Makey Makey®

SAMPLE LESSON PLANS
FOR LEGO®

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INTRODUCING MAKEY MAKEY

Makey Makey is an invention kit for the 21st century. Turn everyday objects into touchpads and combine them with the internet. It's a simple invention kit for beginners and experts doing art, engineering, and everything in between.

With the Makey Makey, students can make any conductive material act as the input device for a computer. Because it comes preprogrammed, students with no coding experience can use it and learn to experiment with it as they start to learn coding.
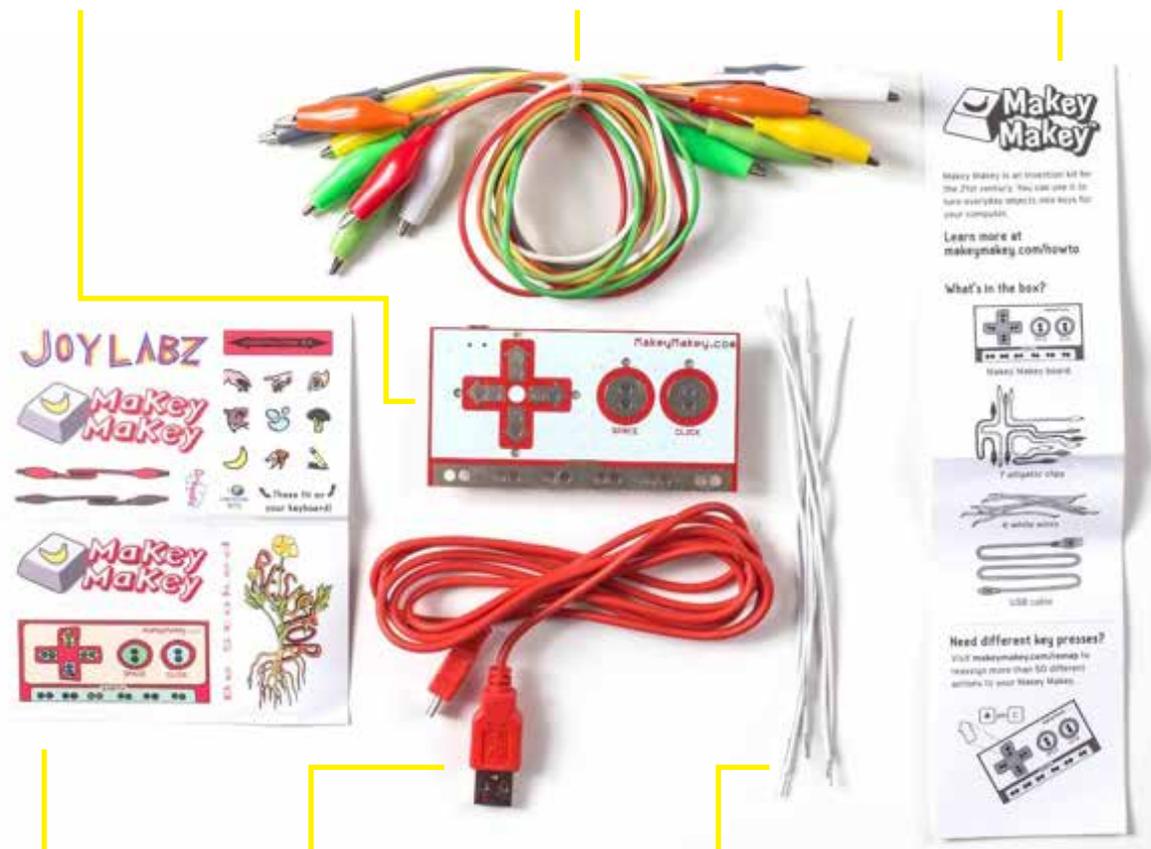
Makey Makey believes that the maker movement is more than just robots, 3D printing, or STEM, or even building things. It allows students to become hardware engineers and solve real-world design challenges by providing a landscape that fosters curiosity and creates vibrant learners.

BECOMING FAMILIAR WITH MAKEY MAKEY

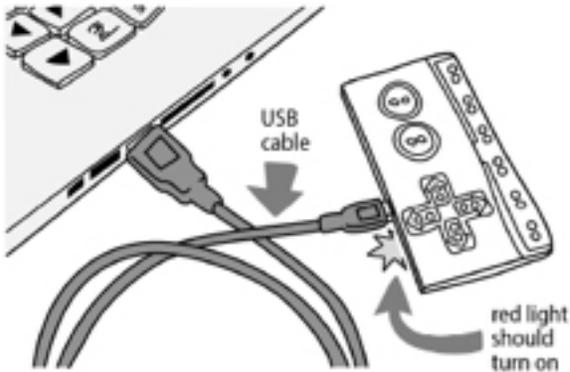**MAKEY MAKEY BOARD**   **ALLIGATOR CLIPS**   **INSTRUCTIONS**

STICKERS   **USB CABLE**   **6 CONNECTOR WIRES**

SETUP

USB cable

red light should turn on

1. Plug in USB

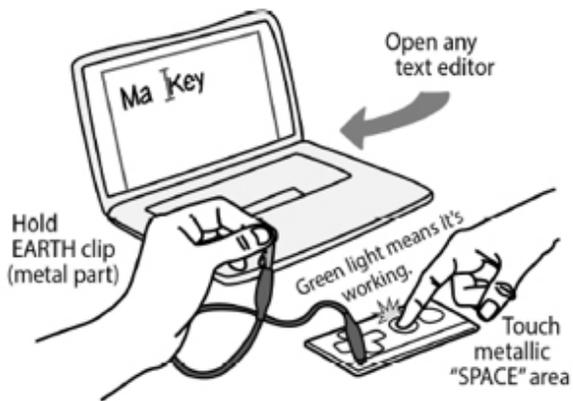Small side of USB cable plugs into Makey Makey, big side plugs into computer

2. Close Pop-Up window

Your computer may ask you to install drivers or do other setup. You can click cancel or close the window

INSTALL DRIVERS? DO SETUP? YOU DON'T NEED TO!

Alligator clip into "EARTH"

Hold the metal part.

3. Connect to Earth

Connect one end of an alligator clip to "Earth" on the bottom of the front side of Makey Makey

Open any text editor

Ma Key

Hold EARTH clip (metal part)

Green light means it's working.

Touch metallic "SPACE" area

4. Connect to yourself

Hold the metal part of the other end of the alligator clip between your fingers. You are now "grounded". While you're still grounded, touch the round "Space" pad on the Makey Makey, you should see a green light go on.

5. Get creative and have fun!

Make anything into a key! You can make a connection through anything that's even a little bit conductive. You can also creative inventions that combine conductive and non-conductive parts.

Go to makeymakey.com/bongos

(hold earth clip)

Add second banana to left arrow input

FREQUENTLY ASKED QUESTIONS

Is the Makey Makey easy to use?

Yes, no programming or software needed! All you have to do is alligator clip stuff together and surf the web to find a cool application to get started.

What is included in each Makey Makey educator's kit?

Everything you need to get started! Each Educator's Makey Makey includes:

- 1 x Makey Makey Board
- 1 x USB Cable
- 7 x Alligator Clips
- 6 x Connector Wires
- Illustrated Instruction Guide to Getting Started
- Educator's Guide Lesson Plans

What operating systems does Makey Makey run on?

Makey Makey works on Windows, Mac, Chromebook and on many flavors of Linux (Ubuntu, etc). Makey Makey works on some tablets and mobile devices, but is not officially supported.

How many keys can be pressed at once with a Makey Makey?

Makey Makey can press as many keys as your keyboard allows at once, which is 6. You can use up to 18 in a session (6 on the front of Makey Makey and 12 on the back), but only 6 can be held down simultaneously.

Can I use multiple Makey Makeys at once on 1 computer?

Yes! You can plug in two or more at once and create an orchestra of Makey Makey! (Officially tested with up to 3, but could work for more).

How do I use the back of the Makey Makey?

The connections on the back of the Makey Makey are what's called "headers." They're rows of little sockets, designed for wires to stick into. One easy way to use them is with the included connector wires (a.k.a. jumper wires), which are wires with little pins on either end that stick nicely into the header. You can also buy additional ones separately, but be sure to get the male/male ones. You can also find clever ways to use stuff you already have — for example, we've found that both paper clips and safety pins work great for this purpose!

How do I remap the keys?

With a Makey Makey version 1.2, you can easily remap keys directly in your browser at this website: www.makeymakey.com/remap

LESSON PLANS

LESSON 1 – DESIGN CHALLENGE
MOVING COMPONENTS WITH LEGO® TO TRIGGER MAKEY MAKEY

by Jen Gilbert

GRADE LEVEL

3rd grade and up
Adaptations for older students include use of LEGO® WeDo 2.0 or other LEGO® robotics

OVERVIEW

This Design Challenge is intended to give students an opportunity to explore options for creating a Makey Makey trigger or switch using LEGO®. The purpose of the project is to challenge students to see the way LEGO® models can be connected to a Makey Makey and create a foundation for further learning (see other lessons with Makey Makey and LEGO®). Samples shown in this lesson can be used for other activities (e.g., switches for Storytelling or Interactive Community activities) and it is a recommended introductory challenge to give students time to think through various switch options they could create. Students will be able to construct an interactive switch that connects LEGO® models to a Makey Makey.

LESSON OBJECTIVES

- Build a LEGO® model that incorporates movement
- Create conductive touch points that trigger when movement is activated (manually for standard LEGO® or automated for LEGO® robotics kits)
- Add interactive audio components to Soundplant (or Scratch)
- Trigger audio with conductive materials featuring a switch connected to a Makey Makey
    - Use appropriate tools to connect audio with the Makey Makey triggers
- Describe how the engineering design process is iterative and scaffolds learning

TEACHERS SHOULD:

- Understand how to set up and explain completing a circuit with a Makey Makey
- Understand how to create a switch for the Makey Makey
    - Common use is a "pressure switch" that triggers when earth/key points touch
    - LEGO® version can use manual movement of pieces to close/complete circuit or automated movement with robotic components (e.g., WeDo 2.0)
- Understand how to remap a Makey Makey (GO or Classic v. 1.2 or higher)
    - Screencast and video of Classic being remapped
    - Reminder: 18 ports and 12 earth/ground connections on Classic for use with Soundplant/Scratch after remapping
- Understand the basics of Soundplant
    - Watch a Screencast
- Understand how to convert audio files to WAV (.wav) format, if needed
    - Basics on video
- Understand basics of Scratch programming language (optional - only if using Scratch)
    - Use the vocabulary (e.g., sprite = character)
    - Create and use a teacher account to manage student accounts

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ENGINEERING/TECHNOLOGY

- Building models with LEGO® to create a switch (can move manually at least)
- Recording audio with Soundplant (or Scratch)
- Wiring and conductivity (completing a circuit)
- Connecting Makey Makey buttons or wiring conductive materials to LEGO® models

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ADAPTATIONS

- Use this project as an introduction to creating interactive models with LEGO® and Makey Makey prior to other activities that require these skills
- For older students or settings with LEGO® robotics, challenge students to create automated movement with switches that trigger through a Makey Makey

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EXTENSIONS/RESOURCES/CONSIDERATIONS

- Use the links provided above to learn more about remapping a Makey Makey
- Consider this activity for a makerspace, technology class or library setting
- Extend the activity into an opportunity for Skype connections to another classroom to share and collaborate about design ideas
- Extend the activity into a written blog post, Google Slides presentation, or ebook (e.g., with Book Creator) that can be shared as part of an ongoing digital portfolio as well as on a classroom website

MATERIALS:

- Makey Makey for testing and sharing creations
    - Can use a single Makey Makey to test the switches
    - Multiple Makey Makey`s needed if key mapping individual sounds for more than 18 students
- Desktop, laptop for Soundplant or Chromebook for Scratch programming
- LEGO® bricks, assorted variety
- Alligator Clips
- 22 AWG solid core wire or scrap wire that works with a Makey Makey
    - Example sources for solid core wires: SparkFun or Radio Shack
    - Alternative are M/M jumper wires and clipping an alligator clip to one end (not as secure, but use what you have!)
- Wire stripper, if using wire in models (e.g., connect ports on the back of Makey Makey)
    - Note that wire ends need to be stripped to attach wire to your contact points
- Conductive materials to trigger Makey Makey (choose one or use variety)
    - Copper Tape (will need to connect to wiring/alligator clip) (used in samples)
    - Aluminum foil
    - Play-Doh
- Painter`s/Removable tape to secure models or temporarily hold wiring

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VOCABULARY/KEY TERMS

- Conduct
- Trigger
- Iteration

STEPS

DAY 1 – INTRODUCTION

This activity is an introduction to the engineering design process and using Makey Makey with LEGO® models. Extensions include connections to math practices, writing skills and using digital tools appropriately to share. The engineering design process foundation of this activity aligns with the K12 CS framework under program development (People develop programs using an iterative process involving design, implementation, and review) and reinforces the iterative nature of physical design.

