Wizards of Wright

Lesson: Cube-lets 1

When doing Student Activity #2, it is important they have only the 3 Cubes they will need. Other Cubes will be needed for Student Activity #3.

Use WOW! Lesson Intro to begin.

Background Info for Wizards:	This lesson is used to review electricity, currents, and energy. This lesson is also an introduction to robots. The Cube-lets are used as a connection between robots and circuitry.
Materials:	Wooden Blocks Student Boxes of Cube-lets (cubes should match the picture) ~~Wizard Boxes of Cube-lets (cubes should match the picture)~~ Battery Cube-lets Explanation Sheets Cube-lets 1 Challenge Sheets charger (if sent)
Lesson Time: 60-80 minutes *Many teachers will want this done in 45 minutes. If so, cut the amount of discussion, and the amount of time on each activity.*	Introduction: 5-7 minutes Guided Lesson #1: 2-3 minutes *(4^{th}-8^{th} grade only)* Student Activity #1: 5-10 minutes Guided Lesson #2: 3-5 minutes *(4^{th}-8^{th} grade only)* Guided Lesson #3: 5-7 minutes Student Activity #2: 15-20 minutes Guided Lesson #4: this happens during Activity 2 Student Activity #3: 10-15 minutes Conclusion: 5-10 minutes
Learning Targets:	Students will describe electricity and circuits. Students will discuss and analyze robots and what they can do. Students will demonstrate how energy is passed through Cube-lets and will test various combinations.
Introduction for Students: 5-7 minutes	Find out/Review what students already know about electricity. *Depending on the grade level (or time of the school year) it is highly possible that these topics will not have been covered yet. Do not expect students in grades K-3 to be able to discuss higher-level terms.*

Please use the adjustments below based on the classroom you are working with.

Discuss the following questions/topics with **K-3rd students**:

What is electricity?
Electricity is a form of energy that makes things work. It cooks our food, keeps us warm, gives us light, and charges our phones.
Ask students: What are some things that you use that need electricity?

How is electricity made?
Everything around us (the sun, the grass, our desks, our shoes, rocks, people – everything) is made of atoms. They are tiny particles that we can't see without a very strong microscope. Atoms are made up of protons, neutrons and electrons. When the atoms' balance gets disorganized, it can lose or gain an extra electron. When the electrons start moving around, we get electricity.

How does electricity get to our equipment to power it up?
Electrical currents (that movement of electrons) flow through a circuit (a specific path).

Let's look at an example. When you enter a dark room, you flip the light switch on. This causes the electrons to flow, and as they move through the path of connecting wires, they complete the circuit, making the light bulb glow. This is electricity.

Is electricity dangerous?
Yes! It definitely can be.
Let's go over some very important rules.

1. Don't stick anything into a wall outlet except the appropriate plug.
2. Never put electronic items into the water, or close enough that it could fall into the water – especially if it is plugged in.
3. Don't put anything on top of your wires – if wires get damaged, they could start a fire.
4. Don't plug too many things into the wall outlet or an extension cord.
5. Don't play near or on transformer box or substations. If you're not sure, assume it's not safe, and play somewhere else.
6. When unplugging something, don't pull from the cord, use the plug.
7. Don't fly drones or kites, or climb trees near power lines.
8. When you're not sure, always ask an adult for help.

Discuss the following questions/topics with **4th-8th grade students**:

What is electricity?

- Electricity is a type of energy.
- Electricity can build up and stay in one place or it can move.
- Electricity happens when electrons transfer and move.
- Electricity provides power for lighting, appliances, and other electric devices in our homes and businesses.

What is electrical current?

- When electrons move, they carry their energy to a new spot. This is called an electric current.
- Electric currents are also involved in powering all the electrical appliances that we use. Washing machines, flashlights, telephones and iPads all need an electric current running through them.

What is potential energy and kinetic energy?

- Potential energy is energy that is stored for use in the future, and kinetic energy is energy being used at that moment.
- Think about all of the times you've been told you have the potential to do something. You have the potential to get straight A's, or you have the potential to hit a homerun, or you have the potential to become President. That means you have the ability to do it in the future, although you aren't doing it right now.
- Energy is the same.
- Imagine a car parked at the top of a hill. It has the potential or ability to roll down the hill, but right now it's just sitting still. If we release the brake, and it begins to roll down the hill, the potential energy is converted into kinetic energy, because it's now moving.

What is an electric circuit?

