Wearable Tech

Objectives

Students Will:

- Learn about a simple circuit system
- Design a simple circuit system to create a piece of wearable technology
- Use a piece of wearable technology to operate an electronic device

Suggested Grade Levels

3rd – 7th

Subject Areas

Science, Engineering, Art, Technology

Timeline

50 - 60 minutes

Standards

NGSS Standards:

- 4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
- 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

21st Century Essential Skills

- Critical thinking, problem-solving, creativity & innovation, communication & collaboration, creativity & imagination, technology literacy

Background Information

A broad definition of wearable technology pertains to items using electronics, functional materials, and mechanical technologies that are attached to the human body and unsupported by our hands. There are many uses for wearable technology, including protecting the user from hazards, accomplish tasks such as collecting energy, or operating electronic devices while maintaining comfort for the user. Some examples of wearable technology are:

- Fitness trackers (for example, Fitbit)

- Tactile displays that help elderly people with vestibular disorders keep their balance and also are used to help navy pilots keep track of their bearings during flight (recognizing which direction is “up”)
- Smart clothing that acts as a “second skin,” providing functionality and comfort for the user
- The Extravehicular Mobility Unit (EMU), NASA’s spacesuit, incorporates almost all aspects of wearable technology. The EMU communicates with computer systems on Earth via on-body interfaces, monitors safety and health continuously, and most importantly, allows the astronaut to survive in the vacuum of space.

A circuit is a route through which electrical current can flow. Electrons flow from the negative side of a battery through a conductive material, through a wire in the LED light and across the filament (the part of the LED that lights up). When the electrons go through the filament, some of the energy is changed to heat and light energy. The electrons continue down the wire, and through the conductive material back to the positive side of the battery. There would not be a complete circuit if the electrons didn’t make it to the positive side of the battery.

Conductive thread is thread that allows electricity to flow through it, although it does have a resistance. One thing to keep in mind about conductive thread is that it is the wires of your circuit so you want to make sure that two pieces that are not part of the same path don't touch each other because then you get what's called a short circuit and your circuit won't function.

Vocabulary

Wearable technology, extravehicular mobility unit (EMU), conductive material, circuit, resistance, filament, terminals, polarity

Materials

- LED light
- Conductive thread or copper tape
- 3V (coin) lithium battery
- Coin cell battery housing
- Needle nose pliers
- Fabric/scrap material/glove/felt
- Kids’ sewing needle or hole punch
- Scissors
- Hot glue gun (optional)

Lesson

1) Discuss background information with students regarding wearable technology, circuits and the properties of conductive thread.
2) Have students brainstorm ideas for designing their wearable tech item. The image below shows a couple examples of design ideas.

3) Students will use conductive thread on a piece of fabric to create a simple circuit in order to make an LED light turn on. As a note, conductive thread frays easily because it is spun from stainless steel. It is a very useful material, so encourage students to save any scraps for using later.
4) First, secure the battery housing. It is optional to first hot glue the battery housing to the fabric, so it doesn't move around while you sew.
    a) Thread the conductive thread into your needle. When you cut the thread, make a knot at the end (1-2 knots should be plenty since conductive thread is fairly thick). Cut off any dangling pieces of thread.
    b) Sew multiple loops to secure the battery housing terminals to the fabric. Start with the negative terminal (Each terminal will connect to the corresponding output on the LED light: positive terminal goes to the positive leg of the LED, and negative terminal goes to the negative leg of the LED).
    c) Once you have your loops through the terminal, make a couple of loops next to the terminal because you need to make a contact point for the path of your circuit. Then make a couple of knots to secure the thread close to the fabric.
    d) Next secure the positive terminal of the battery housing (remember to make a knot at the end of the thread before sewing). Sew a similar number of loops that you did for the previous terminal. When the loops are finished and the terminal is secure, tie a knot to secure the thread, and cut away any dangling pieces of thread.

5) The next step is to secure the LED light to the fabric. Most LED lights have assigned polarity, a negative side and a positive side. The shorter leg of an LED is the negative side and the longer leg is the positive side. Oftentimes, there's also a flat end on the plastic portion of the LED that will indicate which side is negative or positive.
    a) Use the pliers to curl the legs of the LED light, which will make it easier to sew the conductive thread around the legs of the light. Be sure to keep track of which leg is positive and which is negative.
    b) Starting with the negative polarity leg, sew the conductive thread around the leg in order to secure it to the fabric. Be sure to knot the end of the thread so the stitch stays in. Once you've secured the negative leg of the LED, tie a knot in the thread to close the stitch and cut away any dangling pieces of thread.
    c) Using the same method, secure the positive leg of the LED using the conductive thread.
6) The next step is to stitch together the circuit. The polarity of the LED has to match up with the polarity of the battery…make sure that the negative goes to the negative and the positive goes to the positive.
    a) Once again thread the needle and knot the end of the piece of thread.
    b) Start at the contact point near the negative battery housing terminal
    c) We are just using a basic in and out stitch, where each stitch is basically the same length (i.e. the ones underneath the felt are about the same length as the ones on top of the felt). You could choose to sew using more advanced techniques depending on your preference.
    d) Once you reach the LED terminal, ensure the thread makes good contact with the negative leg of the LED light.
    e) Knot the end of the stitch.
7) Repeat step #6 for the positive connection (the positive terminal of the battery housing to the positive leg of the LED light).
8) Once your circuit path is sewn, to test your circuit, insert the 3V battery into the battery housing. Ensure to match the polarity of the battery with the polarity of the battery housing (i.e. positive to positive, and negative to negative).
9) The LED light should illuminate, meaning you have a proper closed circuit. If the light does not illuminate, check that the connections are closed, and the conductive thread only touches it's intended target.
10) Another idea for wearable tech, is to sew conductive thread onto the finger of a glove. Ensure that the conductive thread has contact with both the user's finger and

the outside of the glove. As you can see in this image, conductive thread has been sewn onto the index finger of a white glove. This allows the user to operate an electronic device, while wearing the glove.

a) No circuits are required for this method, which makes it a very simplistic, yet useful, version of wearable technology.

Extensions

- For younger students, punch holes in the material in advance and have students run the conductive thread through the holes (this eliminates the use of a sewing needle).
- Copper tape could be substituted for conductive thread, which is easier for some students to manipulate.
- Have students design and create wearable technology pieces using series and parallel circuits.
- Incorporate an on/off switch into the circuit.

Resources

- Dunne, L. E. (2016, March 8). Wearable Technology. Retrieved May 13, 2020, from https://www.britannica.com/topic/Wearable-Technology-2008498