- **Teacher:** (set up a sample sound file in Soundplant/Scratch connected to a Makey Makey using only two alligator clips: one connected to a key input and one earth/ground connection)
    - How does the Makey Makey work?
    - Discuss how a circuit is completed by touching the ground and a conductive touch point
    - Allow students to test, or show them that touching the ends of the two clips (one to a key input and one to the earth/ground) also triggers the sound (see photos 8 and 9 showing only two clips used)

- **Teacher:** What happens when you touch the ground clip and then the other clip?
    - Completes circuit and triggers sound

- **Teacher:** What happens when you touch the ends of the clips together?
    - Same thing - completes the circuit and triggers the sound

- **Teacher:** We are going to practice making a "switch" that completes the circuit by moving LEGO® pieces together

- Discuss the goals for this activity
    - Your challenge is to use materials provided and create a switch that can be opened and closed by you manually (see extensions for other ideas)
    - You may only use LEGO® bricks to build the switch
    - The pieces must have a way to touch and separate again in order to trigger the sound via a Makey Makey
    - You must have enough space so that you can manipulate the model/switch without touching the conductive parts yourself (then you are completing the circuit)
        - Teacher note: LEGO® pieces that work well
    - Take a look at the samples included here
    - Photos 12 and 13 show examples of connectors that allow movement

- If you do not have enough pieces to facilitate the activity, consider asking for donations from other classrooms or families
- Consider a trip to the LEGO® Store Pick-A-Brick Wall to fill a cup with specific pieces (if available)
- Pick-A-Brick is also available online from LEGO® if you need specific pieces
- Allow students the time to be creative with the pieces, but you should plan ahead to ensure there will be a variety to choose from

- Move the computer/device with the sample sound file and the Makey Makey with two alligator clips to an area that can be used as a testing station

- Note that if you already have small pieces of wire already cut from other projects (or scrap wire that works), you can provide a bin for students to re-use it during this project - there should be no need to keep the sample switches permanently wired
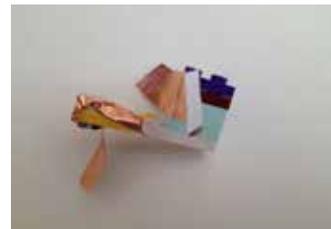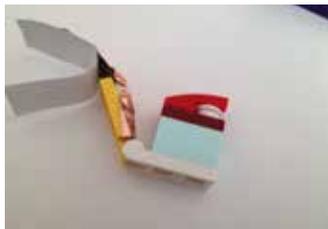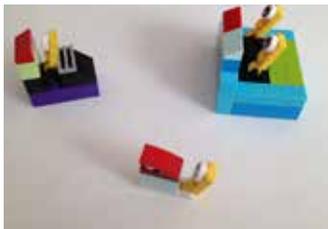
DAY 1 – ACTIVITY

- Students should be allowed to build for the majority of the time available

- After 10 minutes, pause work to remind students about the "testing station"

- Circulate to make sure students are using time wisely, encourage them to test regularly

- Teacher note: Timing and outline checkpoints
  - The activity should be able to be completed in 1 class session, depending on time blocks available
  - Checklist guideline for teachers:
    - Switch model with LEGO®
    - Tested switch (no copper tape) to make sure contact points touch
    - Used engineering design process to improve design and re-test
    - Includes conductive contact points (copper tape used in samples)
    - Model has pieces that move, allowing contact points to touch
    - Wires (stripped) are used at contact points (e.g., under tape)
    - Contact points are not touched by finger/hand when manipulating model
    - Photographed final model for artifact

DAY 1 - WRAP UP

- With 15 minutes remaining, have students complete their final tests if you want to have time for demonstrating as well

- Ask students to complete a page in their design journals (or similar) explaining what worked best in their final switch design

- Students should make a rough sketch of their final model and label the parts using appropriate terms

- If you are working through an extended version of the activity, stop with 7 minutes remaining to let students know about the next steps and explain where they will leave their "in progress" projects

- If individual sound files are being used as part of an extended activity, students will also need a reminder for saving the files properly (e.g., firstname_lastname_switch)
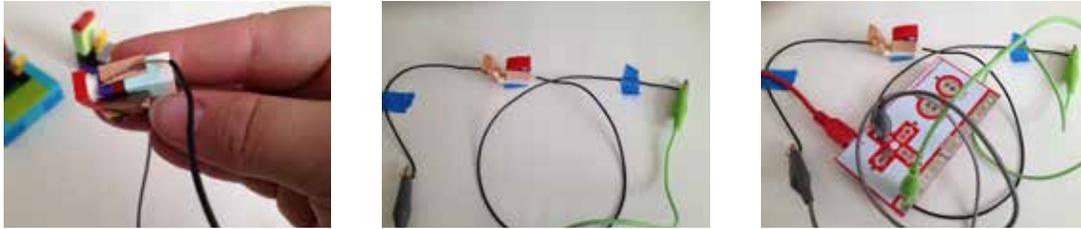

ACTIVITY PHOTOS

Photos 1-3 (above) Samples of 3 different switch models, using basic pieces from a "medium classic" LEGO® box (photo 1). Process of testing conductive material contact points (photo 2) and adding another brick (photo 3) to ensure the top of the touch point connects. Note that this switch has too much copper tape as pictured and hands will manipulating it to open and close will interfere. Consider making smaller switches part of a larger model or using much smaller contact points after testing.

Photos 4-6 (above) Variations on using the switch with a "cap" on top (photo 4) or an open top (photo 5) that allows a mini figure to be attached (photo 6). Again, the copper tape would need to be adjusted/trimmed to accommodate an area for where the model is touched when adjusting the switch.

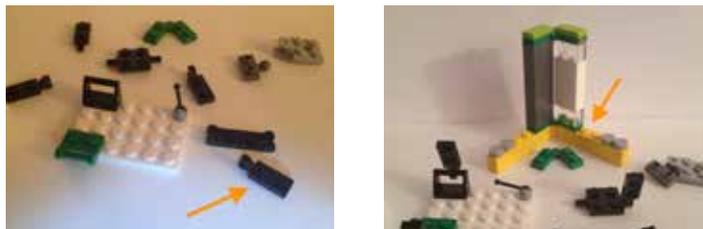**Photos 7–9 (above)** Choose a placement for the stripped wire where it touches the copper tape or is underneath it (photo 7) for each point (the key to be triggered and the earth/ground). Photo 8 shows the wires coming from the sample switch and connecting to the ground (green alligator clip) and up arrow key port (gray alligator clip). Photo 9 shows the Makey Makey in the picture as well. Your testing station can be set up (like photo 9) with the alligator clips and Makey Makey (connected to sample sound file in Soundplant/Scratch), allowing students to connect their wires for testing during the activity.

Photos 10 and 11 (above) In this sample a mini figure can be used as part of the scene/model and when the switch is added they are able to trigger an audio clip or program through the Makey Makey. Note the switch open in photo 10 and closed (contact points touching) in photo 11. These components can be added into other lessons as part of the Interactive Community or Storytelling activities, for example. When used with clear directions on the model, the contact points can be used without the switch by asking people to touch both areas to complete the circuit themselves (without closing the switch).

Photos 12 and 13 (above) The pieces shown in these photos were all found on the pick-a-brick wall at a LEGO® store. Each piece can be used as part of making a model move or creating a basic switch. Photo 13 shows the pieces combined in a way that illustrates how they work together. The black piece (1x2 with vertical holder) marked with the red arrow in photo 12 can be used to clip onto any piece with a shaft/stick as shown in photo 13. The stacked 1x2 bricks in photo 13 are connected with a 1x2 hinge plate on top of yellow 1x6 bricks (red arrow in photo 13). There are two hinges (top and bottom), but the movement will work with only one in place. For specialty pieces like this the pick-a-brick wall is an excellent deal for larger quantities that may be useful in a classroom setting. The hinge plate retails for $0.33 per piece if purchased online.

STANDARDS

COMPUTER SCIENCE AND TECHNOLOGY

ISTE: Empowered Learner	1a: Articulate and set personal learning goals, develop strategies leveraging technology to achieve them and reflect on the learning process itself to improve learning outcomes. 1d: Students understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies.
ISTE: Creative Communicator	6c: Students communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations.
ISTE: Knowledge Constructor	3d: Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.
ISTE: Innovative Designer	4c: Students develop, test and refine prototypes as part of a cyclical design process. 4d: Students exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.
CT.L3A-08	Use modeling and simulation to represent and understand natural phenomena.
CL.L2-02	Collaboratively design, develop, publish, and present products (e.g., videos, websites) using technology resources that demonstrate and communicate curriculum concepts
CT.L2-09	Interact with content-specific models and simulations (e.g., ecosystems, epidemics, molecular dynamics) to support learning and research.
CPP.L3B-01	Use advanced tools to create digital artifacts (e.g., web design, animation, video, multimedia).

COMMON CORE

CCSS.ELA-LITERACY. SL.3.1.B	Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion).
CCSS.ELA-LITERACY. SL.3.4	Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.
CCSS.ELA-LITERACY. SL.3.5	Create engaging audio recordings of stories or poems that demonstrate fluid reading at an understandable pace; add visual displays when appropriate to emphasize or enhance certain facts or details.
CCSS.ELA-LITERACY. SL.3.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others` ideas and expressing their own clearly.

COMMON CORE – CONTINUED

CCSS.ELA-LITERACY.W.3.2	Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
CCSS.ELA-LITERACY.W.3.6	With guidance and support from adults, use technology to produce and publish writing (using keyboarding skills) as well as to interact and collaborate with others.
CCSS.ELA-LITERACY.W.3.8	Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.

GEOMETRY

CCSS.MATH.CONTENT.3.G.A.1	Understand that shapes in different categories (e.g., rhombuses, rectangles, and others) may share attributes (e.g., having four sides), and that the shared attributes can define a larger category (e.g., quadrilaterals).

Mathematical practices:

CCSS.MATH.PRACTICE.MP1	Make sense of problems and persevere in solving them.
CCSS.MATH.PRACTICE.MP2	Reason abstractly and quantitatively.
CCSS.MATH.PRACTICE.MP3	Model with mathematics.
CCSS.MATH.PRACTICE.MP4	Construct viable arguments and critique the reasoning of others.
CCSS.MATH.PRACTICE.MP5	Use appropriate tools strategically.
CCSS.MATH.PRACTICE.MP6	Attend to precision.
CCSS.MATH.PRACTICE.MP7	Look for and make use of structure.

NGSS

3-5-ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
5-PS1-3	Make observations and measurements to identify materials based on their properties.

LESSON 2 – INTERACTIVE COMMUNITY
WITH LEGO® TO TRIGGER MAKEY MAKEY

by Jen Gilbert

GRADE LEVEL

6th grade and up
Adaptations starting in grade 3 can be made for urban/rural community comparisons

OVERVIEW

The Interactive Community project allows students to construct LEGO® models to represent environmental and culturally appropriate settings. Students use guiding questions to bring their project to life through sound recordings and a Makey Makey. Students will be able to demonstrate understanding by adding interactive components to a model that enhances an existing research project.

LESSON OBJECTIVES

- Build a LEGO® model of one component of a community
- Connect representation to historical context - where does your community exist in time?
- Use essential and focusing questions that lead to independent research
- Present arguments and explanations that appeal to audiences using a variety of media
- Discuss the importance of a community
- Gather relevant information from credible sources
- Appropriately cite sources used
- Add interactive audio components to the LEGO® model
    - Record audio digitally
    - Trigger audio with conductive materials and a Makey Makey
    - Use appropriate tools to connect audio with the Makey Makey triggers

TEACHERS SHOULD

- Understand how to set up and explain completing a circuit with a Makey Makey
- Understand how to remap a Makey Makey (GO or Classic v. 1.2 or higher)
    - Screencast and video of Classic being remapped
- Understand the basics of Soundplant
    - Watch a Screencast
- Understand how to convert audio files to WAV (.wav) format
    - Basics on video
- Understand basics of Scratch programming language (optional - only if using Scratch)
    - Use the vocabulary (e.g., sprite = character)
    - Create and use a teacher account to manage student accounts
    - Create a shortened URL link or be able to distribute link in other ways

ENGINEERING/TECHNOLOGY

- Building models with LEGO® to represent components of a community setting
- Recording audio digitally (e.g., free Quicktime on a Mac used in sample)
- Wiring and conductivity (completing a circuit)
- Connecting Makey Makey buttons or wiring conductive materials to models

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ADAPTATIONS

- Flip the lesson to include building at home or provide video programming tutorials so students come prepared to keymap/program with you in the classroom
- For younger students use the same setup process to build and compare rural vs. urban communities (students can record audio information detailing their setting)

EXTENSIONS/RESOURCES/CONSIDERATIONS

- Use the links provided above to learn more about remapping a Makey Makey, using Soundplant and converting audio files to .wav format with iTunes
- Students more familiar with the way a Makey Makey works should be allowed to try their ideas for buttons/wiring, if time allows - this will deepen their understanding of both the subject matter and the engineering/technology components that bring their project to life
- Consider chunking activities into manageable timeframes for students with executive f unctioning challenges
- Plan collaborative groups with the various group roles in mind
- For older or advanced students use scale with LEGO® models
- ScratchEd teacher resources (if using Scratch to program)

MATERIALS

- Makey Makey for presentations (can share among groups)
  - Coordinate groups/community models for a total of 18 sounds per Makey Makey
  - Suggested maximum of 2 Makey Makey`s per computer for a total of 36 sounds
- Soundplant program to keymap sounds that trigger with Makey Makey
  - No laptop/desktop for Soundplant? Use Scratch to program triggers on a Chromebook
- LEGO® bricks, assorted variety
- Foam board or cardboard for base of models
- Alligator Clips
- 22 AWG solid core wire or scrap wire that works with a Makey Makey
  - Example sources for solid core wires: SparkFun or Radio Shack
  - Alternative are M/M jumper wires and clipping an alligator clip to one end (not as secure, but use what you have!)
- Wire stripper, if using wire in models (e.g., connect ports on the back of Makey Makey)
  - Note that wire ends will need to be stripped to attach to wire to your "button"
- Conductive button to connect display and Makey Makey (choose one or use variety)
  - Copper Tape (will need to connect to wiring/alligator clip)
  - Brads (round head brass paper fasteners, minimum 1" length)
  - Alternative materials* can include screws (e.g., carriage/machine for flat bottom)
    - *Color-coding stickers at button can help if a variety of materials are used
- Construction paper and craft materials if needed to complement LEGO® models
  - Options can include using pipe cleaners or toothpicks to build people, if needed
- Painter`s/Removable tape to secure models or temporarily hold wiring

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VOCABULARY/KEY TERMS

- Conduct
- Trigger
- Scale

STEPS

DAY 1 – INTRODUCTION/PRIOR LEARNING

Lead a discussion about how the study of people, places, and environments enables us to understand the relationship between human populations and the physical world.
Big idea from NCSS themes:

- Studying the past makes it possible for us to understand the human story across time.

- The historical experiences of societies, peoples and nations reveal patterns of continuity and change. (The sample project is a simple model of the Indus River Valley Civilization, part of a 6th grade social studies unit on ancient civilizations)

- Remind students about the topic (e.g., ancient civilizations, westward expansion in U.S.)

- Provide outline for research component (are you assigning areas? picking out of a hat?)

- Assign groups (if needed), maximum of four students suggested

- **Teacher:** How do we use the engineering design process to bring this project to life?
    - Cover Makey Makey basics using a sample with buttons attached to alligator clips - if students do not have much experience, take time to allow testing
    - Discuss how a circuit is completed by touching the ground and a button

- Allow time to input existing research on the assigned/selected area into the outline
    - Students should gather information to address the recordings and write a draft
    - Ensure there are common areas (consider the 8 features of civilization) to be used for the interactive components (four buttons suggested)
        - Sample includes: introduction, buildings, transportation, agriculture
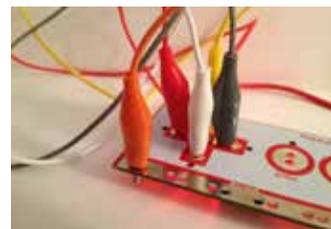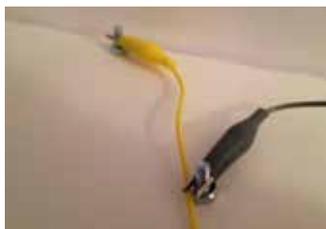
DAY 3 - ACTIVITY

- Allow time for building models, if in groups coordinate building with audio recording (swap for turns)

- Students should take turns recording their audio clips for the interactive buttons
  - Provide recording station areas (e.g., hallway, quiet area of room)
  - Make sure audio files are saved appropriately (group/title and description)
  - Final audio should be in .wav format for unless in trial/full version of Soundplant
    - Convert audio to .wav through iTunes, if needed
    - If using a Chromebook and Scratch to program, audio files can be recorded directly into Scratch - make sure students are signed in to save
    - Select "sounds" tab and choose the microphone, then record

- As audio recording wraps up, rotate students to a key mapping (or programming) station where audio can be mapped to specific keys in Soundplant
  - Ensure audio files are loaded on the proper device or saved in Scratch
  - If using a copy of Soundplant where the trial has ended, files should be .wav
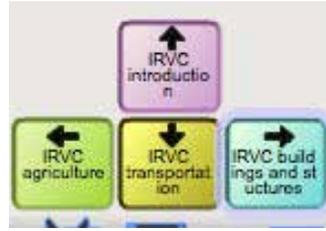

DAY 4 - ACTIVITY

- Students complete key mapping today, coordinating with those sharing same device

- Final touches on physical LEGO® models should be completed today

- Base design (colored/printed) should be secured to the foam board base

- Place models onto foam board base using rolled painter's tape for easy removal

- Students should add interactive buttons (see photos) and earth/ground button (after placement areas are approved)

- Connect wiring between buttons under the base to a Makey Makey

DAY 4 - ACTIVITY (CONTINUED)

- Test audio files once everything is connected and final models are in place

DAY 5 - WRAP UP

- Review outline and checklist components to ensure final products are complete and ready

- Complete any remaining steps from previous day

- Wrap-up discussion should be a debriefing technology circle to discuss what worked and what was a challenge

- Ask students to share (and take note of) discoveries and wonderings as part of the evaluation rubric demonstrating learning

- Option - to provide students time to "present" their model as class gathers around
  - Can share discoveries and wonderings here

- Provide time for a gallery walk so students can try the interactive components

- Share across multiple classes if there is an opportunity to do so

- Coordinate gallery walk so students can access the audio files without overlapping the triggered sounds on a single device

Photo 1 Choose the conductive materials that work from what you have available. For older students consider allowing them to select materials to create their buttons (figuring out if it will conduct is part of the learning). Flat bottom machine screws used here.

