

Table 3. Bookmark Booklights - Sew Electric STEAM Lesson Plan

<p><b>Overview:</b></p> <p>This activity brings together crafts and electronics. You will design and sew a simple circuit using conductive thread to create your own bookmark booklight. There are a variety of different skills and concepts one can explore with this project including playing with variables (types and prints of fabric materials, kind and color of LED lights) as well as energy, circuits, design, pattern, repetition, color, etc.</p>
<p><b>Objectives:</b></p> <p>I can apply my knowledge of electric circuits to design and construct a simple circuit with a battery, conductive thread, and an LED light.</p> <p>I can identify the difference between a conductor and an insulator.</p> <p>I can identify the role of a switch in a circuit and build a circuit with switch.</p> <p>I can build a parallel circuit. I can use the principles of art and design thinking to help me plan and construct my Bookmark Booklight.</p> <p>I can revise my project in response to testing my circuit and feedback from my peers.</p>
<p><b>Materials: (Total cost for electronic materials: \$1.80 depending on vendor)</b></p> <p>3v coin cell battery, LED light(s), coin cell battery holder (ideally connections that you can sew through), conductive thread, chalk or pen for marking fabric, felt, paper, needle, glue, scissors, colored pencils for drawing designs.</p>
<p><b>Artist Connections:</b></p> <p>Leah Buechley <a href="https://www.ted.com/talks/leah_buechley_how_to_sketch_with_electronics?language=en">https://www.ted.com/talks/leah_buechley_how_to_sketch_with_electronics?language=en</a></p> <p>Sew Electric <a href="http://sewelectric.org/">http://sewelectric.org/</a></p> <p>How women are on the leading edge to make robots more humane: <a href="http://www.fastcodesign.com/1665597/how-women-are-leading-the-effort-to-make-robots-more-humane">http://www.fastcodesign.com/1665597/how-women-are-leading-the-effort-to-make-robots-more-humane</a></p> <p>Art with thread and electronics: <a href="http://flickrhivemind.net/Tags/arduino,embroidery/Interesting">http://flickrhivemind.net/Tags/arduino,embroidery/Interesting</a></p>
<p><b>Standards:</b></p> <p>NGSS:</p> <p>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.</p> <p>4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.</p> <p>National Core Media and Visual Arts Standards:</p> <p>MA: Cr2.1.1.4 a.Discuss, test, and assemble ideas, plans, and models for media arts productions, considering the artistic goals and the presentation</p> <p>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</p> <p>VA: Cr1.1.4 Brainstorm multiple approaches to a creative art or design problem.</p>

**Procedure:**

1. Ask students how lights work. What makes them turn on? Off?
2. Review concept of electricity and circuits. Today they will create another version of a circuit only this time using conductive thread.
3. Provide a mini-lesson with conductors vs. insulators by having students test various materials such as a penny, paper, metal paperclip, rubber band within a simple circuit (batter, bulb, wires).
4. View artists examples from on-line. Have students discuss what they are seeing using VTS questioning strategies.
5. Introduce bookmark idea using visuals from *Sew Electric* bookmark designs to get an idea of shape, size and other variables for their own project. Decide on the shape and size of the bookmark and draw its outline on a piece of paper using a ruler. It should be at least 2" (5cm) wide to accommodate the batter holder.
6. Plan out the conductive thread connections between your components. In electronics terminology these connections are called a 'trace'. In your circuit there are two traces: the (+) trace that connects the (+) side of the battery holder to the (+) side of the LED light and the (-) trace that connects the (-) tabs of the batter holder and LED light. Align the (+) and (-) traces in your design. If the (+) and (-) threads/traces touch, you'll create a short circuit and the light won't work.
7. The traces can form part of your decoration. They can be curvy or square, zig-zag, looped or straight lines. You can also choose to cover the traces with decorations when you complete the sewing. Once you've drawn in the traces, embellish your bookmark design using colored pencils.
8. Use the paper design to trace the outline of your bookmark on a piece of felt. Cut out the shape.
9. Next, take your LED light. Using a sharp marker, color the (-) leg/pin of the LED. Curl each leg/pin of the LED into a loose spiral using your fingers, pliers or scissor tip. The (-) leg/pin of the LED is shorter than the (+) leg/pin. Once each leg is curled, the marker will help students know which side is (-).
10. Using chalk or pencil, lightly mark the traces from your design that connect the batter holder and LED on the fabric.
11. Thread your needle with approximately 24" of conductive thread. Thread the needle so that you have one long tail and one short tail. Tie a knot at the end of the long tail
12. Starting in the underside of the fabric, sew up to top side. Next, go through the (+) hole on the batter holder and sew to underside. Repeat three times making sure you go through the (+) hole three times. Pull thread firmly for strong connection.
13. Using a running stitch (visualize marching ants!), sew the trace from the (+) of the battery holder, along your sketched line, to the (+) of the LED light. Stitch three tight loops around the curled LED leg. Guide needle through last stitch underneath, create a loop, push the needle through and pull tight. Cut the thread.

14. Thread needle with new 24" piece of conductive thread. Repeat step 9 for (-) trace from battery holder to LED light.

15. Insert battery to test circuit.

16. Finish embellishing your bookmark.

**Extensions:**

- Add more LED lights to create a parallel circuit.
- Add a switch
- Add LED lights to other objects - pillows, shirts, stuffed animals. etc.

**Assessment:** See Figure 2

**Management Considerations:**

The bookmark project is interactive but requires more fine-motor skills, which we have found to be a challenge for some students. Sometimes it is helpful to have them practice sewing a simple running stitch on felt so that they are familiar with the materials and can practice the required skills. For smaller hands we find it helpful to pre-thread the needles and/or have needle threaders on hand. Students are better equipped for the challenges of creating a soft circuit if they already of some knowledge of simple circuits via the analog motors and time is taken to draw the circuit design paying careful attention to making sure the positive and negative traces do not cross or touch. And like the Doodle Bot project, when students get the LED light to turn on, motivation and excitement increases. Students will share their work with each other and as a result of these interactions, we see an increase in peer-to-peer instruction as well as opportunities to foster it when individual students struggle with, for example, sewing without buckling the fabric, making sure the thread is securing sew around the battery and LED light connections, etc.

**Additional Resource:**

<http://sewelectric.org/diy-projects/bookmark-book-light/>