



Circuits Curriculum

Week 2: Squishy Circuits

Introduction (10 minutes)

Welcome students to the second week of the program. Ask students what they remember from the previous week. Prompt students to think about what materials were used to make circuits. Tell them that for the next few weeks they'll be exploring different materials that can be used to create circuits.

Quickly review conductors and insulators by asking students the difference between the two terms. They might say that conductors allow energy, such as electricity, to easily pass through while insulators do not allow energy to pass through easily. Encourage students to give examples of good conductors (*most metals, salt water, etc.*) and good insulators (*rubber, wood, etc.*).

Making Squishy Circuits Dough (20 minutes)

In the following activity, students will make insulating and conductive dough. They will use this dough to create circuits in the next activity.

Procedure:

Tell students that they will work in groups of four to use recipes to create two sets of dough. One batch will be able to conduct electricity, while the other batch will be insulating.

Have students split into their groups and review the recipes. Ask students to share some differences between the recipes. Based on these differences, which recipe do they think will produce the conductive dough? Why? After a brief discussion, inform students that the batch with the salt and food coloring is the conductive batch. The salt and cream of tartar (or lemon juice) provide the conductivity for the dough. In the insulating dough, distilled water is used; since distilled water is devoid of minerals and impurities, it is not conductive. Have students use the recipes (below) to create a set of conductive dough and a set of insulating dough.

Conductive Dough Recipe (enough for 4 participants)

- 1 ½ cups flour
- 1 cup water
- ¼ cup salt
- 3 tbsp. cream of tartar (can substitute 9 tbsp. of lemon juice)
- 1 tbsp. vegetable oil
- food coloring
- mixing bowl
- mixing spoon
- measuring spoons and cups
- saucepan
- hot plate

Directions: Mix all ingredients, setting aside ½ cup of flour, in a pot and cook over medium heat, stirring continuously. Add food coloring. (*This will differentiate the two types of dough.*) The mixture will begin to boil and get chunky. Keep stirring until a ball forms in the center of the pot, and then remove the saucepan from the heat.

CAUTION: The dough will be very hot! Allow it to cool before handling. Once cooled, mix remaining flour into the dough until it is firm, but moldable.

Insulating Dough Recipe (enough for 4 participants)

- 1 ½ cups flour
- ½ cup sugar
- 1 tsp. granulated alum (*this is a preservative, and can be omitted*)
- 3 tbsp. vegetable oil
- ½ cup distilled water
- mixing bowl
- mixing spoon
- measuring spoons and cups

Directions: Mix the oil and solid ingredients, setting aside ½ cup of flour, in a bowl. Mix in 1 tbsp. distilled water and stir. Continue to add distilled water 1 tbsp. at a time until the mixture becomes moist and dough-like. Remove it from the bowl and slowly knead in the remaining flour until the desired consistency is reached.

Dough recipes have been adapted from the PBS SciGirls activity "Dough Creatures."

After students have created the dough, instruct them to set each batch of dough aside and to clean up their workstations.

Squishy Circuits Designs (1 hour)

In the following activity, participants will explore simple circuits using conducting and insulating dough. They will have the opportunity to create their own "creature" using the dough, LEDs, and electrical buzzers.

Materials (per group of students):

- Insulating dough (see recipe at the beginning of this lesson)
- Conductive dough (see recipe at the beginning of this lesson)
- 6 LED lights (1.9-2.4 V)
- 4 AA batteries
- 4xAA battery holder
- 1-2 electrical buzzers
- 1-2 small motors
- craft supplies (feathers, popsicle sticks, straws, etc.)
- paper and pencil for sketching

Procedure:

Once the workstations have been cleared, place the above set of materials in front of students. Ask them to look at the battery and share what they notice. They will see that the battery has a positive side and a negative side. Now instruct them to look at the LED. When looking at the legs of the LED, they will notice one is longer than the other. The longer one is the positive lead and the shorter one is the negative. Remind students that in order to light up the LED, the positive leg must be connected to the positive side of the battery, and the negative LED leg must be connected to the negative side of the battery.

Students should spend 5-10 minutes experimenting with the materials to see if they can light up one LED.

After each group has had time to experiment, ask students to share out their experiences.

Now that students are more familiar with the properties of the dough, tell them that this week's project is to use the materials to create a creature that incorporates LEDs, buzzers, motors, or some combination of the three. They

can be as creative as they'd like. See the **example images at the end of this document** to view how the dough can be used to create a simple circuit and for sample creations. In order to encourage student innovation, facilitators should not show these examples, but you can provide small prompts if students struggle.