Photo 2 Mark the area where buttons will be placed. If using a variety of materials, you may want to provide color coded circle stickers to mark each button across different projects. Color code them based on required information for each model (e.g., green for transportation, red for housing).
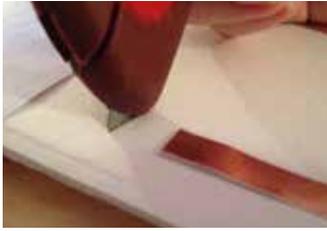

Photos 3 – 5 (above) Make a small slit in the model base (foam board) where the button will go (photo 3). This should only be done once the model is ready to be wired with the interactive buttons. Make sure all materials are in their final positions. In the case of the screws they can be twisted instead of pressed through to keep a neater hole in the base (photo 4). Since there were nuts available, they were used at the bottom of the model to keep the button in place (photo 5). If using other materials like brads and wiring, use tape to secure the button/wire connection for when the model is moved/used.

Photo 6 Four buttons in place for basic sample model representing the Indus River Valley Civilization.

Photo 7 Preparing the earth/ground button using copper tape. Steps shown in photos 8-15 are another option for conductive buttons in general. This method uses two pieces: the small strip for the connection under the base and a larger square as the actual button.

Photos 8-10 (above) Make a slit in the model base (foam board) large enough for the small strip to fit through (photo 8). Pass the small strip through the slit (photo 9) so part of it is showing (photo 10) and part is underneath the base. Keep the protective paper on the strip and square.

Photos 11-13 (above) Peel off the protective paper backing on the small strip. Bend the strip and fold it in (photo 11), allowing the strip to stick to itself and form a tab under the base (photo 12). Secure the top of the strip to the base by pressing the adhesive side down. This can now be used as a button if you prefer a small strip or want to use this option for all buttons. Photos 14 and 15 show the square piece of copper tape added.

Photo 14 Add a larger button on top of the small strip by peeling the paper backing and sticking the square on top of the smaller strip.

Photo 15 Finished earth/ground button using copper tape. Small tab under base to connect to the alligator clip.

Photos 16–18 (above) Use alligator clips to attach each button to the Makey Makey. Note that each button should connect to the appropriate port on the Makey Makey to correspond with the Soundplant keymap (or Scratch program). Encourage students to test these before taping (if needed).

Photo 19 In this sample only the arrow keys were used (up, down, left and right). The Soundplant keymap screen shot is below.

Photo 21 The completed sample model with buttons and earth/ground connection all wired to the Makey Makey. Test the buttons by placing one hand/finger on the ground (copper tape) and use another finger to touch the top of the button (screw). This completes the circuit and triggers the corresponding sound file on the computer.

STANDARDS

COMPUTER SCIENCE AND TECHNOLOGY

ISTE: Empowered Learner	1d: Students understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies.
ISTE: Creative Communicator	6c: Students communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations.
ISTE: Knowledge Constructor	3d: Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.
CL.L2-02	Collaboratively design, develop, publish, and present products (e.g., videos, websites) using technology resources that demonstrate and communicate curriculum concepts
CT.L2-09	Interact with content-specific models and simulations (e.g., ecosystems, epidemics, molecular dynamics) to support learning and research.

SOCIAL SCIENCES

Geography
Human Environment Interaction: Place, Regions, and Culture

SS.G.1.6-8.MC	Construct different representations to explain the spatial patterns of cultural and environmental characteristics.

Geography
Geographic Representations Human Environment Interaction Population

SS.G.3.6-8.LC	Explain how environmental characteristics impact human migration and settlement.

History
Change, Continuity, and Context

SS.H.1.6-8.MdC	Analyze connections among events and developments in broader historical contexts.

COMMON CORE

CCSS.ELA-LITERACY.RH.6-8.7	Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.
CCSS.ELA-LITERACY.SL.6.1.C	Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion.
CCSS.ELA-LITERACY.SL.6.1.D	Review the key ideas expressed and demonstrate understanding of multiple perspectives through reflection and paraphrasing.
CCSS.ELA-LITERACY.SL.6.2	Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study.

NGSS

MS-ETS1-4	Develop a model to generate data to test ideas about designed systems.
MS-ETS1-1	Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.
MS-ETS1-1	All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.
MS-ETS1-1	The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.

LESSON 3 – MUSICAL CREATIONS
WITH LEGO® AND MAKEY MAKEY

by Jen Gilbert

GRADE LEVEL

5th grade and up
Adaptations starting in grade 3 using just the Scratch "Make Music" tutorial

OVERVIEW

The Musical Creations project allows students to experiment with rhythm and sound through the Scratch programming language. LEGO® models are used to represent instruments and a Makey Makey brings their models and programming to life. Appropriate for computational thinking, music and math integration. Students will create a computational artifact for practical intent and personal expression. Students will evaluate and refine a computational artifact multiple times to enhance its performance, reliability, usability, and accessibility.

LESSON OBJECTIVES

- Build a LEGO® model of a musical instrument
- Program musical notes in Scratch
- Add interactive audio components to the LEGO® model
    - Connect model to Scratch program through Makey Makey
    - Trigger audio with conductive materials and a Makey Makey
    - Use appropriate tools to connect audio with the Makey Makey triggers
- Describe how computers can be used as part of the arts (music) to both create and document (e.g., show understanding)

TEACHERS SHOULD

- Understand how to set up and explain completing a circuit with a Makey Makey
- Understand how to remap a Makey Makey (GO or Classic v. 1.2 or higher)
    - Screencast and video of Classic being remapped
- Understand basics of Scratch programming language and complete the tutorial
    - Tutorial: https://scratch.mit.edu/jazz
    - Use the vocabulary (e.g., sprite = character)
    - Create and use a teacher account to manage student accounts
    - Create a shortened URL link or be able to distribute link in other ways

ENGINEERING/TECHNOLOGY

- Building models with LEGO® to create a musical instrument
- Programming with Scratch
- Wiring and conductivity (completing a circuit)
- Connecting Makey Makey buttons or wiring conductive materials to LEGO® models

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ADAPTATIONS

- Use the activity as part of a larger unit on math/music, great way to bring programming and engineering into a music classroom
- For younger students use the "Make Music" tutorial as-is to introduce programming with Scratch

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EXTENSIONS/RESOURCES/CONSIDERATIONS

- Check https://mathsciencemusic.org/#/project/scratch-jazz for inspiration
- Consider partnering with the music teacher - do you have a school song that could be programmed? Could the sharing take place during a concert/music class/portfolio night?
- Use the links provided above to learn more about remapping a Makey Makey
- Students more familiar with the way a Makey Makey works should be allowed to try their ideas for conductive touch points/wiring, if time allows - this will deepen their understanding of both the subject matter and the engineering/technology components that bring their project to life
- Consider chunking activities into manageable timeframes for students with executive functioning challenges
- Create a visual map to play songs through LEGO® models
- ScratchEd teacher resources

MATERIALS

- Makey Makey for testing and sharing creations
    - Coordinate groups/community models for a total of 18 sounds per Makey Makey
    - Suggested limit of 5 notes programmed per student for introductory models
    - Suggested maximum of 2 Makey Makey`s per computer for a total of 36 sounds
- Desktop, laptop or Chromebook for Scratch programming
- LEGO® bricks, assorted variety
- Foam board or cardboard for base of models
- Alligator Clips
- 22 AWG solid core wire or scrap wire that works with a Makey Makey
    - Example sources for solid core wires: SparkFun or Radio Shack
    - Alternative are M/M jumper wires and clipping an alligator clip to one end (not as secure, but use what you have!)
- Wire stripper, if using wire in models (e.g., connect ports on the back of Makey Makey)
    - Note that wire ends need to be stripped to attach wire to your contact points
- Conductive materials to trigger Makey Makey (choose one or use variety)
    - Copper Tape (will need to connect to wiring/alligator clip) (used in samples)
    - Aluminum foil
    - Play-Doh
- Painter`s/Removable tape to secure models or temporarily hold wiring

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VOCABULARY/KEY TERMS

- Conduct
- Trigger
- Tempo
- Melody
- Chord

STEPS

DAY 1 – INTRODUCTION

Lead a discussion about how the study of people, places, and environments enables us to understand the relationship between human populations and the physical world.
Big idea from NCSS themes:

- Create a computational artifact for practical intent and personal expression.
- Evaluate and refine a computational artifact multiple times to enhance its performance, reliability, usability, and accessibility.

• Using LEGO®, Makey Makey and the "Make Music" tutorial on Scratch we are going to build our own instruments to program and play.

• Open discussion around the learning goals: How do musicians use math? How can a computer be part of creating music?

• Essential questions for music creation and connection:
  - How do musicians make creative decisions?
  - How do musicians improve the quality of their creative work?
  - How do the other arts, other disciplines, contexts and daily life inform creating, performing, and responding to music?

• The sample projects show small creations using limited brick choices and creativity in design. Your goals should be clear to students. Are you focused on designing the instrument? Programming a melody/song? Calculating beats per minute/tempo?

• **Teacher:** How can we use the Makey Makey to create an instrument?
  - Cover Makey Makey basics using a sample with conductive touch points attached to alligator clips - if students do not have much experience, take time to allow testing (can use banana piano example here)
  - Discuss how a circuit is completed by touching the ground and a conductive touch point

• **Teacher:** What type of instruments can we build with LEGO® models?

• Watch the introductory video about the Scratch "Make Music" project as a whole class

• **Teacher:** Where do we go in Scratch to find instruments and sounds?

• Discuss the goals for this activity and provide a task list/outline

DAY 1 – INTRODUCTION (CONTINUED)

- **Teacher note:** Options to start
    - Beginning with model building or programming is up to you
    - Alternatively you can have stations that students rotate between: Building and programming (suggested total time for building is 35-40 minutes and programming 45 minutes to an hour)

- For modeling first: Provide LEGO® and pieces of foam board or cardboard for the base

- For programming first: Distribute link to the Scratch activity (https://scratch.mit.edu/jazz)
    - Students should have Scratch accounts and will need to log in

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DAY 1 – ACTIVITY

- Set a timer for building, or choose to rotate groups between the two options (LEGO® building/ programing in Scratch)

- Students should get approval on their model before building time to help them spend time wisely
    - If building realistic instrument models, can they find the pieces needed?
    - If using their own creations to play music, what instrument will it sound like and what do they imagine it to look like?

- Provide LEGO® and pieces of foam board or cardboard for the base
    - Provide craft materials (colored paper, crayons/markers) for base, if needed
    - Optional: Allow students to design base digitally and print (add more time)

- Scratch programming: Remind students about where you go to find instruments (sprites) and sounds (sounds tab)
    - Students need to log into Scratch to make sure their work is saved
    - Allow students to follow tutorial guide for "Make Music" activity and modify requirements as needed (in your outline/checklist)

DAY 1 - ACTIVITY (CONTINUED)

- **Teacher note:** Timing and outline checkpoints

- The activity should be able to be completed in 2-3 class sessions, depending on time blocks available

- Provide a checklist for tasks that includes timing. Guideline:
  - Sketch design, choose bricks
  - Build models (teacher: real instrument representation or imaginative?)
  - Program five notes in Scratch to start when triggered by a specific key
  - Place conductive touch points and connect wiring (test before final placement)
  - Connect Makey Makey to LEGO® model with proper keys from Scratch
  - Test touch points and program (does correct sound trigger?)
  - Photograph final models
  - Optional: Choice of conductive materials - what conducts best?

DAY 2 - ACTIVITY

- Remind students about the previous steps completed and continue where you left off from the previous session

- Scratch programs should be completed today and wiring of the LEGO® models should begin

- Remind students that when creating conductive touch points for the models they have to ensure there is a way to link them to the Makey Makey
  - Will they use all copper tape or aluminum foil? (note that this should all be removable from the LEGO® pieces!)
  - How will the Makey Makey connect to the conductive points? Using both wire and alligator clips?

