No KIBO? No Problem!

Screen-Free STEAM Activities You Can Do Without a KIBO: Excerpts from KinderLab Curriculum

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Activity 1: Sturdy Building

Powerful Idea: *The Engineering Design Process*

Overview: Think Like an Engineer! The students 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 design. The techniques of sturdy building through use of the engineering design process will prove important to the success of the children's KIBO robots in subsequent lessons and should be articulated and discussed during each activity.

Prior Knowledge	Objectives	
	Students will understand that...	Students will be able to...
• None, but prior experience building with crafts or recycled materials is helpful.	• Craft and recycled materials can fit together to form **sturdy structures**. • The **engineering design process** is useful for planning and guiding the creation of **structures**. • There are many different kinds of **engineers**.	• Build **sturdy structures.** • Use the **engineering design process** to facilitate the creation of their **structure**.

Materials / Resources

- ❑ A variety of crafts and recycled materials for building and decorating
- ❑ Engineering Design Process poster showing the six steps
- ❑ Pictures of naturally occurring and human-made objects
- ❑ Engineering Design Journals
- ❑ *Engineering the ABC's* by Patty O'Brien Novak
- ❑ *Rosie Revere, Engineer* by Andrea Beaty

Lesson 1 Vocabulary

Cycle: something that moves in a circle (i.e. the seasons, the Engineering Design Process)

Design: a plan for a building or invention

Engineer: someone who invents or improves things

Material: something used to build or construct

Structure: a building or object made with different parts

Background for the Teacher ...

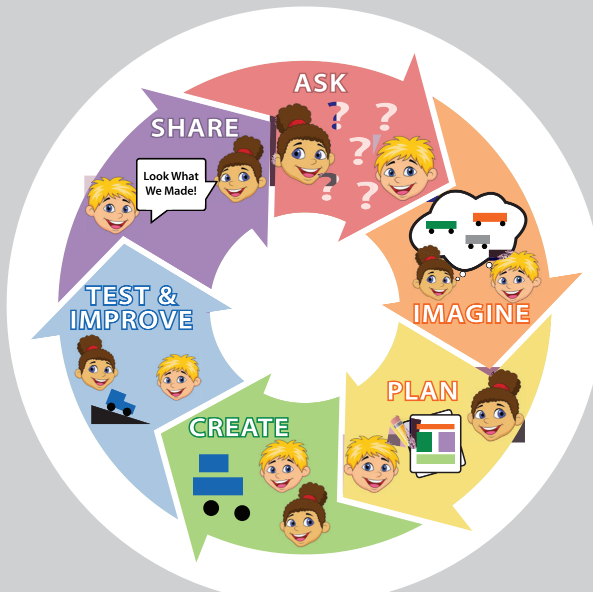
What is an Engineer?

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.

Different kinds of engineers: There are many kinds of engineers, including biomedical engineers, aerospace engineers, computer engineers, and industrial engineers. For descriptions and further activity ideas related to engineering, we recommend the **Engineering is Elementary** curriculum from the Boston Museum of Science.

Think Like an Engineer!

When making 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. You can begin at any step, move back and forth between steps, or repeat the cycle over and over!



Note: It is important to establish rules or expectations for how students should treat each others' materials, programs, and robots. Find a time for students to generate these group expectations. But students may be better able to imagine reasonable expectations after using the robots once, so setting expectations for working with KIBO may need to wait for Lesson 2.

Activity Description

Warm up: Engineered or not? Show a variety of different pictures of naturally occurring and human-made objects, such as trees, clouds, animals, buildings, roads, and tools. Ask students to stand if they think the object is human-made and to sit down if they think it is natural. Explain to students that any human-made object is influenced in some way by engineering.

Introduce the concepts: "Today we will all become engineers. We will be building and creating things that engineers make!" Discuss what an engineer is and introduce the steps of the **engineering design process** using the poster. Discuss as a class what different kinds of engineers make and do. What kind of engineer are we going to be when we build our structures? (There may be more than one answer!)

Suggested reading: *Engineering the ABC's* by Patty O'Brien Novak answers questions about how everyday things work and how engineering relates to so many parts of a child's daily life. In an entertaining way, this book shows how engineers shape our world. *Rosie Revere, Engineer,* by Andrea Beaty, shows the importance of persistence in an engineer's work.

