a different way. Does the KIBO move differently if you change the way the wheel is attached to the motor?

Green dot reminder: Is the robot moving in a different direction than programmed? Make sure the green dot on each motor can be seen through the clear KIBO body.



Novice Lesson 9: Hokey Pokey

Topics: Sequencing, Decomposition, Patterns

Learning goals: students decompose and sequence a dance as individual commands as they program their robots to dance the Hokey Pokey.

Inspire: What is a Program, Revisited

"Today we will give instructions, or programs, to our robots so they will dance the Hokey Pokey." Discuss the concept of a program with the students, as a set of instructions that an engineer gives a robot or computer to tell it what to do. Relate the concept to the KIBO Says games played earlier and the experience in the earlier lesson when children first programmed their robots to move.

Remind students of the lyrics of the Hokey Pokey song and dance, and relate these to the idea of a program as well. "The instructions in the Hokey Pokey — put your right foot in, put your right foot out — are like a program for the dancer. When everyone follows the instructions at the same time, our whole group can dance together. We'll teach our KIBOs to dance along. But first we will need to break down (or **decompose**) the steps of the Hokey Pokey into instructions for KIBO."

Note: If the Hokey Pokey is not a familiar song and dance for your student population, you can substitute a familiar song instead. Ideally, choose a song that involves specific movement instructions.

Connect: Hokey Pokey Dance

As a class, sing and dance the Hokey Pokey! Dance to the normal verses about moving the human body. Then conclude with a "robot verse":

You put your KIBO in, you put your KIBO out,

You put your KIBO in, and you shake it all about.

You do the Hokey Pokey, and you turn yourself around.

That's what it's all about!

Watch a video: See the Hokey Pokey in action! Visit the videos section of **www.kinderlabrobotics.com/curriculum** for a video of the Hokey Pokey.

Repeat the process until you feel that the class is familiar with the song and the sequence of movements that make up the dance.

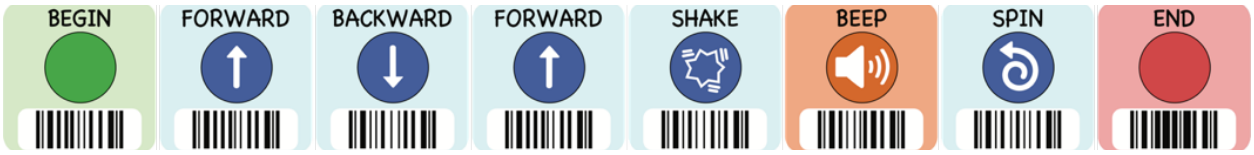
Engage: Program KIBO to Dance

Students work in small groups to program their KIBOs to do the Hokey Pokey dance.

Programming the entire Hokey Pokey can be a daunting task. Try breaking down the Hokey Pokey dance one step at a time. In programming terms, this is called **decomposition**. Then

figure out which KIBO programming block could represent each dance step. For example, the FORWARD block may correspond to "Put your robot in."

Here is one possible Hokey Pokey program for you to keep in mind:



Of course, this is just one possibility and there is no "right" KIBO Hokey Pokey program; the students will come up with their own creative ways to turn the Hokey Pokey into KIBO commands.

Reflect: Hokey Pokey Dance Party

When all groups are done, it's dance party time! Gather all the groups together to dance the Hokey Pokey verse one more time with their KIBOs. If you want, video-record the class dancing the Hokey Pokey with their robots to make a "music video" to send home to parents!

Students can then share about their creations. They may do one or more of the following: explain the blocks they used for the Hokey Pokey program, talk about what they found easy and difficult, and share anything they changed from their original plan.

Tips for the Teacher:

FORWARD blocks. The sample Hokey Pokey program shown here includes two FORWARD blocks, while only one such block is included in each KIBO kit. For this activity, you may want to have students or groups work together and pool their blocks between KIBO kits.

See the Hokey Pokey in action! Visit the videos section of www.kinderlabrobotics.com/curriculum for a video of students dancing the Hokey Pokey with their KIBOs.

Novice Lesson 10, 11: KIBO Dance Party

Topics: Integration (Social Studies)

Let's have a KIBO dance party! Students will decorate their KIBO as a dancer to represent a chosen culture or community; then they will create a program to teach their KIBO to dance to the music of that community. Students build on the decomposition and sequencing work they did in the Hokey Pokey lesson. They'll use those new skills to explore and express what they learn about dancers from their own or other cultures. Allow two meetings for this integration project.