- **Teacher note:** Group considerations for final products

- 18 ports if using front and back of Makey Makey with remap, 12 earth/ground

- One laptop/Chromebook can hold at least two Makey Makey`s for 36 ports, 24 earth/ground connections total

DAY 2 – ACTIVITY (CONTINUED)

- When combining work, can you do so in a way that the LEGO®/Makey Makey band instruments can be played simultaneously?
  - While more than one button can be pressed per Makey Makey, it would be hard to distinguish notes from several instruments on one computer/Chromebook
  - Consider that each "band" member should be part of a separate computer/Chromebook so they can make music together
  - Choose groups prior to students setting up which keys trigger their notes
  - For example: In a class of 20, you may have 4 students playing instruments together. You can set up 4 computers/Chromebooks and assign group groups A-E and students within each group numbers 1-4. See table for visual on coordinating key mapping:
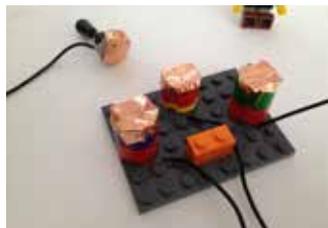
Computer 1	Computer 2	Computer 3	Computer 4
A1	A2	A3	A4
B1	B2	B3	B4
C1	C2	C3	C4
D1	D2	D3	D4
E1	E2	E3	E4

- Spread projects out around room to make it easier to hear and clearly show which are connected to the same computer/Chromebook

- Consider external speakers per computer/Chromebook

DAY 3 – ACTIVITY

- Remind students about the previous steps completed and continue where you left off from the previous session

- Complete wiring of LEGO® models with conductive touch points that connect to a Makey Makey

- Ensure that students are selecting the appropriate key based on their group/number (see table example in Day 2 activity)
    - In example, students with the number 1 could use all arrows and the space bar for their five notes (clips are switched for each group) or
    - Students with the number 1 will need to coordinate between two Makey Makey's (total of 25 keys needed in example) to assign keys (see remapping tutorials above) and wiring stays in place
    - Suggested keys are: arrows (4), space bar, O, W, A, S, D, F, G, 1, 2, 3, 4, 5, 6

- Do not forget about the ground button/touch point
    - Use a pressure switch (see photos of piano model) or make it part of the design (see photos of drum set)

- Place models onto foam board base using rolled painter's tape for easy removal

- Test audio files once everything is connected and final models are in place

- Photograph final models once secured to base with wires ready for Makey Makey

- Allow time to practice simple tunes on the instruments (limited if only using 5 notes)
    - Several sources online have basic tunes that provide the notes and slower tempos to practice
    - Students can translate the notes/proper tempo into Scratch (can try by ear if you prefer)
    - Pre-check sources or provide a list of "approved tunes"
        - Example: Twinkle Twinkle Little Star
        - Example: Happy Birthday song

- For students who complete a song and have time, or if you need a further extension, ask them to create a guide to play the song
    - Can they label the parts of their instrument with notes? Numbers? Use colors of bricks?
    - Write out the tune by note, number or color so that someone else can play the tune by reading the guide
    - Example of the notes G-G-D-D-E-E-D converted to numbers (1-1-2-2-3-3-2) or colors (Red-Red-Blue-Blue-Green-Green-Blue) based on model
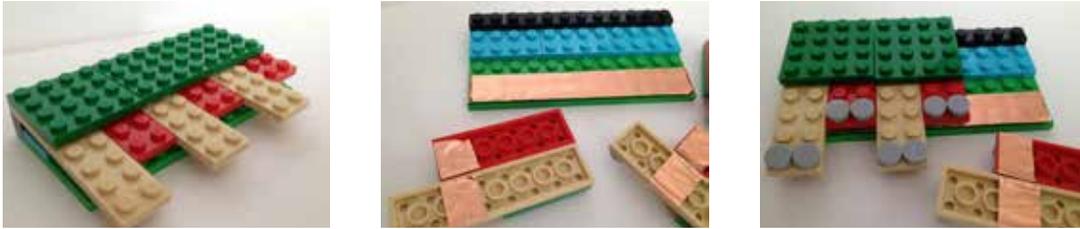
DAY 3 - WRAP UP

- Review outline and checklist components to ensure final products are complete and ready

- Facilitate the sharing of each instrument by grouping as a band, or similar instruments (however you arranged groups)
  - Film the instruments (and songs if applicable) to include as an artifact both for students and for the classroom overall - students can film for each other via iPad or other recording device available

- If students can play a simple song, allow time to do so

- If guides to songs were created, allow time for students (and other teachers!) to try playing the tune

- Wrap-up discussion should be a debriefing technology circle to discuss what worked and what was a challenge, were there unresolved challenges in Scratch?

- Ask students to share (and take note of) discoveries and wonderings as part of the evaluation rubric demonstrating learning
  - This time should be for the students to show what they know - if one student has a question, open it up to others for suggestions or a possible solution
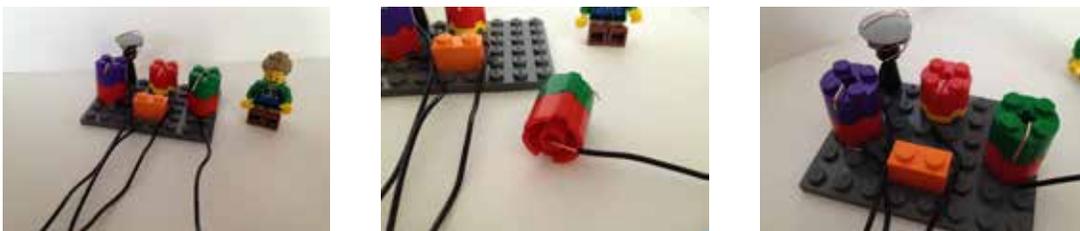
ACTIVITY PHOTOS

Photos 1-3 (above) Sample model of a "piano" using LEGO® pieces and a pressure switch system to trigger each key. The model was built up (photos 1 and 2) to provide some leverage for the "keys (beige and red) to bounce back after being pressed. Keys were attached in sections (photo 3) so they do not all pop up after a couple key presses. The pieces do still separate, but squeezing the back, near the row of black pieces, secures the green plates and "keys" again.
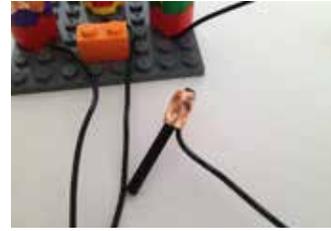
Photos 4-6 (above) In this sample the keys are still too close together to be very effective (photo 4). This can be a good design challenge for students to work out. Do they need to skip putting conductive points on a key (reds, for example) to make the beige keys trigger properly? Would another design produce better results? Photo 5 shows the conductive material added to each key and to the base for the earth/ground connection. Photo 6 shows the keys back in place with added gray buttons on each end (purely decorative).

Photos 7-9 (above) Wires were stripped only enough to have exposed end underneath the copper tape (photo 7). Alligator clips would not fit between the pieces, so this is one option to run wiring out (photo 8) to attach clips on the other end (stripped as well) or plug directly into the back ports of the Makey Makey. The earth/ground connection had a small loop created from copper tape that allowed the alligator clip to attach securely. A wire (like the keys) could be used as instead.

Photos 10-12 (above) This sample drum set model only uses four components: 3 drums and a cymbal (photo 10). The wiring was integrated into (photo 11), under or around the LEGO® pieces for the best fit. The "drums" were able to sit on the base plate (photo 12) over the stripped part of the wire (note longer stripping than normally used).

Photos 13–15 (above) The "drum stick" piece had a small amount of wire wrapped at the top (photo 13) before getting covered with copper tape over that end (photo 15). Each of the components had copper tape added to the top area, over the exposed/stripped wire. When touched by the end of the drum stick, connected to the earth/ground, the notes will trigger in Scratch.

Photos 16 Back view of the completed drum set, wired with mini figure holding the drum stick.

Photos 17 Front view of the drum set. The drum machine project on Scratch (by Eric Rosenbaum) was modified to fit the components of this sample and can be played on Scratch.

Photos 18 (above) Screen shot of an easy piano tutorial on Youtube for Twinkle Twinkle Little Star. This format may be helpful to students familiar with learning notes via video games. For students who struggle with this format, provide alternatives that include highlighting the keys with names of notes (no scrolling blocks).

Photos 19 (above) This remix of the drum machine by Eric Rosenbaum on Scratch fits the LEGO® model sample. Modifications are listed in the notes. Original cowbell was left in place even though it is not included in the LEGO® model.

STANDARDS

COMPUTER SCIENCE AND TECHNOLOGY

ISTE: Creative Communicator	6b: Students create original works or responsibly repurpose or remix digital resources into new creations. 6c: Students communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations.
ISTE: Digital Citizen	2b: Students engage in positive, safe, legal and ethical behavior when using technology, including social interactions online or when using networked devices.
ISTE: Innovative Designer	4b: Students select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.
CT.L3A-11	Describe how computation shares features with art and music by translating human intention into an artifact.
CT.L2-09	Interact with content-specific models and simulations (e.g., ecosystems, epidemics, molecular dynamics) to support learning and research.
CL.L3A-03	Describe how computing enhances traditional forms and enables new forms of experience, expression, communication, and collaboration.
CPP.L2-03	Design, develop, publish, and present products (e.g., webpages, mobile applications, animations) using technology resources that demonstrate and communicate curriculum concepts.
CPP.L2-05	Implement problem solutions using a programming language, including: looping behavior, conditional statements, logic, expressions, variables, and functions.

FINE ARTS

Music Creation

MU:Cr2.1.T.Ia	Select melodic, rhythmic, and harmonic ideas to develop into a larger work using digital tools and resources.
MU:Cr3.1.T.Ia	Drawing on feedback from teachers and peers, develop and implement strategies to improve and refine the technical and expressive aspects of draft compositions and improvisations.
MU:Cr3.2.T.Ia	Share compositions or improvisations that demonstrate a proficient level of musical and technological craftsmanship as well as the use of digital tools and resources in developing and organizing musical ideas.

COMMON CORE

CCSS.ELA-LITERACY. RST.6-8.3	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
CCSS.ELA-LITERACY. RST.5/6-8.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 5-8 texts and topics.

Math Practices

CCSS.MATH.PRACTICE.MP4	Model with mathematics.
CCSS.MATH.PRACTICE.MP5	Use appropriate tools strategically.
CCSS.MATH.PRACTICE.MP7	Look for and make use of structure.

NGSS

MS-ETS1-4	Develop a model to generate data to test ideas about designed systems.
ETS1.C	Optimizing the Design Solution: The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.
MS-ETS1-1	Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.

LESSON 4 – RACING CHALLENGE
FINISH LINE WITH LEGO® WEDO 2.0 AND MAKEY MAKEY

by Jen Gilbert

GRADE LEVEL

3rd grade and up
Adaptations for older students include use of other LEGO® robotics and more free building/programming (see adaptations and extensions)

OVERVIEW

This Challenge goes with LEGO® WeDo 2.0 "Speed" lesson. The purpose of the project is to create a pressure switch finish line that triggers a sound file through Soundplant or Scratch. Standard LEGO® can be used with cars that move manually (by push), but they need to be heavy enough to activate the pressure switch.

LESSON OBJECTIVES

- Build the LEGO® WeDo 2.0 "Speed" model
- Create a "pressure switch" with conductive touch points that triggers when rolled over
- Add audio sound effects to Soundplant (or Scratch)
- Trigger audio with conductive materials connected to a Makey Makey
    - Use appropriate tools to connect audio with the Makey Makey triggers
- Program a race car through the LEGO® WeDo 2.0 software

TEACHERS SHOULD

- Understand the basic functions of the LEGO® WeDo 2.0 kit components
- Have access to the teacher's guide for the LEGO® WeDo 2.0 software
- Understand how to set up and explain completing a circuit with a Makey Makey
- Understand how to create a pressure switch for the Makey Makey
    - Triggers when earth/key points touch
- Understand how to remap a Makey Makey (GO or Classic v. 1.2 or higher)
    - Screencast and video of Classic being remapped
    - Reminder: 18 ports and 12 earth/ground connections on Classic for use with Soundplant/Scratch after remapping
- Understand the basics of Soundplant
    - Watch a Screencast
- Understand how to convert audio files to WAV (.wav) format, if needed
    - Basics on video
- Understand basics of Scratch programming language (optional - only if using Scratch)
    - Use the vocabulary (e.g., sprite = character)
    - Create and use a teacher account to manage student accounts
    - Create a shortened URL link or be able to distribute link in other ways

ENGINEERING/TECHNOLOGY

- Building models with LEGO® WeDo 2.0 robotics kit
- Audio sound effects through Soundplant (or Scratch)
- Wiring and conductivity (completing a circuit) with a pressure switch
- Measuring distance for race track and length of pressure switch enabled finish line

ADAPTATIONS

- You can use only standard LEGO® for the race cars, setting start points and discussing force for the manual push (e.g., greater force applied in the push = greater distance traveled) along with mass (cars weigh enough to trigger switch)
- For children familiar with WeDo 2.0, use a free build option to create a car using only a motor/pulley system or different sensors and focus on the programming as the challenge
- Expand the activity to include specific programming/distance challenges

EXTENSIONS/RESOURCES/CONSIDERATIONS

- Prerequisite activity: At least two (A-B) of the four steps in the "Getting Started" project for WeDo 2.0 (build Milo and learn about motor, sensors and Smart Hub)
- For an extra programming challenge, use Scratch to operate the race car, keep time and automatically stop when the pressure switch is triggered with the Makey Makey
- Consider using the WeDo 2.0 software on a computer (or try a Chromebook) to start the race car with one button and stop it with another on the pressure switch (see photo 19)- extension to try to coordinate multiple race cars (may need more than one computer/ Makey Makey)

MATERIALS

- LEGO® WeDo 2.0 kits (2 students per kit)
- Tablet, computer or Chromebook with LEGO® WeDo 2.0 software (currently free)
    - Chromebook
    - iPad/Android
    - Mac computer (or Windows 7)/Windows 8 computer
    - Ideally the WeDo 2.0 control should be separate from the device with the Makey Makey
        - Tablet is ideal so the computer/Chromebook can be used with the Makey Makey
        - With older or more advanced users, one computer to control all can be a fun challenge
- Documentation tool (WeDo 2.0 software has one built in)
    - Book Creator is suggested as a more robust option
- Printed guide to program blocks in WeDo 2.0 software (provides descriptions)
- Makey Makey for testing and sharing creations
    - Can use a single Makey Makey at finish line if swapping "finish line" creations or creating one shared class "finish line" switch
- Desktop, laptop for Soundplant or Chromebook for Scratch programming (sound effects)
- Alligator Clips
- Conductive materials to trigger Makey Makey (choose one or use variety)
    - Copper Tape (will need to connect to wiring/alligator clip) (used in sample)
    - Aluminum foil (used in sample)
- Card stock or similar to create pressure switch finish line that the race cars can run over
- Foam or similar to provide gap in switch that is closed with pressure (see photo 1 and 8)
- Scotch tape or glue to secure aluminum foil (if used) in pressure switch
- For extensions - use wire (e.g., 22 AWG solid core) for greater flexibility when setting up triggers through WeDo 2.0 software (using letter keys and back ports of Makey Makey)

VOCABULARY/KEY TERMS

- Conduct
- Trigger
- Speed
- Acceleration
- Pulley
- Document

STEPS

DAY 1 – INTRODUCTION

This activity comes from the LEGO® WeDo 2.0 "Speed" lesson. Steps have been broken down with tips and a checklist for student use. Teachers should review and be familiar with the guide in the manual that provides sample talking points and rubrics to assess learning. Students go through three phases in the WeDo 2.0 activities: Explore, Create and Share. Modifications to the steps are included in this outline for students, including use of Book Creator as a tool to document learning with text, video, screen shots, photos and audio recording. The blended approach using both Book Creator and the WeDo 2.0 documentation is not required - adjust to suit your classroom.

- Teacher: Review the suggested talking points for the introductory video from the teacher's guide (p. 72)
    - Watch the introductory video as a class
    - Lead a discussion around those talking points, or your own, based on the topic of "speed" defining speed vs. acceleration.

- This activity will require 1.5-3.5 hours total over 2-3 days, depending on extensions used. Maximum time is needed if all of the "create more" options are used in addition to a free building time to modify and race unique cars.