Individual/pair work: 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 child or group will choose one thing and make a model of it using crafts and recycled materials or LEGO bricks. Next, they will follow the steps of the engineering design process and create new models. These models need to be sturdy! Test your models by dropping them from ankle height to see if they fall apart.

> **Classroom Tip:** If models do not survive the ankle-drop test, remind students of the "Test and 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 child's model is sturdy enough to survive the ankle drop test, they can modify their design so that it can survive from a knee-height drop.

Technology circle: 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.

Free-play: Provide opportunities for children to build freely with other building materials.

Activity 2: Build a "Draw Bot"

(1–1.5 hour activity)

Powerful Ideas: *Engineering Design Process, Sturdy Building*

Overview: This is an engineering-focused lesson in which children construct a "draw bot" from craft and recycled materials. The bot is powered by a DC motor and battery which you'll provide for the students, but the body of the bot will be up to them. The bot moves randomly and leaves a messy, fun record of its movements. The children can explore sturdy building with this activity, leading to an example of an "uncontrolled" drawing machine to contrast with their programmed KIBOs later. The time dedicated to this lesson can vary depending on how much free engineering/building time you'd like to include.

Note: this lesson does not involve KIBO. It does require some hobby materials which must be acquired specially. Depending on your schedule and your goals for the unit, you may wish to skip this activity and begin with Activity 2.

Learning Goals

After this lesson, students will be able to:

- build a motorized "draw bot"
- create a sturdy draw bot frame that can hold the markers
- understand and apply the engineering design process

Materials / resources:

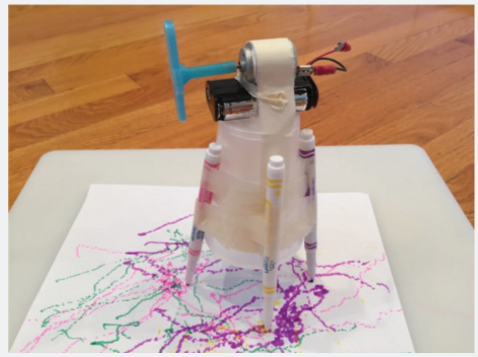
Required materials/resources:

- ❑ Motor supplies for draw bots (one set per group):
  - DC hobby motor (e.g. https://www.adafruit.com/product/711)
  - 6V battery pack (e.g. https://www.adafruit.com/product/830)
  - 4 AA batteries
- ❑ A variety of art and craft materials and recyclables, including: tape, plastic cups, various small boxes, cardboard pieces, plastic pieces, and assorted options for decoration
- ❑ Washable markers (at least 3 per group). Note: you can use the markers included in the Marker Extension Sets.
- ❑ Large sheets of paper taped to the floor, on which the draw bots will draw (poster board, rolls of butcher paper, or similar large surfaces). Ideally, each group should have an area roughly 4 feet by 4 feet.
- ❑ Engineering Design Journals, notebooks, or loose paper, for students to plan with

Optional materials/resources:

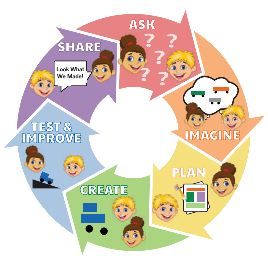
- ❑ Recommended reading: *Lines that Wiggle* by Whitman and Wilson
- ❑ Engineering Design Process poster (from KinderLab Robotics)

Activity Description



Background: There are many different ways to build a motorized "draw bot". The example pictured here uses the supplies listed in the Resources/Materials section on the previous page, with a tripod of pens taped to a plastic cup, and the motor providing the vibration needed to wiggle the cup. This design comes from the Lesley University STEAM Learning Lab (**steam.lesley.edu**).For more ideas, you can search the internet for terms like "draw bots", "wiggle bots", or "marker bots" for other examples of this activity using different supplies, different motors (such as recycled electric toothbrushes), and different designs. Children will create their own ideas, within the constraints of the supplies you provide.

Introduce the concepts and the task (10 minutes): "Today we are going to build our own wiggling draw bots! We'll build with motors and art supplies to make robots that draw and move on their own. Our robots probably won't work when we first build them, but we'll follow the **Engineering Design Process** to test, revise and improve them!"

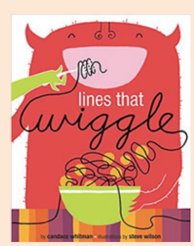


Review the **Engineering Design Process** and ask students to describe the steps in their own words: Ask, Imagine, Plan, Create, Test&Improve, and Share. Review the poster, if it is available. Explain that the robot the children build today will shake a lot and will need to be constructed in a sturdy way. For a refresher on any of these topics, see Lesson 1 in *Creating with KIBO*.

