verizon

PLTW

Wearables
Facilitator Guide

Overview

The focus of this experience is for learners to develop a STEM mindset. Students will use design thinking, creativity, problem-solving, and procedural skills to create a wearable soft circuit. This activity does not use a computer. The **LilyPad E-Sewing ProtoSnap Kit** used in this activity helps students develop a STEM mindset. It is important to allow students to work through the process as independently as possible with the facilitator acting only as a guide.

Materials

LilyPad E-Sewing ProtoSnap Kit, available for $10.95 online at https://www.sparkfun.com/products/14528.

Additional items that help students design and make their wearable patches are:

- Ruler or measuring tape,
- Pencil,
- Scissors,
- Scraps of felt,
- Fabric glue,
- Permanent markers, and
- Googly eyes (optional).

Note: If you want to reuse materials, inform students that they will have to turn in these materials at the end of the session and do not let them use permanent markers nor glue on the felt. Also, allow for time to disassemble everything for the next group of students. Ideally – as the thread is not easily reusable – plan on purchasing new conductive thread every two to three sessions.

Preparation

1. To best prepare for this experience, read through the facilitator and learner guides and documents.
2. Order the LilyPad E-Sewing ProtoSnap kits, one kit per student.
3. Gather additional materials for students to complete their patches.

Essential Questions

- How do you use the Design Process to design and make a wearable?
- In what ways do wearables uniquely suit a person's needs or wants?
- More generally, how can you use the Design Process to design a solution or create a product which answers a specific need or want?

Session Length

60-120 minutes

Note: The artistic design, electronics, and sewing phases of this project likely require 120 minutes to complete.

Facilitation Notes

Begin by watching the Wearables Design video. Students learn about other types of wearables and their uses (e.g., a scrolling name badge).

STEM Mindset

Invite students to follow the directions in the Learner Guide to learn how the LilyPad E-Sewing ProtoSnap circuit works, and to learn how to sew using the needle and conductive thread. Stress that this is a new learning experience. Let the students know that evaluation does not solely rely on the wearable patch they produce, but – more importantly – on how they participate in the learning process. You will need to model a STEM mindset by stressing the idea that effort builds skill.

Phrases to use with students who struggle despite strong effort:

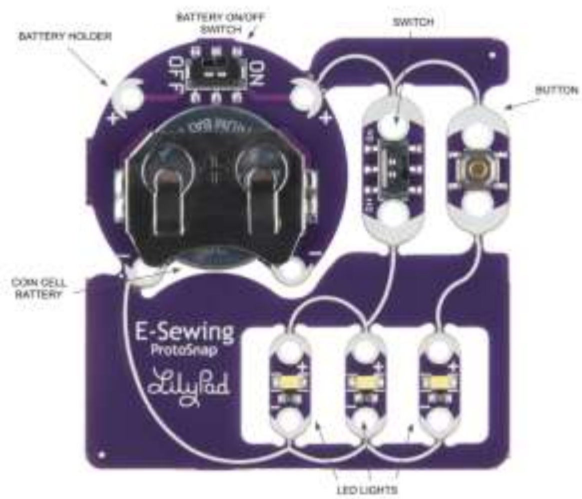
- Mistakes are expected. This is new material. We learn by fixing our mistakes
- You are not there, yet.
- You might be struggling, but you are making progress.
- Do not give up until you feel proud.
- You can do it. It can be tough or confusing, but you are making progress.
- I admire your persistence.

When students need help with solutions, give them strategies to help themselves (do not always just tell them how to solve the situation):

- Which part is not working as expected? What was the expected behavior and how is it different from what is happening right now? What can be causing the issue?
- Which part is difficult for you? Let's look at it.
- Let's think together about ways to improve this.
- Let me add this new bit of information to help you solve this.
- Here is a strategy to try so that you can begin to figure this out.
- Let's ask ________for advice. S/He may have some ideas.

Explore

2. Identify the parts:



3. Switch the battery to the ON position and experiment with the circuit to see how it works. The battery supplies the energy needed to run components such as LEDs, speakers, or motors. Electrical energy from the battery keeps looping around the circuit until the battery dies.

   a. Press and release the button.
      Which LED lights up? Answer: The LED on the far right.
      Which LED does the "wire" from the button connect to? Answer: The LED on the far right.

   b. Slide the small switch to On.
      Which LEDs light up? Answer: The LED on the far left and the LED in the center.
      Which LEDs does the "wire" from the small switch connect to? Answer: The LED on the far left and the LED in the center.

   c. Leave the small switch on and press the button.
      Now which LEDs light up? Answer: All three LEDs.
      Can you predict why this happens? Answer: Because this is a "closed" circuit, it allows the flow of electricity along the wires on the ProtoSnap to all three LEDs.