- Decide if you are making one finish line for the class to share or allowing groups (2-4 students total) to make their own
    - For one-day option it is best to have a shared finish line

- Provide materials for finish line pressure switch construction (card stock, chart paper, foam pieces and conductive materials)

DAY 1 – ACTIVITY

Teacher Note: Finish line (pressure switch) construction is best before the build since students will be excited to test their race cars once complete. Place students into collaborative groups, two students per WeDo 2.0 kit and two groups that will then compare strategies/race. Adjust color coding/bullets/check list below as needed. Highlight any key instructions for students in bold, black text with a yellow background.

- Share an example of a pressure switch with Makey Makey, showing a top and bottom with conductive material, separated by foam or similar pieces that trigger when pressed together

- Explain that you will be using this type of switch as your finish line for the race cars

- If completing the extended activity options, provide an overview now
    - Once race cars are tested we will adjust the program to see try to increase speed
    - Extension: With the same program we will try adjusting the model itself to test
    - More free building: Your own car design and head-to-head racing (ensure finish line is long enough to for multiple cars)

- Have students measure out the finish line materials (minimum two sheets of paper long)

- Build the finish line pressure switch with the class (or in groups for extended activity)

- Ensure that there are spacers (thin foam or similar) that prevent the top and bottom pieces from touching, but will still allow cars to roll over them (see photos 1-9 for setup)

- Split students into groups (2 students per kit)

- **Explore Max and Mia's questions by talking with your partner:**
    1. What are some ways that cars have been improved to become faster?
    2. What factors influence the time a car takes to travel a distance?

- DISCUSS and then create a new book in Book Creator
    - Put the name of this project (Speed) on the cover
    - Record yourself saying the questions and the answers

- Have a teacher check your work.

- Return to the WeDo app.

- Watch the sample video then move to "create" phase: Build a race car that can move forward and stop at the finish line (use your blue bin). BUILD HERE. Switch at step #14.

- Open the WeDo capture tool to take a picture of your race car.

- Connect your Smart Hub (please connect only to your device number).

- Program your race car to move forward and stop when it sees an obstacle like it does in the video.

- Open the WeDo capture tool to take a picture of your first program string.

- Check the race track to ensure the obstacle is positioned near the finish line

- Check the Makey Makey connection to the finish line

- Test out your program at the race track! Use a stopwatch! What happens?
    - Record your times in Data Table 1

- Open the capture tool to take pictures and/or videos of your race car at the track.

- Open Book Creator to the page after the "speed" title.
    - ADD pictures of your race car and program.
    - Record your voice explaining the program.
    - Be sure to say or write how long it takes your car to get to the finish line.

- Have a teacher check your work.

- Return to the WeDo app.

- Can you adjust your program to make the car go faster?

Data Table 1			
Car	Run 1	Run 2	Run 3
My Design			

Record time in seconds for each run

DAY 1 - WRAP-UP

Teacher Note: If you are continuing to another session DO NOT break down models - keep them in cubbies or set aside on top of each kit and skip to Activity - Day 2 below.

- With 10 minutes remaining, have students break down models. One student can take the model apart while the other checks/saves their work in both the WeDo 2.0 software and Book Creator
    - If using shared devices, make sure the name of the files represents the students/group and track which students had each device just in case

- Final 5 minutes can be used to share out what worked to make the fastest run (refer to data tables)

DAY 2 - ACTIVITY

Teacher Note: This is the separation between one session and the next. If time and resources allow you to continue to another session, this is an excellent way to give students a chance to explore more through the WeDo 2.0 software. Students can save their project file and return to it when it is time to continue with the steps below. Re-use models, program strings and finish line pressure switch on day 2. Make sure students have screen shots or written out program strings from day 1.

- **Investigate with Max and Mia:**
    1. Set the motor power to 10.
        - Open the WeDo capture tool to take a picture of your program string.
    2. Time the race car with small wheels 3 times. Do NOT change the program. RECORD YOUR TIMES IN THE DATA TABLE 2
        - Open the WeDo capture tool to take a picture with SMALL wheels.
    3. Change to the big wheels. Do NOT change the program.
        - Open the WeDo capture tool to take a picture with BIG wheels.
    4. Time the race car with the big wheels 3 times. Do NOT change the program. RECORD YOUR TIMES IN DATA TABLE 2

- Discuss with your partner: Which setup went faster - big wheels or small wheels? Why do you think that happened?

- Open Book Creator to the next new page.
    - Record your voice sharing the results of your investigation.
    - Take turns talking and include opinions from each of you.
    - Take a picture of your data table, add it into Book Creator.

- Return to the WeDo app.

- **Choose the "Investigate more with Max and Mia" option 1**

- Change your program to match this:

- Change your pulley to look like picture A in the WeDo app.

- Time your race car at the track 3 times.

- Change ONLY the pulley to match picture B.

- Time your race car at the track 3 times. Record times in Data Table 3.

- Open the capture tool to take pictures and/or videos of your race car.

- Open Book Creator to the next new page.
    - Add pictures and videos of your race car with each type of pulley.
    - Record your voice sharing the results of your investigation.
    - Take turns talking and include opinions from each of you.

- Have a teacher check your work.

- Return to the WeDo app and go back to the page with your code blocks.

- CHALLENGE: Build a new car design using the same motor setup.
    - Open the capture tool to take pictures and/or videos of your race car.
    - Draw a new data table labeled "Data Table 4" for your own design.
    - Time your race car at the track 3 times.
    - Take pictures and/or videos of your own race car design while racing.

- SHARE in Book Creator and be ready to present to the whole class:
    - Which design was the fastest? Why?

Data Table 2			
Wheel Size	Run 1	Run 2	Run 3
Small back wheels			
Big back wheels			

Record time in seconds for each run

DAY 2 – ACTIVITY (CONTINUED)

Data Table 3			
Pulley Type	Run 1	Run 2	Run 3
Pulley A			
Pulley B			

Record time in seconds for each run

DAY 2 – WRAP-UP

Teacher Note: Collect data tables and checklist guide or secure in design journals

- With 20 minutes left, give students a five minute warning that they should be wrapping up their testing and recording the last runs. No new building should take place.

- At 15 minutes remaining ask students to come back together for sharing
  - If you are allowing time for sharing with the physical models, you may have to break them down separately. Otherwise make sure students have photographed their different car designs and give them five more minutes to wrap up their Book Creator/journaling about which design was the fastest.

- Remaining time can be used to share briefly out loud, or project and share from digital documentation (e.g., Book Creator or WeDo 2.0 software)

ACTIVITY PHOTOS

Photos 1–3 (above) Basic construction of a pressure switch finish line includes a ground contact (aluminum foil in sample) taped down, foam pieces (photos 1 and 2) with a connection running out to the edge (photo 3). Make sure the material used is flat enough to stay below your spacers (foam pieces in sample) to avoid interference with the top of the switch (copper square in sample). Copper strip running from ground is secured underneath the aluminum foil and taped down to ensure a good connection.

Photos 4–6 (above) Photo 4 shows the ground connection tab created from the thin strip of copper tape. The tape was folded back on itself to create the tab that sticks out. The top of the switch has the same thin copper tape running to the edge (photo 5) but also has a larger square of copper tape smoothed on top (photo 6) to provide a greater surface area to trigger the switch.
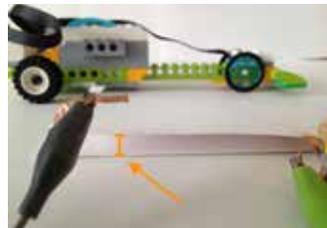

Photos 7–9 (above) Photo 7 shows the top part of the switch with the tab at the edge for the connection. Alligator clips are shown connected to the ground (gray clip, aluminum foil) on the left and the top of the switch (green clip, copper square) on the right of photo 8. When the top sheet is on top of the ground sheet (photo 8) the spacers (foam pieces) provide enough of a gap that the switch does not activate, but a LEGO® car can still roll over it. This is a delicate balance for this type of pressure switch since the object needs to activate it just by rolling across it. Consider making this part of a greater challenge involving measurement and mass of the LEGO® cars.

Photos 10 and 11 (above) When using the LEGO® WeDo 2.0 software in teams it is important to provide additional directions for students working in pairs. One student should be the "picker" gathering the correct pieces and the other student should be the builder who assembles the pieces. Both students need to be able to see the step-by-step instructions and teachers should select appropriate places to swap roles. In this case the suggestion is to swap at step 14 (shown in photo 10). The completed model is shown in photo 11. Note that the distance sensor will be optional once students move to extensions - up to you if you choose to make it part of the challenge or give free building.

Photos 12 and 13 (above) The sample speed program from the activity is shown in photo 12. Important to note for teachers (and sharing with students) is how to use the various blocks of code in the WeDo 2.0 software. Photo 13 shows the variety of options available on blocks. Students need to be aware that they have to tap to rotate through various options within the same block. The options for several blocks (tilt sensor, distance sensor, and two display blocks) are shown here.

Photos 14 and 15 (above) The comparison between a standard LEGO® car and the race car from the WeDo 2.0 speed activity is shown in photo 14. When the race car travels across the pressure switch finish line it has enough mass to depress the top sheet down to the ground connection. Photo 15 shows the race car triggering the switch.

Photos 16 and 17 (above) Standard LEGO® models may not have enough mass if pushed to roll across the pressure switch finish line. Photo 16 shows that this car model could roll right across the finish line without triggering the switch. It is possible to add more mass to the LEGO® model or configure the pressure switch in a different way (e.g., lighter material on top or wider lane for it to trigger). This can be a great additional challenge for students. Important to note in the race car design is the pulley assembly between the wheel and the motor. Often the rubber band will slip and be on the small yellow piece (red arrow in photo 17). This causes the race car to go significantly slower. It is a good teachable moment (and part of the various extension options), but one to be aware of when troubleshooting with students.

Photos 18 (above) This screen shot shows how to select different sounds in the LEGO® WeDo 2.0 software. When you click on the number block below the musical note you see all of the sound effects pop up below. Note that pre-recorded sounds are the orange color and the blue (far right) indicate sounds you have recorded yourself. In this screen shot the sound recorded would be number 21. Clicking on that would change the number under the musical note to 21.

Photos 19 (above) In a possible extension challenge or for students already familiar with WeDo 2.0 models, the following program is a sample that shows how the Makey Makey is used to trigger the race car itself, indicate when the race is over (with a sound/pop-up message) and stop the race car. This is a great way to allow creativity and critical thinking as students are challenged to use one computer and the Makey Makey with the WeDo 2.0 software. Consider this in Scratch as well - can the race car be controlled through the Makey Makey with a program there? See resources for this online.

STANDARDS

COMPUTER SCIENCE AND TECHNOLOGY

(examples based on grade 3-5 — adapt for older students as needed)

ISTE: Empowered Learner	1c: Students use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways. 1d: Students understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies.
ISTE: Creative Communicator	6c: Students communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations.
ISTE: Knowledge Constructor	3c: Students curate information from digital resources using a variety of tools and methods to create collections of artifacts that demonstrate meaningful connections or conclusions.
ISTE: Innovative Designer	4c: Students develop, test and refine prototypes as part of a cyclical design process. 4d: Students exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.
CT.L3A-08	Use modeling and simulation to represent and understand natural phenomena.
CL.L2-02	Collaboratively design, develop, publish, and present products (e.g., videos, websites) using technology resources that demonstrate and communicate curriculum concepts.
CT.L2-09	Interact with content-specific models and simulations (e.g., ecosystems, epidemics, molecular dynamics) to support learning and research.
CPP.L3B-01	Use advanced tools to create digital artifacts (e.g., web design, animation, video, multimedia).

COMMON CORE

Mathematical Practices

CCSS.MATH.PRACTICE.MP1	Make sense of problems and persevere in solving them.
CCSS.MATH.PRACTICE.MP2	Reason abstractly and quantitatively.
CCSS.MATH.PRACTICE.MP3	Model with mathematics.
CCSS.MATH.PRACTICE.MP5	Use appropriate tools strategically.
CCSS.MATH.PRACTICE.MP6	Attend to precision.

CCSS.ELA-Literacy.SL.3.1.A	Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.
CCSS.ELA-LITERACY.SL.3.1.B	Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion).
CCSS.ELA-Literacy.SL.3.1.D	Explain their own ideas and comprehension in light of the discussion.
CCSS.ELA-LITERACY.SL.3.4	Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.
CCSS.ELA-LITERACY.SL.3.5	Create engaging audio recordings of stories or poems that demonstrate fluid reading at an understandable pace; add visual displays when appropriate to emphasize or enhance certain facts or details.
CCSS.ELA-LITERACY.W.3.2	Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
CCSS.ELA-LITERACY.W.3.6	With guidance and support from adults, use technology to produce and publish writing (using keyboarding skills) as well as to interact and collaborate with others.
CCSS.ELA-LITERACY.W.3.8	Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.

NGSS

3-PS2-2	Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
4-PS3-1	Use evidence to construct an explanation relating the speed of an object to the energy of that object.
3-5-ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
5-PS1-3	Make observations and measurements to identify materials based on their properties.

LESSON 5 – STORYTELLING

WITH LEGO® WEDO 2.0 AND MAKEY MAKEY

by Jen Gilbert

GRADE LEVEL

3rd grade and up
Adaptations for older students include more free building/programming (see adaptations and extensions and photos for examples)

OVERVIEW

This lesson goes with the LEGO® WeDo 2.0 "Robust Structures" activity. The purpose of the project is to add interactive components to models that will trigger audio recordings of a story or report through Makey Makey and Scratch, Soundplant or the WeDo 2.0 software. Standard LEGO® can be used and the interactive components of this project can be adapted for other lessons. Students will be able to design switches and record appropriate audio content aligned with their final project.