Introduce and demonstrate the DC Motor and Battery Pack assemblies. Explain that each group will get one of these assemblies to provide the power that makes their robot move. Show the students how it works; you may want to pass the assembly around the circle and invite children to turn on the power or attach the wire.

Classroom tip: You may choose to explore the electrical principles behind the battery and motor assembly with your students, but these topics are outside of the scope of instruction for this curriculum.

Recommended Reading: *Lines that Wiggle*, by Whitman and Wilson. This book is a lighthearted exploration of lines in the world, with all of their different qualities, and an invitation to readers to look for lines all around them. This sets the stage for the work the students will do throughout this unit.



Activity: Free build of draw bots (20–50 minutes): Give each group a complete motor and battery pack assembly and point out the building supplies available. Each group should use these supplies to create their own "draw bot." A draw bot should:

- move around on its own (wiggling, vibrating, shaking, sliding, spinning — it all depends on how the students build their frame and how they attach the motor);
- draw while it moves (markers might be attached to the sides or bottom of the frame; or might be the "legs" of the bot as in the image above);
- not fall apart under the shaking caused by the motor.

Beyond these constraints, students should build however they want with the materials you provide. They can test their draw bots on the paper squares taped to the floor.

Remind students of the Engineering Design Process and encourage them to plan as they work: they can discuss ideas among their group, sketch ideas in their journals, or just experiment and see what works ("plan with their hands").

If you find that groups are having trouble progressing, call a short Technology Circle to check in. Ask each group to share something that is giving them trouble, and ask other groups to respond with ideas that might help their peers.

> **Classroom tip:** If children are having trouble making their robots move, suggest that they attach something off-center to the axle of the DC motor; the extra weight will increase the vibration caused by the motor.

Technology Circle: Sketch and Share (20 minutes): Call a halt to the building and ask students to bring their draw bots to a closing technology circle. At the circle, groups should share their draw bot. They should explain something about the design that was the result of a change or improvement they came up with during the building work.

Finally, lead the class in a Gallery Walk to visit all of the drawings that the draw bots created. Ask students to share anything they notice about the drawings. Do the drawings look messy, or organized? Do they look like drawings a person would make?

> **Classroom tip:** Leave time for clean-up at the end of technology circle. You might want to ask the children to help clean up the stray marks where their draw bots went off the paper. This can reinforce their choices of conduct and good digital citizenship!

After the lesson is complete, collect and save the drawings for creating the gallery in Activity 6.

Activity 3: Program Each Other!

Powerful Ideas: *Sequencing, Representation*

Learning goals: students will continue to learn about the symbols and sequencing of KIBO's programming language, reinforcing the work from lesson 2.

Inspire: KIBO's Symbols

Using the KIBO Says cards from the previous lesson, review each of the KIBO commands that students have interacted with so far. Ask students to say what they remember about each of the commands. Show students a few new cards too (such as the LIGHT ON blocks) and ask them what they think these might do.

Remind students about the difference between the different **representations** on each block: the written words, the symbol, and the barcode. Each of these components of a KIBO block represent the same thing, but in different ways. The word is how readers might recognize the block. The symbol or picture lets non-readers recognize the block. The barcode is how KIBO recognizes the block.

Remind students about the importance of **sequence**. Each program must begin with BEGIN and end with END, and the order of the blocks in between becomes the "story" of the program.

Connect: Sequence and Pattern Reading

Read one of these books that emphasize sequence and pattern. Afterwards, ask students to discuss what they noticed about the pattern in the story.

The Very Hungry Caterpillar *by Eric Carle*

One sunny Sunday, the caterpillar was hatched out of a tiny egg. He was very hungry. On Monday, he ate through one apple; on Tuesday, he ate through two pears--and still he was hungry. When full at last, he made a cocoon around himself and went to sleep, to wake up a few weeks later wonderfully transformed into a butterfly!

If You Give a Mouse a Cookie *by Laura Numeroff*

If a hungry little mouse shows up on your doorstep, you might want to give him a cookie. And if you give him a cookie, he'll ask for a glass of milk. He'll want to look in a mirror to make sure he doesn't have a milk mustache, and then he'll ask for a pair of scissors to give himself a trim...

