Table 2. Doodle Bot STEAM Lesson Plan

Unit: Electricity **Grade**: 4
Overview: Doodle Bots can be made from found objects and recycled materials. They work using a simple circuit that demonstrates motion created by an offset motor. You can use new motors or motors and switches from discarded toys and electronics. There are a variety of skills and concepts one can explore including playing with variables (weight of materials, drawing implements) as well as energy, circuits, kinetic motion, balance, design, pattern, repetition, color, etc.
Objectives: I can apply my knowledge of electric circuits to design and construct a simple circuit with motor. I can identify the pathway the energy travels from the battery through the motor and back. I can use the principles of art and design thinking to help me plan and construct my Doodle Bot. I can revise my project in response to testing my machine and feedback from my peers.
Materials: **(Total cost for electronic materals: $1.90 depending on vendor)** One 1.5 to 3 volt DC hobby motor One AA battery (can accommodate two AA batteries) Battery holder OR Broccoli band or tape Glue guns and glue sticks, masking tape, scissors Misc. materials including: recycled containers, cardboard, pipe cleaners, popsicle sticks, colored tape, markers and other drawing implements, foam paper, etc. White butcher paper for students to test their machines. It can be helpful to set up a barrier around the paper using ¾" baluster molding so that the machines don't wander off!
Artist Connections: Cameron Robbins: http://www.abc.net.au/arts/stories/s3636858.htm Bruce Shapiro: http://egg-bot.com Maillardet's automaton: https://www.youtube.com/watch?v=jfeNC28vpYo Juan Fontanive: https://vimeo.com/102453528
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. Media and Visual Arts Standards: MA: Cr1.1.1.4 a. Conceive of original artistic goals for media artworks using a variety of creative methods, such as brainstorming and modeling. MA: Pr5.1.4; b. Practice foundational innovative abilities, such as design thinking, in addressing problems within and through media arts productions; c. Demonstrate use of tools and techniques

in standard and novel ways while constructing media artworks.
VA: Cr3.1.4 Revise artwork in progress on the basis of insights gained through peer discussion.

Procedure:

1. Introduce the lesson by asking students what they know about electricity and what life would be like without electricity.
2. Provide students with a battery, wires and motor and ask them to connect the materials to make the motor run. Some students will be able to do this right away whereas others will struggle and look for help from others. Once all circuits are running, ask students what is making the motor run. Record student ideas and discuss until the class reaches a unified model of how electricity drives the motor (electrons generated by the battery which then travel through the wires to the motor and back to the battery).
3. Show artists examples. Using Visual Thinking Strategies[1], ask the students to respond to the images/videos.
4. Let students know that they will be designing their own Doodle Bots using the materials provided at the centers. Do a quick demonstration on how one can construct simple forms and attach materials including the pens.
5. Have students do a sketch of their machine.
6. Making the motor run! Connect the battery to the motor using wires from the battery holder. If you are using Broccoli band or tape, cut two 6" pieces of Twisteez wire and attach to the right and left sides of the motor and battery.
7. Offset the motor by attaching an off-centered weight to the rotor pin. This will create the motion needed for the machine to move across paper. Suggestions include using a glue stick, an oblong or rectangular piece of heavy cardboard, a plastic bottle cap, etc. The different materials and sizes will influence the offset motion of your Doodle Bot.
8. Create the basic form or base of your Doodle Bot to attach the offset motor. For this first project, we recommend keeping the form smaller vs. larger. Suggestions to start with: water bottles, yogurt containers, cardboard forms including square, rectangular, cylindrical. Students can embellish and modify the form once the motor is attached and tested.
9. Attach the offset motor to the form. Make sure there is enough clearance for the offset motor to spin and that the form, with motor, can stand.
10. Attach drawing materials such as three or more markers, charcoal, pencils, chalk, etc.
11. Test your Doodle Bot to make sure it moves. Revise as needed.
12. Finish embellishing/designing your Doodle Bot
13. Start drawing with your classmates!

Extensions:

- Once you have completed the Doodle Bot create a character sketch and story to

[1] Visual Thinking Strategies (VTS) is a method initiated by teacher-facilitated discussions of art images using a series of questions to help students developthinking skills that become habitual and can transfer from lesson to lesson, oral and written language literacy, visual literacy, and collaborative interactions among peers. (http://www.vtshome.org/)

accompany your creation.

- Experiment and modify your design to make it go faster, slower. Note the kinds of marks it makes and modify - what happens when you use long markers vs. short ones?
- Attach a pen to a piece of wire vs. to the body to observe how this impacts the mark-making.
- Encourage students to experiment with multiple variables including: what kind and the number of drawing implements to add as well as how to off set the motor to change the movement of the machine.
- Set up a room-length runway where long lengths of butcher paper are laid out and framed by ¾" baluster moulding in 6' lengths. Students can place their robots on the paper and observe the different ways the robots move and make adjustments that influence the speed and marks made.

Assessment:

Assessing these design-based products can be accomplished through peer and self review. The peer review process should start with allowing students to clean all materials and display their final product. Students should gather around one group and their project. The teacher should facilitate the process: "Look at your classmates' work. What aspect of their work shows an interesting solution to the design challenge?" Provide students a sentence frame such as "this is successful because…the evidence is…" To support the feedback and improvement process, we provide students with a handout that prompts each of them to consider multiple aspects of the design and construction of the machine (*see Figure 2).* Students can then document their responses in writing for the teacher to assess at the conclusion of the project.

Management Considerations:

Initial construction of the Doodle Bot: connecting the motor to the battery and adding it to a form that can move without falling down, can be challenging for the students. When they begin to test their machines on the paper, however, they see the results of their work and of their peers, and the excitement and motivation increases. It is at this point in the lesson where we can encourage the students to make adjustments or challenge them to modify their designs towards specific criteria. Testing of the Doodle Bots also reveals other challenges students might encounter such as attaching the drawing implements to the form so they don't fall off, creating a form that can move without falling over, etc. Often the students themselves will step in to assist a peer when these problems arise.

Additional Resource:

http://tinkering.exploratorium.edu/scribbling-machines