- An electric circuit is a closed path or loop for electric current to flow around.
- In a flashlight, there is a simple circuit with an on/off switch, a light bulb, and a battery linking everything together with some pieces of wire. When you turn the switch on, electricity should flow through the circuit.
- The electricity will stop flowing if the path isn't complete. Think about walking up a flight of stairs. When you start going, you should be able to get to the top pretty easily. But, if there's a broken step in the way, you would have to stop moving up those stairs.
- In our flashlight, if one of the wires is broken, the bulb will not shine. The electricity won't flow. Electricity also won't flow if the switch is turned off.

Have you heard the term circuit breaker? Let's use what we now know, and explain what that term means. (Guide them through.)

	- Some circuits are made without wires, they happen in nature. A circuit can be formed between a storm cloud and the Earth. If there is a big enough electrical charge in the cloud, it can charge particles in the air called ions. The ions work like an invisible string connecting the cloud, the air, and the Earth. Lightning flows through the air between the ions.
Guided Lesson #1: 2-3 minutes *(4th-8th grade only)*	Discuss the following with **4th-8th grade** students: Remind students that they cannot see electricity because electrons, the charged part of the atom that is moving and causing electricity, are too small to be seen. Ask students if they can define a simple circuit. A simple circuit is a complete/closed path that electrons travel through. It needs to have 4 parts: a switch to turn power on and off, a power source (like a battery), the light bulb or other mechanism that reacts to the electricity, and conducting wire. Tell students to look for these 4 parts in the robots they will build. (*I have included a handout that reviews Simple Circuits. You can give it to students to look over during the conclusion, if you want.)*
Student Activity #1: 5-10 minutes	**Act Out an Electric Circuit** With **Kindergarten – 2nd grade**, only do this activity with a small group of students. If you have time, you can have several groups come up and take a turn. With **3rd-8th grade**, do this with a small group of students first as an example. Continue increasing the group to include the whole class. - Ask a few students to come up and make a circle. The circle will represent our circuit. - Distribute an object – wooden blocks -- to each member of the circle, including yourself. These wooden blocks are our electrons inside a wire. - Explain to students that you are playing the part of the battery in this circuit, and explain that all batteries have a positive end, (your left hand) and a negative end, (your right hand). - Pass your "electron" to the student on your right. There can only be one electron there at a time – we have to keep the flow moving. So, when someone receives an electron, they must pass the electron they are already holding. (Everyone keeps passing electrons, one at a time, to the right.) This

	is an example of an electrical current. - Explain that this is a closed circuit - the circle remains intact and the electrons continue to flow. - To show an open, or broken circuit, either drop an electron or create a gap in the circle that is too wide to continue passing electrons. The current will stop as a result. - (This can be a slow process. Each person passes the block one at a time. Students should always have only one electron in their hands.)
Guided Lesson #2: 3-5 minutes *(4th-8th grade only)*	**Input and Output** Discuss the following questions/topics with **4th-8th grade** students: - Input and output are pretty self-explanatory. Input is what goes in and output is what you get out. - Let's think about common input devices we use frequently…the computer mouse and keyboard are examples of input. When you type on the keyboard – that's input. You are putting information in. What you see on the monitor is what is coming out – that's output. Other input devices include numbers on a calculator, letters on your texting pad, and stylus pens**.** - Examples of other output devices include a monitor or screen, speakers, headphones, a printer, and a television. Tell students to look for input and output in the robots they are about to build.
Guided Lesson #3: 5-7 minutes	Ask the Students what they know about robots. Most people think of robots to be like humans — they communicate and do things like people would. But this kind of robot is actually not very common. - A robot is a mechanical device that can perform different tasks on command or according to instructions programmed in advance. - Engineers design robots to perform complex tasks. Some everyday examples of robots include: - automatic car washes - vending machines - automatic doors - robotic arms used in manufacturing

	- remote control cars and trucks - automatic teller machines (ATMs) Ask the students what tasks they do every day that they would like to have a robot do for them. (Homework? Make their bed? Do the dishes?) Ask the students if they have ever heard of Cube-lets. Briefly explain: *Cube-lets are a line of toys. The Cube-lets are small color coded cubes that people magnetically stick together to build a variety of simple robots.* https://en.wikipedia.org/wiki/Cubelets Explain the different Cube-lets to the students. Black – These are Sensors. The Inputs. (the signal or info received by the system) *There are Cube-lets that sense distance and brightness, and one with a knob for adjustments.* Clear – These are for Action. The Outputs. (the signal or info sent by the system) *There are Cube-lets that rotate, drive, emit, noise or light, and one with a bar graph.* You can give students the Explanation Sheet at this time, if you think it will be beneficial to them. (**3rd-8th grade** students only) Pass out the box of Cube-lets – **one box to be shared by 3 or 4 students**. Give them a few minutes to look, feel, discuss, and notice differences. The boxes will all be identical, or close. **Do not give the students the battery cube yet.**
Student Activity #2: 15-20 minutes	Tell students that their objective will be to use the Cube-lets to understand how the cubes work together as they create robots. As they build simple robots – go around asking students what their robot is sensing, and what the action is. Let's make a robot with just three Cube-lets. ***Do this with them, and show them which Cube-lets you want them to use. Do it together.***

Tell the group of 3 or 4 to work in pairs:
Take out a cube that senses. That's a black cube.
Take out the Brightness Cube.