Engage: Program Each Other

"Let's get to know KIBO's programming language even better! Last time, we played KIBO Says. Today we'll create our own symbols to play a game to program each other."

Preparation: This activity will require colored markers and paper.

This activity focuses on creating sequences and gaining familiarity with symbols to represent programming commands. Ask student groups to draw their own versions of KIBO's BEGIN, END, and movement commands. They should draw extra copies of the movement commands. Allow groups to be creative if they wish, so long as the group members understand the symbols used. If students wish, allow them to include (or invent!) additional commands for their programs.

After spending a few minutes creating their own programming symbol cards, the groups will "program" one of their classmates to move from one part of the room to the other, perform a dance, or move through an obstacle course. An example would be for the children to "program" their friend to move from the front of the room to the library area by using the cards BEGIN, FORWARD, FORWARD, TURN LEFT, FORWARD, and END.

Groups should rotate the "robot" role so that each child has the chance to act out a program created by the others in the group.

Reflect: Our Symbols and Our Programs

Ask students to share the programming symbols they created. Ask students to share their reactions to other groups' symbols. Ask students to share what was surprising or challenging when creating programs for each other to act out. Did they notice the importance of sequence or order in the programs? What if one of the programs had been in a different order?

Tips for the Teacher:

Symbols and Representation. Both our everyday language and computer programming rely on the idea of symbols that represent concepts. When learning KIBO's programming language, children learn to associate the symbols such as arrows and spirals with actions that KIBO takes. As children work with these symbols, they are developing foundational skills in literacy and abstract thinking.

Activity 4: The PB&J Game

Powerful Ideas: *Algorithms, Decomposition*

Learning goals: students will learn that the sequence of the instructions in their programs matter. They will explore the importance of sequence by breaking down the steps required to make a peanut butter and jelly sandwich.

Inspire: When Following Instructions, Sequence is Important

Students encounter many situations where the order of steps is very important. Ask students to share examples that they can think of where they have to do things in the right order. An example you might offer is the process of getting ready to go outside for recess in the winter. Ask students to reflect on why the order of the steps in these situations matter. What if they put on their boots **after** going outside?

Connect: Red Light, Green Light

In this simple movement game, you will play the role of the "traffic cop." The Traffic cop gives out orders to the group such as "If green, jump. If red, sit down." In your "green" instructions, try giving the children sequences, like "walk forward 5 steps, then spin around."

Engage: P, B, and J game

"A program is a list of instructions. The order of those instructions really matter. Let's work together to create a program for making a peanut butter and jelly sandwich! I have all the ingredients we need right here, but I'm going to pretend I'm a robot when assembling the sandwich and I will follow your instructions in the exact order you give them to me. Ready to start?" (If you are concerned about student food allergies, you can use different ingredients.)

This activity will be delivered in a whole-class format. As students suggest steps, write out their list of instructions or "program" on the board. When the group is done, the teacher (acting as a "robot") should assemble the sandwich according to the class's directions.

Did the sandwich come out as the class hoped? Did they forget any instructions such as opening jars or picking up a knife? If problems occurred, engage the students in identifying where the sequence was incorrect or missing a step. Then re-run the "program."

Reflect: The Importance of Sequence

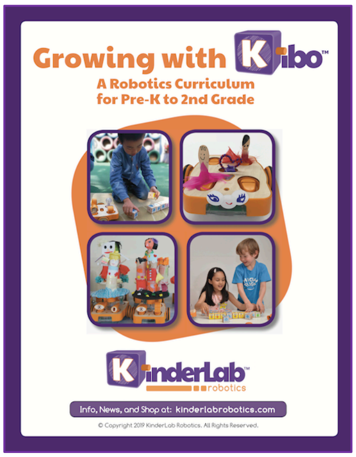
What did the students observe about the importance of sequence? For example, what would happen if you gave the instruction "spread the peanut butter" before you gave the instruction "open the peanut butter jar"?

Tips for the Teacher:

The Literal Robot. You can make sure to create learning opportunities by requiring the students to be very precise – as if you were a robot! For example, if students said to "spread the peanut butter" but never said to "pick up the knife," you can create an amusing example of what happens when a step is missed!

Where to Go Next

The lessons presented here are drawn from three of our KIBO curriculum booklets.



You can purchase the full booklets – and many more, totalling over 160 hours of standards-aligned lesson plans – at **shop.kinderlabrobotics.com**.