Ask participants to create a sketch of what they'd like their creature to look like. They should indicate how the electricity will flow from the battery through the dough and to the LED or buzzer, ensuring that the dough circuits' paths do not cross or touch.

Once participants have created a sketch, they can use the materials to build their creature. They should feel free to refine their design as much as they'd like.

Documenting Your Work (20 minutes)

Students will document their work by uploading photos to the SMART Lab website.

Materials:

- Cameras
- Computers

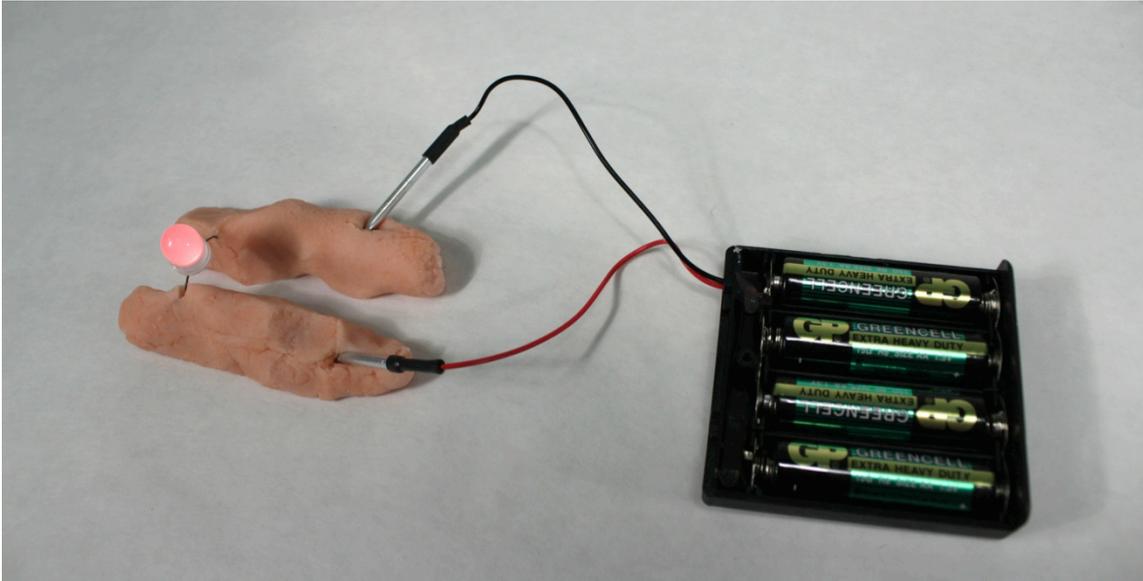
Procedure:

After students have created their designs and had the opportunity to share their work with the class, they should use the cameras to take photos of their work and upload 1-2 images to the SMART Lab website. In addition to the photo itself, they should create captions as prompted by the website.

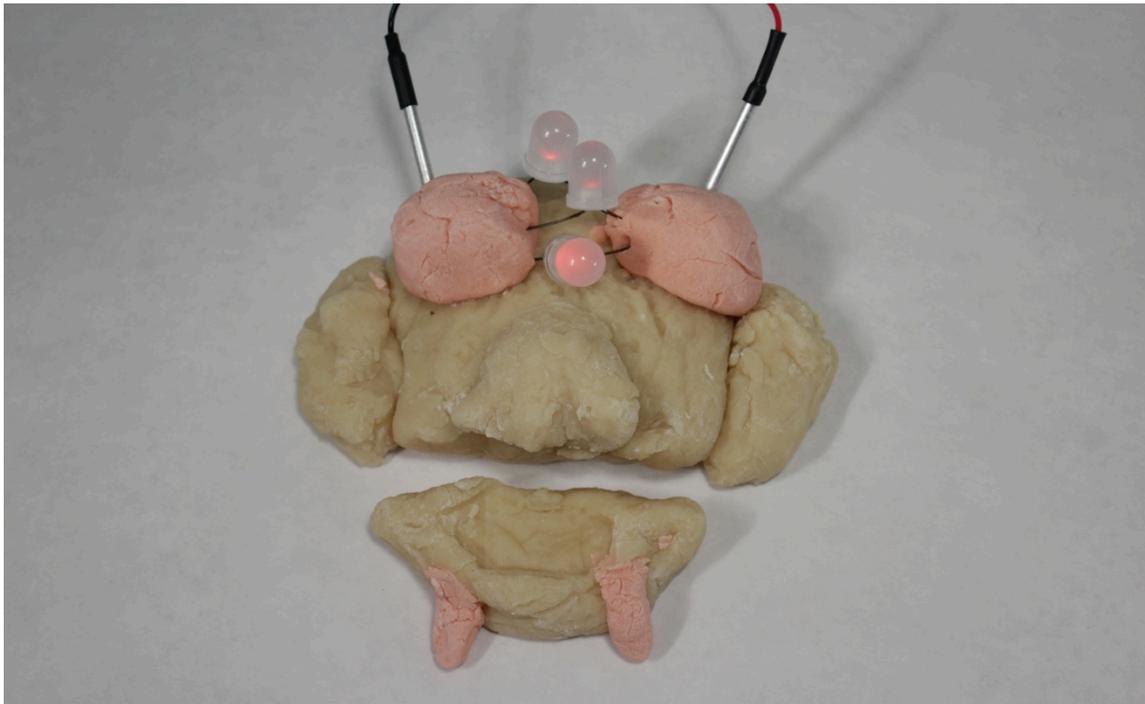
Closing Discussion (10 minutes)