This is a multi-lesson integration project. This project is estimated to require two meetings. However, you can organize the individual meetings in whatever way makes sense for you and your class. A typical integration project might flow like this, spread out over multiple meetings:

- Circle time, readings, games and movement activities to inspire and connect
- Small group time to imagine and plan
- Circle discussion to share plans
- Small group hands-on time to create
- Circle discussion to share challenges and successes
- Small group time to test and improve the creation
- *Alternate circle meetings and small group work as needed*
- Final showcase to reflect on the process and share the projects

Inspire: Dances and Dancers from Many Cultures

In this project, students will build on their experience with the Hokey Pokey in the prior lesson. They'll decorate KIBO as a dancer and create a program to let KIBO dance to the music.

This integration project can connect to an exploration of the dances, music, and costumes of a particular culture. Are there cultures, countries, or festivals that might be of particular interest to your students based on their backgrounds, their families, or just their curiosity? Even if you don't want to make a cultural studies connection, you can give the students the goal of making outlandish costumes for their own "KIBO Festival," playing any song of your choice.

Connect: Let's Dance Together

Use Connect times to explore videos, books, and music about the culture you've chosen. Include the music you'd like to use in the dance project. This project can be a wonderful opportunity to collaborate with a music teacher!

Engage students in choosing the song(s) to which the KIBOs will dance. Give students the chance to dance to these songs themselves, to give them ideas about how their KIBOs might move. You may want to include the Hokey Pokey dance, to build upon the work students did in the previous lesson.

Engage: Building and Testing the Dancing Robots

During the work periods for this project (as with all longer-term, integrated projects in the curriculum), students will alternate as needed between programming, building, decorating, and testing their robots.

During the work periods for this project, provide lots of "loose parts" for building onto KIBO. Ensure that the students have some structural materials to provide sturdy bodies for the dancers, such as paper towel tubes, boxes, cardboard pieces, or the like; along with options for connecting these to the KIBO motorized platforms.

Some children like to plan, while others work best through hands-on experimentation and building, and may prefer to jump right into crafting and programming. This is an opportunity to suggest students take on roles within their groups; one student can sketch while another experiments with KIBO programming, for example.

KIBO **Engineering Design Journals**, available from **shop.kinderlabrobotics.com**, are a useful resource to allow student groups to record their ideas, plans, and designs when working on longer-term integrated projects.

Check in with students frequently on an individual/group basis, and with whole-class Technology Circle meetings.

Reflect: Final Project Showcase

Once the dancing robots are completed, it is time to share! A group dance party is a great way to bring all of the students' work together.

Children can choose to share about one or more of the following if they would like: how they built or decorated their robot, how they programmed their robots, what inspired them, what was difficult, etc. They should also be encouraged to thank any friends from the class who helped them when they encountered challenges. Remember, teamwork is an important part of engineering. Ask questions that allow children to reflect on their process and not just their final products. For example, "How did you decide to make the robot Beep twice?" or "Why did you decide to have your robot go forward and then turn?"

This showcase can easily be extended into an Open House that you invite parents, siblings, and more to attend. Additionally, the dance theme is a wonderful way to get a music teacher involved a presentation that unites classes throughout your school.

Tips for the Teacher:

See KIBO Dancers in action! Visit the videos section of **www.kinderlabrobotics.com/curriculum** for videos of dance integration projects. One class in Boston programmed their robots to dance to Hava Nagila; while Kindergartens in Singapore used KIBO to explore the different traditional cultures and music of their country.

The Engineering Design process. Integrated activities highlight the importance of the engineering design process for children. Using the Engineering Design Journals (or notebooks of your own devising) makes the process concrete for students. If you like, you can also create stations or badges for each section of the design process. For example, you can have children tally how many times they tested their robot at the testing station.

Mid-point technology circle ground rules. At mid-point technology circles, invite children to share their in-progress work, and let them know that this is a time for questions and feedback. You may want to model for children what helpful feedback is, and lay some ground rules to avoid hurt feelings. Sample rules might include:

- If you say something you don't like about someone's project, also say something you do like.
- If someone is dealing with a problem that you also had, share how you solved it, or let them know you also have the problem and you can work together to solve it.
- Remember how you would feel if someone told you they don't like your creation that you worked hard on. Try to use words that wouldn't hurt a friend's feelings when you give your feedback.
- Use sentences that start with "I" (example: "I like…", "I notice…", etc.).