Digital Dice—Instructor Notes

Time: 45 minutes – 1 hr

As of 6/1/23 this activity has been tested in 7 different settings with hundreds of students (one group was middle school). All students were able to get working circuits in the end with debugging help from the instructor.

Introduction:

Remind them that the goal is to create a working product and not to necessarily understand how every circuit part works.

Have them open their kits and takes the parts out together one by one (you hold up each part from your own kit).

1. Microcontroller (also known as an Arduino). This is the "brains" of the circuit. It looks at how much light the sensor sees and determines how many LEDs should be on as a result. You program this circuit using a form of the C++ coding language. This microcontroller was already pre-coded, so you don't have to do anything.
2. Just like we need to eat to power our brain, the microcontroller needs power. Hold up 9V battery and connector. Remind them not to connect the battery until AFTER they are done building the circuit.
3. 7 segment display. The metal pins on the back each lead to a different segment of the display, so by applying a voltage to that segment, we can turn it on. Ask students which segments need to be turned on to create an "8" or a "1".
4. Button. When you push the button, the metal legs are now electrically connected.
5. Resistors. Resistors limit the current flowing through the circuit. Resistance is measured in Ohms which is representing by the Greek symbol Omega (Ω). Explain the color code lets us tell them apart. Write color codes for the two types of resistors needed on board. (Someone may ask if these have directionality, and you can tell them, "Good question! No!")
6. Photoresistor. (This is in the bag with the buttons and capacitors.) Walk around and show the little item to each group, because this is the hardest one for them to find. I describe it as having long legs and a squiggle on top. Tell them a photoresistor is just a resistor that changes its resistance depending on how much light is shining on it and that is how we sense the brightness of the room.
7. Cables and breadboard. Draw a picture of the breadboard on the board. Show which holes connect to which. Have them flip their page over to the back and look at the circuit they are building. Tell them they can follow the picture exactly, or they can use the rules of the connections of the breadboard to build the circuit. As long as any two things are in the same row that are supposed to be connected, then it doesn't matter which absolute row number you use. Also inform them that the color of the wires does not matter (someone will invariably ask that).

Things to check when debugging:

1. Display not turning on:
    a. Forget wires to Gnd (the little black ground wire from the display is the most commonly missed one)
    b. Two items that are supposed to be connected are not in the same breadboard row (about 1/3 of students struggle to understand this)
    c. Button may not be pressed firmly into board
    d. Battery could be low
2. Segments of display not lighting up:
    a. Two items that are supposed to be connected are not in the same breadboard row (about 1/3 of students struggle to understand this)
    b. Loose wires
    c. Saw one or two displays where a segment broke after being abused at several schools
    d. Once saw a group accidentally have a pin bent and so two pins of display were in same hole
3. Display making nonsense numbers: 2 wires crossed or resistor legs touching
4. Display sometimes lighting up sometimes not: resistor for a segment in the ground row for the display
5. Display dim: Wrong resistors (10k resistors on display will make it dim)