Instruct students to clean their workspaces. The dough will rust the LEDs over time, so be sure that the LEDs are particularly clean. Give them a small preview of what they will be working on during Week 3 by telling them they will be working with circuit series and switches.

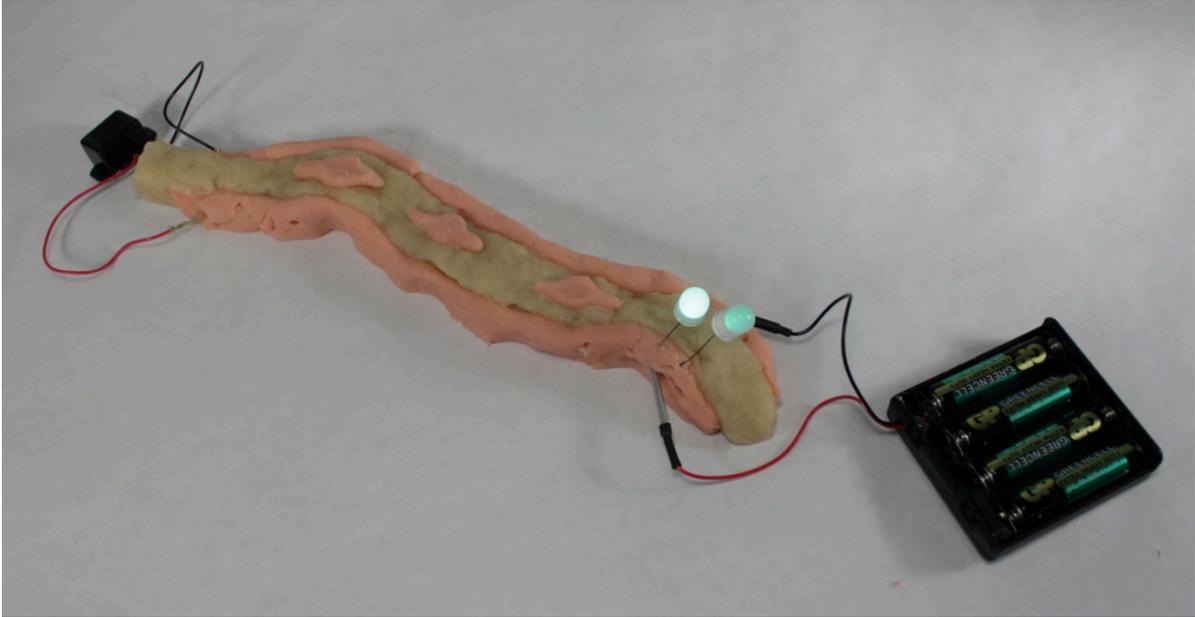
Squishy Circuits Examples



Above is an example of a basic circuit using the conductive dough and an LED. The red wire is positive, and connects to the positive leg of the LED, which is slightly longer than the negative leg. Notice that the dough circuits are not touching or overlapping.



An example of a basic squishy dough creature using LEDs.



Above is an example of a squishy dough rattlesnake using LEDs and a buzzer. Note how far from the battery pack the buzzer is located. Dough circuits can be made fairly long, encourage students to try out longer circuits.