Squishy Circuits (Resource Exchange)

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AnnMarie Thomas is a professor in the School of Engineering at the University of St. Thomas where she is the director of the UST Center for Engineering Education. Her research group, the Playful Learning Lab, focuses on engineering and design education for learners of all ages.

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Dr. Besser, PE, ENV SP, holds a PhD in education and MS and BS in civil engineering. Currently, she is civil engineering chair and Center for Engineering Education director. Previous experience includes faculty positions in diverse universities where she has taught a variety of coursework including steel, timber, concrete and masonry design, construction, engineering economy, engineering graphics and engineering education. Prior to teaching, Dr. Besser, a licensed engineer, was a design engineer with HNTB-CA, where she worked on seismic retrofits and new design of high profile transportation structures.

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Undergraduate Research Assistant for the Playful Learning Lab at St. Thomas under the direction of Dr. Annmarie Thomas. Second-year Mechanical Engineering major with a Peace Engineering minor. Has led many STEM activities and is interested in using engineering to encourage peoples' interests and collaborate with developing countries.

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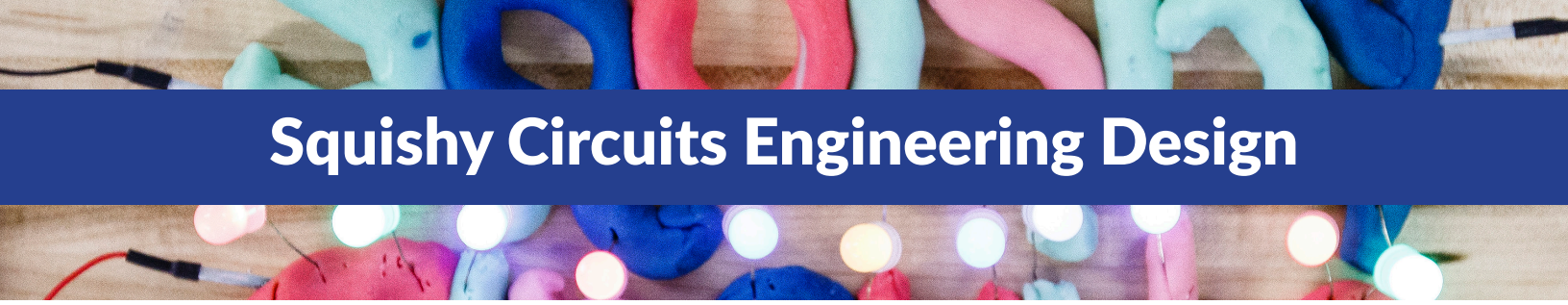
I am an undergraduate student studying mechanical engineering and math and the University of St. Thomas. I am the lab operations manager at the Playful Learning Lab

Esmée Verschoor, Playful Learning Lab

Esmée Verschoor is a Communications and Journalism major at the University of St. Thomas in St. Paul, Minnesota. She is passionate about graphic design, visual communication and cultural studies. Currently, Esmée is the Visual Manager at the Playful Learning Lab, led by Dr. AnnMarie Thomas, where she creates, designs and implements educational materials focused on incorporating joy, whimsy and play into education.



Squishy Circuits Engineering Design

squishycircuits.com

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Introduction

In 2011, a team of undergraduate students, the Playful Learning Lab, at University of St. Thomas created Squishy Circuits under the instruction of AnnMarie Thomas. Squishy Circuits are conductive and insulating dough used to create circuits. They aid the teaching of circuits and engineering concepts, while encouraging creative play.

The purpose of this resource is to use squishy circuits to teach students the basic fundamentals of circuits and how they function, through hands-on participation.

The reason that the dough is conductive is because of its high salt content. Salt is an electrolyte, so it is a conductive ion that allows the free flow of electrical currents. The insulating dough is created with sugar, which is not an electrolyte, so it prevents the flow of electrical current.

This activity is designed in a layered cumulative learning process. Fundamental concepts will be presented first, and will build to include more complicated ideas that can be expanded or limited to fit the desired age group.

Resource Time: 45 - 60 min
Suggested Grade Levels: K-8

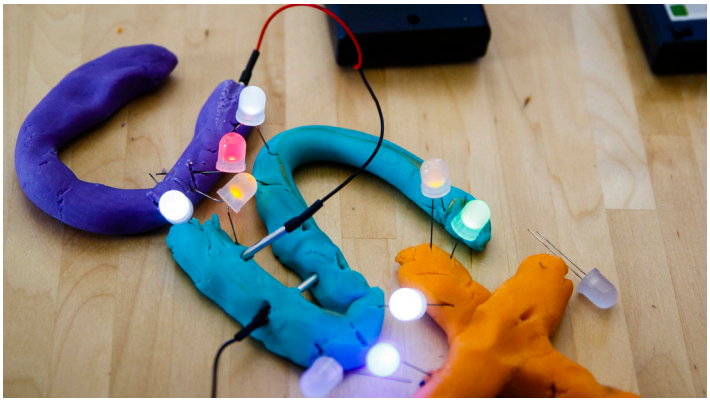
Learning Goals

Learn basic concepts of circuitry and electricity, the process will look something like this:

Circuit → conductivity → short-circuiting → pathway direction of electricity → insulation → parallel and series circuits → creative design → presentation

Practice main components of the engineering design process.

Materials



All materials can be found and ordered from squishycircuits.com, and there are homemade dough recipes.

Conductive and insulating doughs, Bi-pin LED light bulbs, Battery packs, Motors, Switches, and *Buzzers.

*optional - may impact cochlear implant

Standards

Science Standards (NGSS):

K-2-ETS1-1 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

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.

3-PS2-3. Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another

4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

Activity

Begin by introducing the main steps of the engineering design process, which will serve as the structure for this circuit activity.

Ask students what they already know about circuits and conductivity. Present a basic introduction of electrical currents and how they function within circuits and conductive materials. This serves as a bit of background research for engineering design

The problem: we want to create a circuit with our dough, how can we do that?

Ask the students to create a simple circuit with the dough that can light up one light bulb. This is a specific requirement for the first problem, and further requirements will be defined at each step.

Give the students 1 minute to brainstorm and then tackle the problem.

After letting the students work for some time, acknowledge potential challenges in this first step. The most common reasons that the circuit will not work is if, the battery pack is dead or not turned on, the LED is not oriented in the right direction (mention the downhill or +/- flow of electrons) or there is short circuiting occuring (electrons travel the shortest path only, which can 'skip' the light bulb. This helps the students problem solve and make changes to their circuits if they haven't reached a solution.

Prompt the students to share what they know about insulation, explain how this can help prevent short-circuiting problems.

As a second challenge, ask the students to incorporate insulating dough into their circuit design, as well as more light bulbs or the addition of motors.

Next, introduce the different types of simple circuits. Students will most likely gravitate towards creating a parallel circuit first. Explain the differences between how parallel and series circuits look and function, emphasizing the differences in how voltage runs through each kind of circuit, and how this affects the brightness of the light bulbs.

If the student has a parallel circuit, challenge them to create a circuit in series, and vice versa.

Encourage the students to make creative shapes with their dough and create more complicated circuit designs with their gained knowledge.

Present a final problem challenging the students to create a visually and physically creative circuit design using what they have learned. After work time, have each student present their final design, and share a bit about what they were thinking about while designing.

This activity can be expanded to include the role of switches and resistors in circuits, and the complexity of the challenges can be adjusted to be simpler or more in depth to fit the age group of the participants.