Table 5. Makey-Makey Musical Instruments STEAM Lesson Plan

Overview: Design and create your own electronic musical instrument using art materials, cardboard and simple coding through Scratch. Your instrument can be as simple as a drum to more complex forms including guitars, pianos or futuristic new forms. There are a variety of different skills and concepts one can explore with this project including playing with variables (size of instrument, sounds, etc.) as well as coding, energy, circuits, design, pattern, color, etc. This project can be scaffolded to include more sophisticated concepts including manipulation of sound to create original music.
Objectives: I can apply my knowledge of electric circuits to design and construct a simple circuit. I can use the computer program SCRATCH to code for musical sounds. I can explain how the energy can be moved from place to place through sound and electric currents. I can explain how sound is produced through energy transferring to the air and heating the air. I can use the principles of art and design thinking to help me plan and construct my instrument. I can revise my project in response to testing my machine and feedback from my peers.
Materials: (Makey Makey kit cost: $40; recommend purchasing 1 per group of 4 students). laptop computer(s), Makey-Makey kit, misc. materials including cardboard, cardboard tubes, pipe cleaners, tape, Twisteez wire, paint, markers, etc.
Artist Connections: Variety of Makey-Makey musical instruments: https://www.youtube.com/watch?v=wkPt9MYqDW0 Musical painting: https://vimeo.com/74969550 Bruce Odland& Sam Auinger: Harmonic Bridge: http://www.massmoca.org/event_details.php?id=150Standards
Standards: NGSS: 4-PS3-2. Students who demonstrate understanding can make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. National Core Media and Visual Arts Standards: MA: Cr2.1.1.4 a.Discuss, test, and assemble ideas, plans, and models for media arts productions, considering the artistic goals and the presentation VA: Cr1.1.4 Brainstorm multiple approaches to a creative art or design problem VA:Cr1.2.4 Collaboratively set goals and create artwork that is meaningful and has purpose to the makers. Techonolgy (ISTE): 1. Creativity and Innovation – Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology.

Procedure:

1. Tell students that they are going to learn how to design their own futuristic instrument and make it come alive with sound through coding (Scratch).
2. Teach a mini-lesson on how explain how the energy can be moved from place to place through sound. Explain how sound is produced through energy transferring to the air and heating the air.
3. As a class or in small groups ask students to brainstorm a list of musical instruments. Add details on shapes, sizes, and sounds these instruments make.
4. Show videos of other artists' and students' work creating instruments
5. For this project we create an instrument for the future. As a class discuss, what might it look like? Who is it for? What is its size? Can it play in a zero gravity environment? Under water? How do these characteristics influence the form and shape of the design?
6. Sketch a design of your instrument. Label the materials you will use, and how the electricity will form a complete circuit. Be sure to label where aluminum foil will be attached to activate each note. We recommend two to four notes depending on size of class. The more notes you have, the more time you need to code using Scratch and the more alligator clips which can short circuit the instrument if they touch.
7. Enlarge and transfer your design onto thick cardboard and/or incorporate other cardboard forms to create the instrument.
8. At each note site tape a small circle or square of aluminum foil. At the same site, attach a different color piece of twisteez wire (24") so that the wire makes contact with the aluminum. You can use tape *or* thread the wire through a hole in the cardboard so the wires run out the back of the form. Just be sure that the aluminum and wire touch.
9. Add other visual elements to create your instrument such as pipe cleaner strings for a guitar, decorated base for a drum. Now it's time to code for sound using Scratch.
10. In Scratch create your own file. Click "Sounds" tab. Choose a sound for your first note (Scratch has pre recorded sounds you can use). Continue for other notes. Now you're ready to play!
11. Attach Makey-Makey to the computer. Attach one alligator clip end to the Makey-Makey designated hole, i.e. 'space bar'. Attach the other end to one of your instrument note wires. Repeat for next note choosing another designated hole, i.e. 'left tab'. Lastly attach one end of an alligator clip to the Makey-Makey ground. Attach other end to your instrument. Other option is to hold it while playing your instrument. Once you've grounded the instrument you can play by touching the aluminum foil 'notes' on your instrument.

Extensions:

- Add more notes or create your own songs using Garage Band or other music making software.
- Experiment with closing the circuit. Have a friend touch your arm and then they can play the instrument. If they let go of your arm, there will be no sound.

- Create a band and do a music video using a green screen.

Assessment: See Figure 2

Management Considerations:

One of the big considerations is that one computer is required for each Makey-Makey project or a system for sharing. It is helpful to pair students or, if the students are working individually, to encourage them to help each other with coding. If working in teams students can do several iterations of their instrument designs, providing opportunities for problem-solving, collaboration and prototyping before choosing final design. This is one of the most successful projects we have seen in terms of fostering peer-to-peer interaction.

In the initial lesson, limit the number of musical notes (at most 6) students can build into their instrument to prevent wires from crossing and short-circuiting.

Simple materials are the best to use to construct the body of the instruments – cardboard is durable and inexpensive. Keeping the materials simple also makes it easier (and cheaper) to prototype and redesign the instruments. If students are new to Scratch it's a good idea to use the pre-recorded sounds provided on the website. If students are more familiar with Scratch they can create their own music/sound using other software such as Garage Band.

Additional Resource:

http://makeymakey.com/gallery/?tag=instrument