   Slide the small switch to off.

4. Look at the plus (+) and minus (-) signs on the circuit.
    a. Which components have plus (+) and minus (-)signs on them? Answer: The battery (holder) and the LEDs.
    b. How are these components arranged? Answer: Does where the (+) and (-) signs are matter? The (+) sign on the battery is close to the (+) sign on the LEDs. In electrical circuits, we connect (+) to (+) and (-) to (-). Adults perform this same connection when jumping a car battery.

5. Unroll some thread from the bobbin and cut a piece approximately 12 inches long. The thread – made from stainless steel fiber – is conductive. This means that it acts like a wire. Conductive thread connects components in an electrical circuit. It carries the electric current from the battery to the components. Because it is soft and bendable, conductive thread works well in wearables that need to conform to the shape of the human body. Examine the thread closely.
    a. What does the thread look like? Answer: The thread is thick, shiny, and silver in color.
    b. What does the thread feel like between your fingers? Answer: It feels mostly like any other string or thread, but it also has a metallic feel to it.
    c. How difficult is it to cut, compared with normal thread or string? Answer: Conductive thread is harder to cut because of the metal in the thread.

Note: Sewing is probably new to most of your students. These learners will likely need help threading needles, looping knots, stitching seams, and tying off a seam. If you are finding that students are having a difficult time with sewing, consider gathering additional needles, thread, and cloth. Have students practice sewing before moving on to the rest of the activity.

Create

Designing the Patch

It is important for students – as they begin the Design Process – to keep their patch designs simple. Creating an overly complicated design may prove difficult to complete within the allotted time frame, leading to student frustration. Let students know that, after they master the basic design and stitching skills on this first project, they can always work on an extension to create a new wearable with a more complex design and circuit.

Students follow the Learner Guide directions on how to layout their artistic elements and circuit components on the blank patch.

Note: As a facilitator, help students avoid getting bogged down developing design ideas. Consider setting a time limit for this phase of the project, such as 5 minutes per design.

Students first add their artistic elements to the patch. They then carefully stitch their circuit.

Note: Students should remove the coin battery from the battery holder prior to stitching.

After stitching, students should place the coin battery back in the holder, turn on the battery switch and test their circuit. Occasionally, even when a circuit "appears" perfectly stitched, the LED does not light. This happens with faulty LEDs and with burned-out LEDs due to incorrect alignment.

Upon completion, students may (optionally) pin or otherwise attach their patch to an article of clothing. Alternative attachment methods include fabric gluing (which is more permanent) or stitching the patch with regular thread around the circumference.

Warn students not to wash their completed patches in a washing machine. Battery-operated devices generally stop working after getting all wet.

Standards

Next Generation Science Standards (NGSS)

MS-ETS 1-1 Engineering Design

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 Engineering Design

Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

MS-ETS1-3 Engineering Design

Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS-1-4

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.

ELA Common Core Standards

CCSS.ELA-LITERACY.RI.6.7

Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

CCSS.ELA-LITERACY. SL6.1, 7.1 and 8.1

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly.

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.

CCSS.ELA-LITERACY.RST.6-8.1

Cite specific textual evidence to support analysis of science and technical texts.

CCSS.ELA-LITERACY.RST.6-8.3

Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical task.

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 topic.

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).

CCSS.ELA-LITERACY.RST.6-8.9

Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

CCSS.ELA-LITERACY.WHAT.6-8.2

Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

CCSS.ELA-LITERACY.WHST.6-8.9

Draw evidence from informational texts to support analysis, reflection, and research.

Computer Science Teachers Association Standards (CSTA)

3A-IC-27

Use tools and methods for collaboration on a project to increase connectivity of people in different cultures and career fields.

3B-DA-07

Evaluate the ability of models and simulations to test and support the refinement of hypotheses.

3B-IC-25

Evaluate computational artifacts to maximize their beneficial effects and minimize harmful effects on society.

3B-IC-27

Predict how computational innovations that have revolutionized aspects of our culture might evolve.