LESSON OBJECTIVES

- Build the LEGO® WeDo 2.0 "Robust Structures" model
- Create switches or buttons with conductive touch points that trigger when activated
- Add audio sound effects to Scratch (Soundplant or WeDo 2.0 software* are options)
  - WeDo 2.0 software may limit number of recordings, to use multiple recordings per model use Scratch (or Soundplant) instead
- Trigger audio with conductive materials connected to a Makey Makey
  - Use appropriate tools to connect audio with the Makey Makey triggers
- Program the earthquake simulator through the LEGO® WeDo 2.0 software
- Summarize your findings by recording a response to the analysis questions
  - Connect recordings of responses to buttons/switches with the Makey Makey

TEACHERS SHOULD

- Understand the basic functions of the LEGO® WeDo 2.0 kit components
- Have access to the teacher's guide for the LEGO® WeDo 2.0 software
- Understand how to set up and explain completing a circuit with a Makey Makey
    - Check examples for buttons/switches in the sample models (see PHOTOS)
- Understand how to create a pressure switch for the Makey Makey
    - Triggers when earth/key points touch
- Understand how to remap a Makey Makey (GO or Classic v. 1.2 or higher) if you need to assign more than one group to a Makey Makey
    - Screencast and video of Classic being remapped
    - Reminder: 18 ports and 12 earth/ground connections on Classic for use with Soundplant/Scratch after remapping
- Understand the basics of Soundplant (optional - only if using Soundplant)
    - Watch a Screencast
- Understand how to convert audio files to WAV (.wav) format, if needed
    - Basics on video
- Understand basics of Scratch programming language
    - Use the vocabulary (e.g., sprite = character)
    - Create and use a teacher account to manage student accounts
    - Create a shortened URL link or be able to distribute link in other ways

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ENGINEERING/TECHNOLOGY

- Building models with LEGO® WeDo 2.0 robotics kit
- Audio recordings in Scratch (or Soundplant/WeDo 2.0 software)
- Wiring and conductivity (completing a circuit) with a button/switch
- Creating stable structures to withstand a simulated earthquake

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ADAPTATIONS

- You can use standard LEGO® for similar lessons then focus on the audio recordings and programming to have students document their learning and share the results
- Extend the activity to become part of a larger unit on weather phenomena or engineering challenges with building structures
    - Can use one simulator and have students build "houses" out of standard LEGO® to test on the single simulator

EXTENSIONS/RESOURCES/CONSIDERATIONS

- Prerequisite activity: At least two (A-B) of the four steps in the "Getting Started" project for WeDo 2.0 (build Milo and learn about motor, sensors and Smart Hub)
- Consider a challenge to design additional structures out of other material. Document what materials and designs are the most stable.
- Make a data table that presents the results of all tests. Create the data table in Google Sheets (or similar) or draw the data table on a separate sheet of paper and photograph it to add to the documentation tool.
- Using LEGO® WeDo 2.0 with Scratch via extension blocks
- Mini figures can be added as "narrators" (with switches) to the final presentation piece
    - Ask for donations from other classrooms or families
    - Purchase options include: Pick A Brick online (10 for about $16-$17 shipped), Brick Loot (Groupon deal for 10 at $15.99 or packs - shipping additional), and LEGO® store ($9.99 for 3 figures, includes 1 accessory per figure)

EXTENSIONS/RESOURCES/CONSIDERATIONS

- LEGO® WeDo 2.0 kits (2 students per kit)
- Tablet, computer or Chromebook with LEGO® WeDo 2.0 software (currently free)
    - Chromebook
    - iPad/Android
    - Mac computer (or Windows 7)/Windows 8 computer
    - Ideally the WeDo 2.0 control should be separate from the device with the Makey Makey for initial activities (extensions and challenges call for same)
        - With older or more advanced users, one computer to control all can be a fun challenge
- Documentation tool (WeDo 2.0 software has one built in)
- Printed guide to program blocks in WeDo 2.0 software (provides descriptions)
- Makey Makey for testing and sharing stories
- Desktop, laptop for Soundplant or Chromebook for Scratch programming (stories)
- Alligator Clips
- Conductive materials to trigger Makey Makey (choose one or use variety)
    - Copper Tape (will need to connect to wiring/alligator clip) (used in sample)
    - Aluminum foil (used in part of sample)
- Card stock/foam board or similar base for models, something to attach conductive material
- Optional - use wire (e.g., 22 AWG solid core) to connect conductive points and/or connect to back ports of Makey Makey
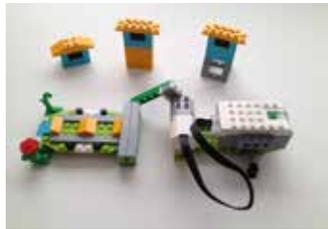
VOCABULARY/KEY TERMS

- Conduct	- Structure
- Trigger	- Hazard
- Document	- Stationary
- Stable	- Simulate
- Resistance	- Magnitude
- Robust	

STEPS

DAY 1 – INTRODUCTION

This lesson comes from the LEGO® WeDo 2.0 "Robust Structures" activity. Steps have been broken down with tips and a checklist for student use. Teachers should review and be familiar with the guide in the WeDo 2.0 manual that provides sample talking points and rubrics to assess learning. Students go through three phases in the WeDo 2.0 activities: Explore, Create and Share. Modifications to the steps are included in this outline for students (**remove text marked for the teacher in student copy**). Use the built in documentation tool or something like Book Creator that may provide more options. The initial activity calls for building the earthquake simulator and assessing the three sample buildings (A, B and C). Taking the time to modify the buildings and build new structures for testing will improve learning as students are able to design, test and evaluate the new structures (be sure to include steps for documenting).

- Teacher: Review the suggested talking points for the introductory video from the teacher's guide (p. 85)
    - Watch the introductory video as a class
    - Lead a discussion around those talking points, or your own, based on the topic of earthquakes and their impact on structures (cause and effect).

- This activity will require approximately 1.5 hours, not including any extensions. More time is needed for free building to modify buildings or create new structures.

- Decide if your story requirement will be a report or a made-up scenario with the model used as part of the story
    - For report option students will record their responses to the analysis questions
    - Using a made-up scenario should require students to build a story around the model that uses real facts to explain their understanding of the concepts
        - This option should allow creativity and flexibility, but be clear on the expectations so students do not end up working on purely imaginative fantasies

- Have materials for button/switch construction (card stock, chart paper, foam pieces and conductive materials) on hand

DAY 1 - ACTIVITY

Teacher Note: Adding the buttons or switches is best after the build since students will need their completed models in place on a base. Place students into collaborative groups, two students per WeDo 2.0 kit. Adjust color coding/bullets/check list below as needed. Highlight any key instructions for students in bold, black text with a yellow background.

- Share an example of a different buttons/switches with Makey Makey, showing how each one triggers a sound file via Scratch

- Explain that you will be using one type of switch within your final project (Teacher: Up to you if you give choice or assign type - consider groups, time and materials available when making the decision)

- If using any extended activity options, provide an overview now
    - Once buildings A, B and C are tested tomorrow we will evaluate what makes the sturdiest design in a structure
    - Extension: Free building to test structures with earthquake simulator

- Split students into groups (2 students per kit)

- **Explore Max and Mia's questions with your partner:**
    1. What causes earthquakes, and what are the hazards they create?
    2. How do scientists rate the strength of an earthquake?
    3. What factors can influence the resistance of buildings during an earthquake?

- Open the documentation tool and use your first page to answer based on what you both THINK about the questions above (work together). Please number your responses.

- Have a teacher check your work.

- Watch the sample video then move to "create" phase: Build an earthquake simulator that can shake buildings. (Switch the builder/picker role with your partner at step 24).

- Open the capture tool to take a picture of your earthquake simulator.

- Connect your Smart Hub (please connect only to your device number).

- Program your earthquake simulator to simulate an earthquake with various magnitudes.

- Open the capture tool to take a picture of your first program string.

- Open the documentation tool and make a new page. Insert a picture of
         1) your program string and 2) your earthquake simulator.

- EXPLAIN in words what the code is doing. Use your guide to the program blocks as needed.

- Have a teacher check your work.

- Return to the project library (tap the books) to go back to your code.

- Choose two areas of the model to create your touch points. Is the model stationary (does not move)? If it moves, consider where buttons will be placed on the base instead.

- Have a teacher check in to confirm your placement.

- Add skinny strips of copper tape from your touch points down to the base paper and leave a strip to connect your alligator clips.

- Have a teacher check in to confirm your placement.

- Add a strip or larger "button" for the ground (Teacher Note: Can remove this step and just hold the ground clip attached to the Makey Makey - see examples in photos)

DAY 1 - WRAP-UP

Teacher Note: If time will be split between two days, this is a good place to pause work. Ensure that models can be left intact between the two sessions. If completing the lesson with more than one class that shares the kits, plan accordingly (stagger days if possible). Block scheduling is ideal for these longer lessons.

- Ask students to complete their final step for today with 10 minutes remaining. Names should be written on the bottom of their base and all materials kept together.

- With 5 minutes remaining help students move their project materials to a safe location (Teacher: Will need space for kits, built models and base with conductive materials attached)

DAY 2 - ACTIVITY

Teacher Note: Keep students moving through the testing so there will be enough time for recording and programming. If necessary, plan for a third day that allows time to complete these steps and set up the final presentations.

- Students continue with the same partner from day 1.

- Begin with testing (see steps for students below) (approximately 15 minutes)

- Provide time for recording audio responses to questions (or recording scenario of a story, depending on what you chose) (approximately 10 minutes)

- Final 15 minutes should be used for programming and connecting conductive touch points to the base/model

- Student checklist continues below

- **Investigate with Max and Mia:**
    1. Find the smallest magnitude earthquake to make building B fall. Test building A with the same magnitude.
        - Open the documentation tool and make a new page. Document and compare your results with photos, text and/or video.
    2. Run the same program to shake buildings B and C
        - Open the documentation tool and make a new page. Document and compare your results for both tests.

- Have a teacher check your work.

- Return to the project library (tap the books) to go back to your code.

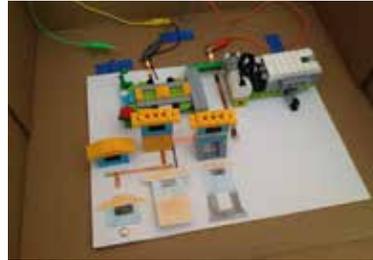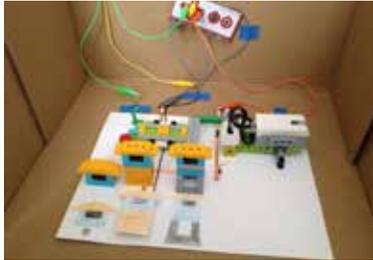- Select the arrow to move forward to the sixth "Create" screen (dot)

- **Choose the "Investigate more with Max and Mia" option**
  1. Predict what would happen if you repeated your investigation with a high-magnitude earthquake.
     - Open the documentation tool and make a new page. Document your predictions (write).
     - Have a teacher check your work.
  2. Build the tallest structure (using LEGO®) that can withstand an earthquake \ with a magnitude of 8.
     - Open the documentation tool and make a new page. Document your structures with pictures and text.
     - Have a teacher check your work.

- Teacher Note: Modify steps/questions as needed and see teacher's guide for more information

- Log into your Scratch account, create a new project named "Earthquake Simulator Results"

- Add sprites for each button or a narrator character

- Record your responses to the following questions in Scratch:
  - Record: Describe which factor influences a building's stability.
  - Record: Reflection for each building (A, B and C), discussing what the results were during testing.
  - Name your recordings to identify them

- Save your project!

- Add blocks of code to trigger the audio clips with the Makey Makey
  - Make sure they correspond to the buttons you are using on the Makey Makey

- Have a teacher check your work.

DAY 2 - ACTIVITY (CONTINUED)

- Connect the wires/conductive points on your base to the alligator clips and the Makey Makey to test your audio clips

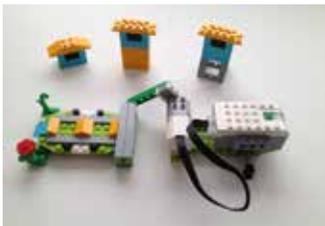- Film your model and the audio story with your partner

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DAY 2 - WRAP-UP

Teacher Note: Leave models put together for any final presentations - if time does not allow for whole group presentations then provide time for the students to film their projects while they are still set up.
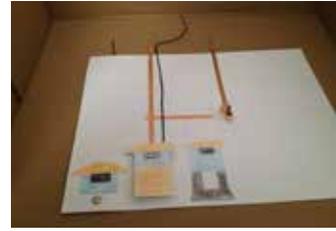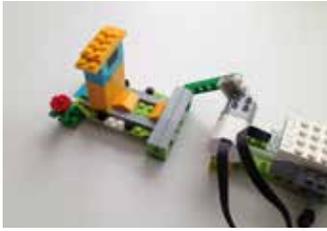
- With 5 minutes left, give students a warning that they should be wrapping up their testing and recording.

- Note any students who will need more time to finish documenting the final product.

- Plan for the final product being shared - will this take place in a larger setting or just be documented on film to be shared in their portfolios/on your school website?

- If more time is needed make sure you have a location to safely store the models/bases.

- Ensure that you have your own photographs and videos of the final products as well.

ACTIVITY PHOTOS

Photos 1-3 (above) Photo 1 shows the build for this activity "Robust Structures" that includes an earthquake simulator and 3 sample buildings (A, B and C). Each building sits on the simulator for testing. Buildings A (photo 2) and B (photo 3) can sit at the front or back of the simulator. Building C sits in the middle (photo 4).
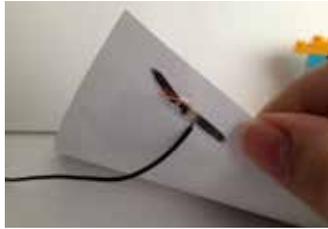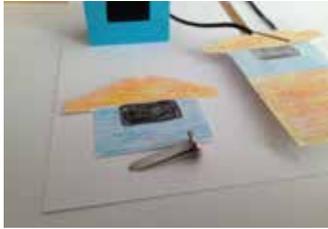
Photos 4-6 (above) Photo 4 shows building C sitting in the middle of the simulator. This sample includes three options for connecting the conductive points needed for this lesson. The buildings were drawn on card stock and cut out to attach to the base (photo 5). This allows the button or conductive point to stay in one place, even if the actual buildings are being used for testing. Photo 6 shows the samples in place.
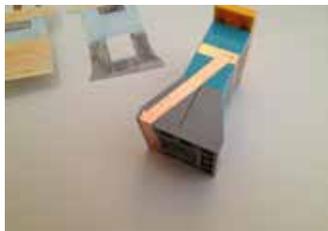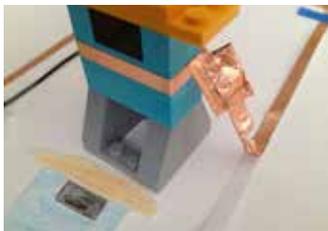

Photos 7-9 (above) Steps to create each type of button/switch are included in detail over the next several photos. Photo 7 shows the pressure switch option being laid out. Starting with the ground point made out of aluminum foil between the two thin pieces of foam (photo 8), a thin piece of copper tape is run underneath and to the back edge of the paper. Each material is taped in place with scotch tape (photo 9), ensuring that the copper tape is on the bottom and the foam pieces are on top (over aluminum foil).

Photos 10-12 (above) The back of the building B cutout gets a contact point made from a piece of copper tape and a 22 AWG wire, stripped (photo 10). The stripped end of the wire is secured underneath the tape and the tape is smoothed around it (photo 11). Photo 12 shows both pieces of the pressure switch option. When pressed together this switch will trigger the Makey Makey.
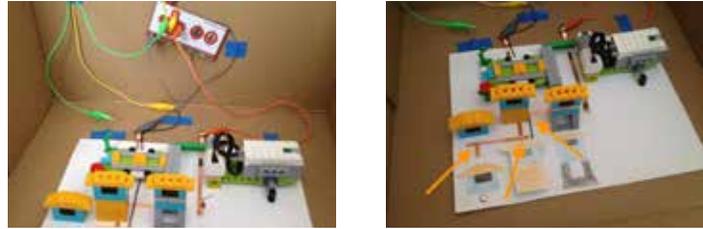
Photos 13–15 (above) One of the simplest forms of a button involves using a brad (paper fastener) (photo 13) that pokes through the paper to the bottom side where it can be connected to a wire (or copper tape etc.). Ensure that the stripped end of the wire touches the metal of the brad and tape it securely to hold it in place (photo 14). The entire length of wire can be taped down across the bottom of the page (base) to keep the wire in place (photo 15).