Take out a cube that acts. That's a clear cube.
Take out the Flashlight Cube.

Let's put the rest back in the box for right now.
Wait for this to happen, so you know they are all using the correct cubes.

Every robot, like every electrical circuit, needs power. You will need the Battery Cube-let, it has a switch to turn the power on and off.

Show the class one of these Battery Cube-lets and demonstrate how the on/off switch operates and how the green light comes on when the Battery is operating.
Whenever a Cube-let is connected to the Battery it will receive power.
See what your team can discover by using just the 3 Cube-lets you have out.

Pass out one battery to each group.
Allow them to explore and test for a few minutes.

Experiment with different ways you can make your robot behave by rearranging just these 3 blocks. Can you make the light shine more or less?

Have the students put the sensor cube (brightness) back in the box. Show them which cube to take out next, but don't tell them what it does.

(Have them take out the Distance Cube.)
Have them try it out and **ask students**:
What do you think this robot is sensing?

Have the students put the action cube (flashlight) back in the box. Have them take the Drive Cube-let out.
They should now experiment with the battery, the distance cube, and the drive cube.

Ask students: Can you use the Distance sense to control the Drive action and make it go fast and slow? Does the order of the cubes change how it works? Can you drive it across this table?

	Ask students: Using ONLY these three Cube-lets and building only in <u>linear</u> arrangements - How many different Robots can you make? (We know of at least 7!) **Ask students**: What changes your robot most - moving the order of Cube-lets or changing an individual Cube-lets direction/position while keeping it in the same place on the robot? **Ask students**: How many more driving robots can you make if you build in non-linear configurations?
Guided Lesson #4: this happens during Activity 2	<u>Helpful tips for the students</u>: Remembering that you must have a Battery Cube-let, a black Sense Cube-let, and a clear Action Cube-let, investigate how many different ways you can make your robot behave by changing the way you put the Cube-lets together. As you wander around, ask some of these questions – What do you think is causing your robots action? – What could your robot be sensing? – How can you test for this? ○ Encourage them to try something like clapping, moving their hand in front of or away from it, having something to block it, etc. – When they come close to the black Sense Cube-let what happens? – What makes your robot stop its action? – Can you get your robot to react in an opposite way? – How many different configurations can you make? – Did the direction of the wheels on the Drive Cube-let effect the direction the robot moved? – How does each affect the action of your robot? – Can you build your robot to be taller than one Cube-let high? – If you could use this robot for a task, what might you get this robot to do?
Student Activity #3: 10-15 minutes	With **Kindergarten – 2nd grade**, do not pass out the challenge sheets. You should choose the challenge yourself and lead them through testing and experimenting. With **3rd-8th grade**, give student pairs a copy of the Cube-lets 1 Challenge Sheet. They may work through these in any order that they would like.

	Let students know that you have a few boxes of extra Cubes if they don't have everything they need in the boxes they are sharing. **Students should be following Challenge sheets and building these robots, <u>not</u> creating their own. The Cube-lets 2 lesson gives students the opportunity to make up their own.**
Conclusion: 5-10 minutes	Review with students the definitions for…electricity, electrical currents, potential and kinetic energy, an electrical circuit, and robots. Do students recognize that a robot needs to sense and act? Do they recognize that by controlling or changing what it senses, they can change the action/behavior? How did these robots use electricity, electrical currents, potential and kinetic energy, and electrical circuits?

Students should be asked to…

1. Turn the batteries off.
2. Return the batteries to the Wizard.
3. Return Cube-lets they borrowed from another group.
4. Return Cube-lets they borrowed from the Wizard Boxes.
5. Match the Cube-lets in the picture to the layout in the box they've used.

Please remind the teacher that this was the *Cube-lets 1 Lesson*, a review of Electricity and Currents, and an Intro to Cube-lets. We have a *Cube-lets 2 Lesson* which will allow students to spend time only on Cube-let Challenges now that they have been introduced and have briefly used them.

Challenges from:
http://robotcourse.com/cubelets/lesson_plans/CubeletsChallenges-Part-1.pdf
http://cache.smarthome.com/manuals/83233-guide01.pdf

Photos from: https://www.modrobotics.com/shop-cubelets/#individual-cubelets