Photos 16–18 (above) Building C features conductive points secured to the actual model itself. A thin piece of copper tape is wrapped around the middle of the model (photo 16) and connected by another strip to a small piece of copper tape running along the bottom of the model (photo 17). A tab is created by another thin strip of copper tape (photo 16) that connects to the input key. Touching the tab to the model, while on the ground, will trigger this switch. The ground strip for building C is connected to the same ground strip used for building B (photo 18), running it under the wire and on securing on top of the copper strip from building B's pressure switch. Note the outline for building C that shows where to place the model to complete the connection (see photo 20).

Photos 19 and 20 (above) Photo 19 shows that the building can be placed on the simulator the same way. The copper tape does not interfere in this case since the model does not need to stick to studs (it sits on the simulator, not connected). Photo 20 shows the third option illustrated with building C completed and in place to make the connection. Touching the tab on the right side, while the model is in place touching the ground strip, will complete the circuit and trigger the Makey Makey.

Photos 21 and 22 (above) Connections for all sample switches/buttons are shown in photo 21. All three buildings use the same ground connection (see arrows in photo 22). Ground is the gray alligator clip. Building A uses a button connection (green alligator clip) with a brad (paper fastener) and stripped ends of 22 AWG solid core wire. Building B uses a pressure switch with aluminum foil, foam pieces, copper tape and the same solid core wire, also stripped at either end. Building B is connected to the up arrow (yellow alligator clip). Building C uses a copper tape strip with tab (to complete circuit when touching the grounded strip on the model) that runs to the edge of the paper (red alligator clip).

Photos 23 (above) This screen shot shows the original program with instructions from the robust structures activity in the LEGO® WeDo 2.0 software. This is the basis for initial testing and should be used for recording data.

Photos 24 (above) It is possible to control the WeDo 2.0 model through Scratch to use the same device/program both for testing the buildings and recording audio for the final presentation. Audio can be recorded and programmed for the Makey Makey triggers directly through Scratch. It is the recommended program for the final presentations in this lesson. See resources for using Scratch with WeDo 2.0 online.

Sample Buildings (above) Transparent images of the sample buildings (A, B and C) from the WeDo 2.0 software. These images were used in the Scratch sample shown in photo 24.

Mini figure parts list (left) Limited options to purchase parts to make your own mini figures are shown in this parts list from the Pick A Brick online store. Options may change over time, but this sample shows enough parts to build 10 mini figures and have 6 extra hats (option to switch between hair or hat) on hand. Shipping will vary by location but was $4.95 for this set of parts ($12.32 for these 46 pieces).

My selected pieces

	FIGUR HEAD CLOTHING NO 6	$0.13	2	$0.26 Remove
	MINI LOWER PART	$0.36	2	$0.72 Remove
	MINI LOWER PART	$0.36	2	$0.72 Remove
	MINI BODY LOWERPART BLUE	$0.30	2	$0.60 Remove
	MINI BODY LOWER PART WH	$0.30	2	$0.60 Remove
	MINI BODY LOWER PART BLACK	$0.30	2	$0.60 Remove
	MINI CONTRACTOR'S HELMET	$0.13	2	$0.26 Remove
	MINI HEAD "NO. 916"	$0.17	2	$0.34 Remove
	MINI HEAD NO 677	$0.17	2	$0.34 Remove
	MINI HEAD NO 891	$0.17	3	$0.51 Remove
	MINI HEAD NO. 893	$0.17	3	$0.51 Remove
	MINI U.S. CAP	$0.13	2	$0.26 Remove
	MINI UPPER PART NO. 2913	$0.53	5	$2.65 Remove
	MINI UPPER PART "NO. 1182"	$0.53	5	$2.65 Remove
	WIG BOY	$0.13	5	$0.65 Remove
	MINI WIG MAN	$0.13	5	$0.65 Remove
			Order total	$12.32

STANDARDS

COMPUTER SCIENCE AND TECHNOLOGY

(examples based on grade 2-5 — adapt for older students as needed)

ISTE: Empowered Learner	1d: Students understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies.
ISTE: Creative Communicator	6c: Students communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations.
ISTE: Knowledge Constructor	3c: Students curate information from digital resources using a variety of tools and methods to create collections of artifacts that demonstrate meaningful connections or conclusions.
ISTE: Innovative Designer	4c: Students develop, test and refine prototypes as part of a cyclical design process. 4d: Students exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.
CT.L3A-08	Use modeling and simulation to represent and understand natural phenomena.
CL.L2-02	Collaboratively design, develop, publish, and present products (e.g., videos, websites) using technology resources that demonstrate and communicate curriculum concepts.
CT.L2-09	Interact with content-specific models and simulations (e.g., ecosystems, epidemics, molecular dynamics) to support learning and research.
CPP.L3B-01	Use advanced tools to create digital artifacts (e.g., web design, animation, video, multimedia).

COMMON CORE

Mathematical Practices

CCSS.MATH.PRACTICE.MP1	Make sense of problems and persevere in solving them.
CCSS.MATH.PRACTICE.MP5	Use appropriate tools strategically.
CCSS.MATH.PRACTICE.MP6	Attend to precision.

CCSS.ELA-Literacy. SL.3.1.A	Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.
CCSS.ELA-LITERACY. SL.3.1.B	Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion).
CCSS.ELA-Literacy. SL.3.1.D	Explain their own ideas and comprehension in light of the discussion.
CCSS.ELA-LITERACY. SL.3.4	Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.
CCSS.ELA-LITERACY. SL.3.5	Create engaging audio recordings of stories or poems that demonstrate fluid reading at an understandable pace; add visual displays when appropriate to emphasize or enhance certain facts or details.
CCSS.ELA-Literacy. RI.2.3	Describe the connection among a series of historical events, scientific ideas, or concepts, or steps in technical procedures in a text.
CCSS.ELA-Literacy. RI.4.3	Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.
CCSS.ELA-LITERACY.W.3.6	With guidance and support from adults, use technology to produce and publish writing (using keyboarding skills) as well as to interact and collaborate with others.
CCSS.ELA-LITERACY.W.3.8	Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.

NGSS

3-5-ETS1-3	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
4-ESS3-2	Generate and compare multiple solutions to reduce the impacts of natural earth processes on humans.
3-5-ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
5-PS1-3	Make observations and measurements to identify materials based on their properties.

LESSON 6 – AUTOMATED VEHICLE CHALLENGE
WITH LEGO® WEDO 2.0 SCRATCH AND MAKEY MAKEY

by Amber Jadis and Nellie Keating

GRADE LEVEL

6th to 8th grade

OVERVIEW

Summary: Autonomous vehicles are quickly becoming reality. Students will design and evaluate two options for controlling vehicles.

Supplies: Computers (2 per group of 5-7 students), Wire, Aluminum foil, Tape, Pencils, Internet, Gloves made with rubber or other non-conductive material, Scissors, Paper

Products: Makey Makey (1 per group of 5-7 students); LEGO Education WeDo 2.0 Core Set (1 per group of 5-7 students)

App: Scratch, LEGO WeDo 2.0 Software, WeDo 2.0 extension for Scratch, TED Talks (links in Introducing Autonomous Vehicles Extension), Prezi (for optional Presentation Extension)

Theme Tags: robotics, problem solving, modeling, presentation, experiment, data,

Duration: Core lesson (2 hours); Introducing Autonomous Vehicles Extension (30 minutes); Creating Schematics (20 minutes); Introducing Makey Makey, Scratch, and WeDo 2.0 Extension (30 minutes to 2.5 hours); Persuasive Writing Extension (1 hour); Presentation Extension (2 hours)

Prior knowledge/skills/prep: Some experience with Scratch is helpful, but not required. If this is the students` first exposure to Makey Makey, Scratch, and/or WeDo 2.0, please review the Introducing Makey Makey, Scratch and WeDo 2.0 Extension on page 11 for some ideas and assistance.

Design Challenge: Does a vehicle perform better when controlled remotely or by its surroundings?

Outcome: Demonstrating a working car that drives itself using Makey Makey controls, Scratch, and Lego WeDo 2.0.

LESSON OBJECTIVES

- Students will become familiar with the Makey Makey and how it can be used to affect the non-digital world.
- Students will practice following detailed instructions building a motorized vehicle using LEGO WeDo 2.0.
- Students will exercise their creative engineering problem solving by improving the vehicle as the situation demands.
- Students will practice coding using basic building-block style commands in Scratch.
- Students will collect and analyze experimental data.
- Students will present their data and findings to their peers.
- Students will evaluate different solutions to choose the best fit for the problem.
- Students will discuss the real-world applications for technology and the implications new technology can have on society and the environment

PROCEDURE

NOTE

The procedures here are outlined specifically in detail. Teachers are invited to follow or abandon these prescribed steps as desired. With fewer instructions and more flexibility to explore, this lesson works as an exercise in creative problem solving. Given materials, time, and guidance, many students will cooperatively come to workable solutions which may or may not be outlined here.
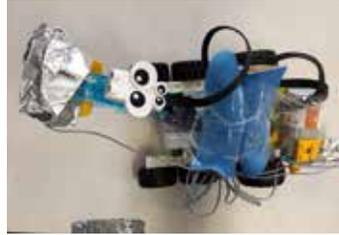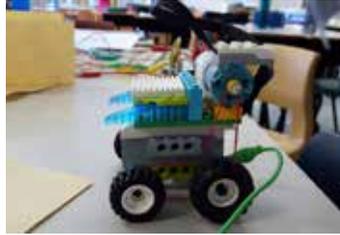
The class will be organized into groups of 5-6 students. Half of the groups will work on controlling a vehicle remotely (referred to as the Controls Groups) and the other half will work on controlling a vehicle using its surroundings (referred to as the Infrastructure Groups).

STEP 1
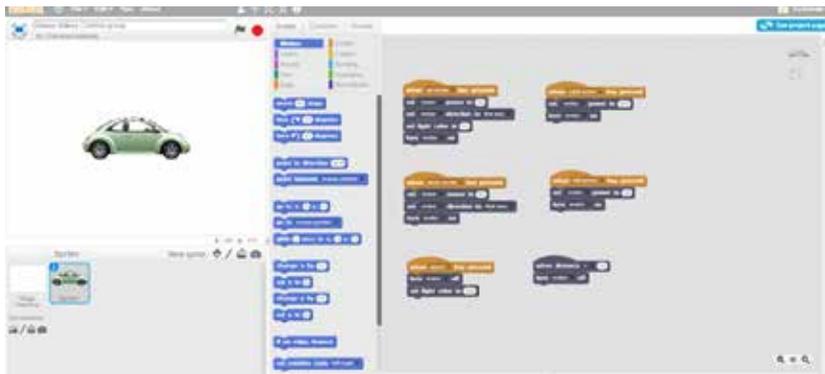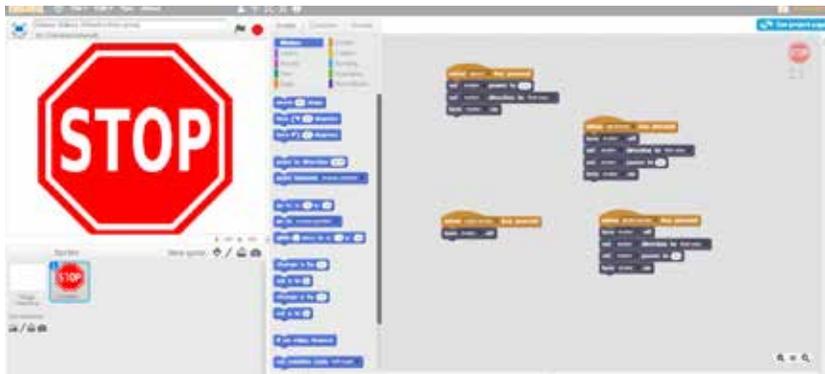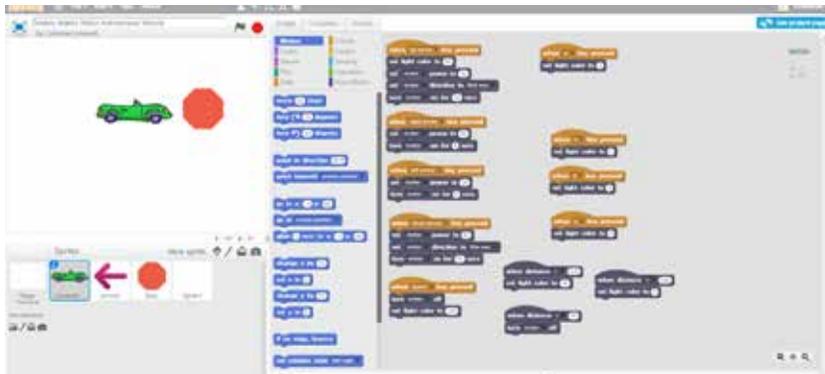
2 people build the car with grounded contact points.

Follow the instructions from WeDo 2.0 to build the basic driving vehicle. Modify the vehicle to improve its performance and stability as desired.
- Open the WeDo 2.0 software.
- Click on the book to start a new project.
- Click on the Gears icon.
- Click on 2. Drive.
- Click the right arrow button near the top of the screen to Build.
- Build the vehicle. Click the right arrow key at near the bottom of the screen to progress through the building instructions.
- Program the vehicle either using the program LEGO WeDo 2.0 provides in the instructions or by creating your own program.
- Customize, modify and improve the vehicle if desired.

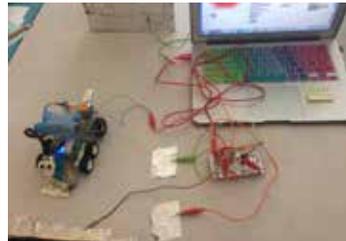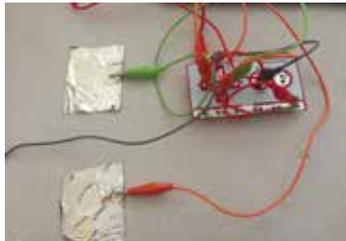1-2 people write the Scratch program compatible with Makey Makey,

- Install the LEGO WeDo 2.0 extension for Scratch from this link (https://scratch.mit.edu/wedo).
- Write a Scratch program to control a WeDo 2.0 motor or open the Scratch program at this link to use a program already created. https://scratch.mit.edu/projects/145468431/

For the groups working on controlling a vehicle using its surroundings (referred to as the Infrastructure Groups), 2 people build the infrastructure with Makey Makey contacts.

Infrastructure: create circuits that are completed when the car comes in contact with or senses elements on the road such as barriers, road markings, and signage. Make sure there are grounded contacts on the car so that the circuits are completed and the car can respond to the Scratch programming.

- Tape aluminum foil on the table as a road marking to indicate danger, with an alligator clip connecting it to the up arrow control on the Makey Makey.
- Place an aluminum sheet on a barrier wall as a sign to indicate danger, with an alligator clip connecting it to the down arrow control on the Makey Makey
- Tape two pieces of aluminum foil on the table in a convenient location and attach them with alligator clips to the right arrow and space controls on the Makey Makey. These will help the user turn the vehicle's motor on and off.
- Attach aluminum foil as sensors to the vehicle in a "snowplow" position so that the car can sense the markings on the road. Wire these sensors to the ground bar.
- Tape aluminum foil as sensors to the front and back of the vehicle so it can sense the barrier signs. Wire these to the ground as well. (The on-board sensors can be all attached to the same grounded wire.)
- Plug the Makey Makey into the computer using the USB cable.

For the groups working on controlling a vehicle remotely (referred to as the Controls Groups), 2 people build the controls with Makey Makey contacts.

Controls: create a set of controls that can be used remotely to drive the vehicle. They should be functional and intuitive.

- Tape aluminum foil around each of the fingers on the glove.
- Attach one Makey Makey clip to the aluminum foil on the middle finger of the glove. Attach the other end to the up arrow control on the Makey Makey.
- Attach one Makey Makey clip to the aluminum foil on the thumb of the glove. Attach the other end to the space bar control on the Makey Makey.
- Attach one Makey Makey clip to the aluminum foil on the index finger of the glove. Attach the other end to the right arrow control on the Makey Makey.
- Attach one Makey Makey clip to the aluminum foil on the ring finger of the glove. Attach the other end to the left arrow control on the Makey Makey.
- Attach one Makey Makey clip to the aluminum foil on the little finger of the glove. Attach the other end to the down arrow control on the Makey Makey.
- Tape a strip of aluminum foil on the palm of the glove.
- Connect one end of a Makey Makey clip to the aluminum foil on the palm and the other end to the ground bar on the Makey Makey.
- Connect the Makey Makey to the computer with the USB cable.

STEP 2

Each of the 4 groups now works together to create a working model of their vehicle system, integrating the Makey Makey, Scratch programming and LEGO WeDo 2.0.

- The Coding students in each group works together with the students in their group who created the LEGO WeDo 2.0 vehicle.
- Practice using keyboard commands to control the vehicle. This will require pairing the hub on the LEGO WeDo vehicle with the computer.
- Add the group members who built infrastructure or controls for the vehicles. Practice using the infrastructure or remote controls to drive the vehicle.
- Refine and tweak the systems as required.

STEP 3

Each of the 4 groups demonstrates their solution to the problem to the rest of the class and answers questions about their model.

STEP 3

Each individual student evaluates the proposed solutions, chooses which they think is the best model for an autonomous vehicle, and explains why.

CURRICULUM CONNECTIONS

COMMON CORE STATE STANDARDS AND NEXT GENERATION SCIENCE STANDARDS

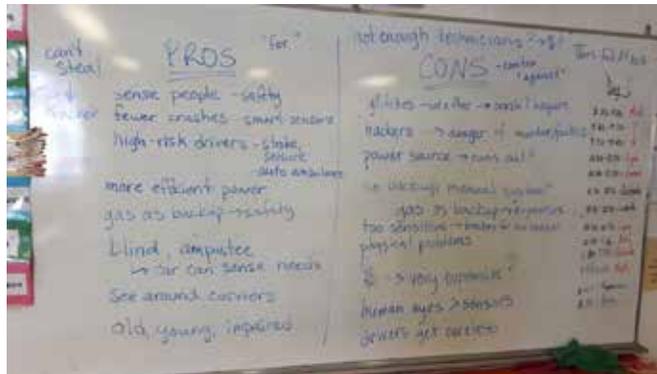|	
NGSS Appendix F — Science and Engineering Practices	2. Developing and using models 3. Planning and carrying out investigations 5. Using mathematics and computational thinking 6. Constructing explanations (for science) and designing solutions (for engineering)
NGSS Appendix G - Crosscutting Concepts	4. Systems and System Models: In grades 6-8, students can understand that systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. They can use models to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. They can also learn that models are limited in that they only represent certain aspects of the system under study.
MS-ETS1-1:	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-2:	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3:	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
MS-ETS1-4:	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
Mathematical Practices	CCSS Mathematics standards overview 1. Make sense of problems and persevere in solving them 2. Reason abstractly and quantitatively 3. Construct viable arguments and critique the reasoning of others
CCSS.ELA-LITERACY. RST.6-8.3	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
CCSS.ELA-LITERACY. RST.6-8.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.
CCSS.ELA-LITERACY. RST.6-8.7	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
CCR Reading Anchor #3:	Analyze how and why individuals, events, or ideas develop and interact over the course of a text. • RST.6-8.3: "Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks."

EXTENSIONS

1. INTRODUCING AUTONOMOUS VEHICLES EXTENSION (30 MINUTES)

Watch a TED talk about self-driving cars and how they work. Host a discussion on the pros and cons of self-driving cars. Invite creative input and possible solutions.
http://www.ted.com/talks/sebastian_thrun_google_s_driverless_car 4:14 - simpler concepts
http://www.ted.com/talks/chris_urmson_how_a_driverless_car_sees_the_road 15:29 - complex ideas
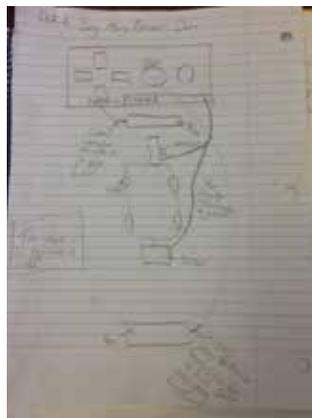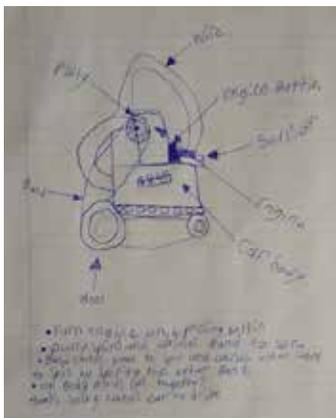

CCSS.ELA-LITERACY.SL.6.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6-8 topics, texts, and issues, building on others` ideas and expressing their own clearly.
CCSS.ELA-LITERACY.SL.6.1.C	Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion.

2. CREATING SCHEMATICS EXTENSION (20 MINUTES)

Each group draw schematics for the work they have completed: labelling the contact points, the circuit connections, the modifications, and the purpose of every piece.
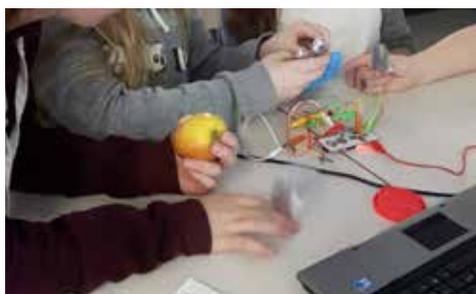
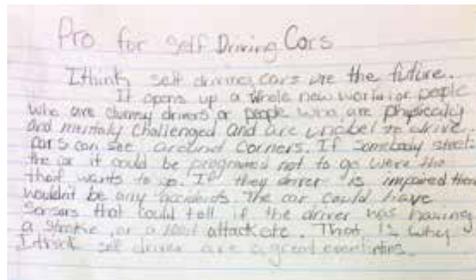| CCSS.ELA-LITERACY. WHST.6-8.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
CCSS.ELA-LITERACY. WHST.6-8.2.A	Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories as appropriate to achieving purpose; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.
CCSS.ELA-LITERACY.W.8.2.D	Use precise language and domain-specific vocabulary to inform about or explain the topic.
CCSS.ELA-LITERACY.W.8.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

3. INTRODUCING MAKEY MAKEY, SCRATCH, AND WEDO 2.0 EXTENSION (30 MIN TO 2.5 HOURS)

- To introduce Makey Makey, show students the following video https://vimeo.com/42879207 and have them create a Makey Makey banana piano using the website http://makeymakey.com/piano/ , a Makey Makey kit, a computer and bananas. Students may also experiment with other items from their lunch boxes or classroom and may also play the bongos on the website http://makeymakey.com/bongos/

- To introduce Scratch, show students the Scratch overview video https://vimeo.com/65583694. Have students create accounts at https://scratch.mit.edu/. Students might like to go through the Getting Started Tutorial at https://scratch.mit.edu/projects/147373013/#editor. Search for existing Makey Makey projects on Scratch. Play then click See Inside to manipulate the existing code.

- To introduce WeDo 2.0, open the LEGO Education WeDo 2.0 software, and click the play button on the image with the mini-figures to watch an introductory video. Click on the book to start a new project, then click on the gears icon and select a model to build.

4. PERSUASIVE WRITING EXTENSION (30–60 MIN)

Each individual writes a persuasive paragraph or essay (depending on grade level and expectations), arguing for or against the development and use of self-driving cars. This extension works well in conjunction with the Introducing Autonomous Vehicles Extension.

CCSS.ELA-LITERACY.W.6.1	Write arguments to support claims with clear reasons and relevant evidence.
CCSS.ELA-LITERACY.W.6.1.A	Introduce claim(s) and organize the reasons and evidence clearly.
CCSS.ELA-LITERACY.W.6.1.B	Support claim(s) with clear reasons and relevant evidence, using credible sources and demonstrating an understanding of the topic or text.

5. PRESENTATION EXTENSION – INFOMERCIAL (120 MIN)

Each group creates and presents an infomercial to promote their design solution. They can either film a video infomercial and show it to the class, or write a powerpoint (prezi.com is convenient) and present it. The infomercial should both promote their design solution in a persuasive style and explain how it functions. Both styles of presentation will have a written script to turn in for assessment.

CCSS.ELA-LITERACY.SL.6.4	Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.
CCSS.ELA-LITERACY.SL.6.5	Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.
CCSS.ELA-LITERACY.WHST.6-8.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
CCSS.ELA-LITERACY.WHST.6-8.2.B	Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.
CCSS.ELA-LITERACY.WHST.6-8.2.C	Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.
CCSS.ELA-LITERACY.WHST.6-8.2.D	Use precise language and domain-specific vocabulary to inform about or explain the topic.

MAKEY MAKEY TIPS AND TRICKS

SOLVING COMMON PROBLEMS

The following tips and tricks can help you solve some common problems you may encounter when using the Makey Makey in your classroom.

I can't get a key to press!

- Make sure your Makey Makey is plugged into the computer.

- The Makey Makey should have a red light on the back showing that the power is on. Is it lit? If not something is wrong with the computer, the USB cable, or the circuit board.

- If the USB connector on your computer is blue, it's USB 3.0, and may not work with Makey Makey. Try using a USB 2.0 port.

- Try making a connection in the simplest way you can. One way is to connect an alligator clip to "earth" and then touch other end to "space."

- When you make a connection, you should see an LED light up on the front of the Makey Makey

- When you are making a connection using everyday materials they need to be at least a little bit conductive. For example, play-doh, a banana, your skin, or aluminum foil should work, but plastic, most fabrics or paper will not work directly. You can always combine materials, for example by wetting the paper or putting play-doh onto the plastic.

One of the keys won't stop pressing over and over! What should I do?

- Try unplugging the Makey Makey from your computer, then plug it back in again

- Disconnect all of you alligator clips from the Makey Makey, then start reattaching them one by one

- If your stuck key is still pressing, have a look at your connections. They might be touching accidentally somehow. Try taking things apart and putting them back together again.

- Perhaps one of the things that you are using as an insulator (or non-conductor) isn't insulating enough. Try using a different material.

- If one of the objects connected to the Makey Makey is your own body, then perhaps you are "grounded" to the earth via touching your computer's metal case, or by not wearing shoes. Take a step back and see what you are touching.

One of the keys won't stop pressing over and over! What should I do? (CONT.)

- Perhaps one of the objects connected to the Makey Makey that you think is well insulated is not. For example, if you connect a banana to your Makey Makey and it's sitting on a wooden cutting board, is that cutting board moist or dry? If it's moist then perhaps all of your bananas on the cutting board are connected to each other through the cutting board. Try a dry table instead.

- Is it raining? Is it extremely humid- are you in a rainforest? This can sometimes cause porous materials, such as paper or clothing, to become conductive.

It works sometimes, but not other times...

- Your materials might not be conductive enough. For example, if you are making a connection with your fingertip, it can help to moisten your skin by licking it.

- If you are using a drawn graphite line from a pencil, make sure the line is heavy and dark. Draw your line on a hard smooth surface, such as a table without any grain in it. Take care in folding the paper, because it can sometimes break the graphite connection. Once you are expert at drawing the lines, you don't have to follow any rules, but if you can't get it to work try the tips mentioned.

TRY OUT DIFFERENT MATERIALS

Make anything into a key! You can make a connection through anything that's even a little bit conductive. You can also create inventions that combine conductive and non-conductive parts.
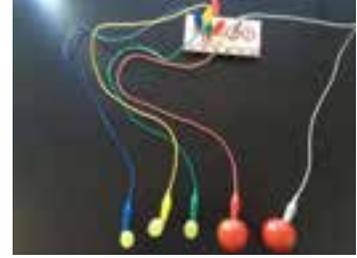
Conductive Materials

Here are a few things to try:

- Most fruits and vegetables work great.

- Lots of other foods work too. We've tried marshmallows, gummy candies, macaroni and cheese, cupcakes, shrimp, and lots of other things.

- Plants can work too. Try some leaves or flowers, but nothing too dry.

- Play-Doh, Model Magic and other clays work very well as long as they stay moist.

- People are conductive! Connect one person to ground, and another to an input, and you can trigger sounds when they high-five.

Conductive Materials (CONT.)

- Graphite from a pencil can work. Make thick, dark lines, and be sure to draw on a smooth surface.

- Foil and other metal objects will work. Try out coins, magnets, nuts and bolts, forks and knives, or pots and pans.

Craft Materials

When you're inventing, anything goes! Here are a few things we have enjoyed using:

Inflatable beach balls, paper plates, cardboard boxes, various types of soft and rigid foam, Lego bricks, plastic storage boxes, stuffed animals and other toys, funny hats and other pieces of clothing, sheets of fabric, string, yarn, elastic, and paper.

It's also important to have around some tools for cutting, like scissors and exacto knives, and ways to stick things together, like hot glue, superglue, various kinds of tape, and clips or clamps.

MAKEY MAKEY COMMUNITY

In addition to the resources referenced throughout this guide, these web resources will provide continued support as you implement Makey Makey in your classrooms.

LABZ ONLINE
labz.makeymakey.com
Additional full lesson plans that you can implement into your classrooms.

GROUP ACTIVITY GUIDES
makeymakey.com/guides/
Detailed inspiration for leading a group of curious activities in your home, Makerspace or school!

SHARE YOUR IDEAS

Have a great Makey Makey lesson idea? Or do you want to share some of your experiences with the Makey Makey? Please share with us at info@joylabz.com.

CONTACT US

Our team is happy to help with any of your questions, comments and enquiries:

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