

# What's the buzz?

Facilitation Time: 90 minutes

**SAFETY INFORMATION** Be safe using scissors or working with sharp ends of a pipe-cleaner.

**FOCUS QUESTION/S** (central focus of a topic & promotes inquiry)

How do things move?

How can we model the role bees play in pollination?

## SUMMARY OF ACTIVITIES

- Activity 1: Students build and decorate a bristle bot to look like a bee.
- Activity 2: Students model the Waggle Dance using their bee-bots.

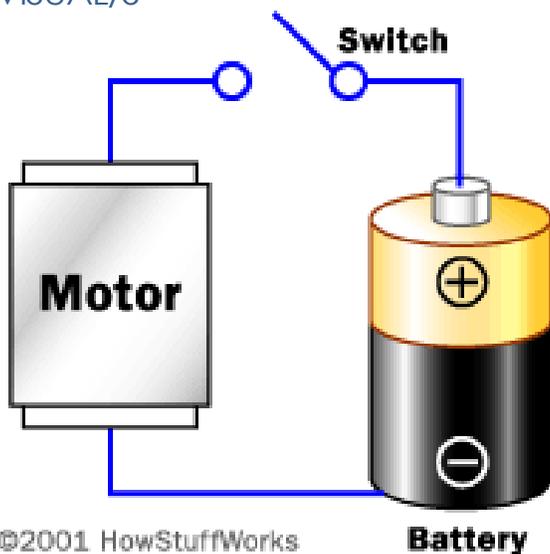
## SCIENCE STORYLINE

Bees can be scary, but they are super important because they help pollinate plants that create much of the fruits we eat. And, they have a funny way of communication. Today, we're going to bee-come electrical engineers who need to create a fun model that represents how bees communicate using the Waggle Dance.

## ESSENTIAL TAKE-AWAYS

1. The basic parts of a circuit are: battery, load, conductor and switch.
2. Open circuits are off; closed circuits are on.
3. Bees play an important role in pollination.
4. The waggle dance is one way bees communicate.

## VISUAL/S



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Figure 1 A Basic Circuit Diagram

## IMPORTANT INFO TO KNOW

An electric circuit is a path of electricity. Only some materials are able to conduct electricity. The main components of a simple circuit are an **energy source** (for us it will be a battery), the **load** (what we are powering – for us a motor), and some **conductor** - a material that allows the electricity to freely flow (for us it will be wires). There is also the option of adding a **switch**, which can stop the flow of electrons and turn the load on (close the circuit) and off (open the circuit).

There is much to be discovered about the important role honey bees play in ecosystems as **pollinators**. Without honey bees, we'd have no honey, but we'd also have a much more limited selection of produce at the grocery store. Bees are fascinating, social creatures that work together to run a successful hive and they rely on interesting ways to communicate to accomplish their many tasks. One mechanism of bee communication relating to pollination and honey production is the **Waggle Dance**, a precise way for scout bees to inform their hive mates where a food source (e.g. flower patch) is located (Dyer, 2002; von Frisch, 1967).



Figure 2 Example Bee-Bot

## OBJECTIVES

<b>Objective:</b> <i>The learner will know and be able to...</i>	<b>Activity</b>	<b>Assessment:</b> <i>What will the learners produce as evidence of meeting the objective?</i>
<u>define</u> the terms: circuit, energy, load, conductor, switch, pollinator	1, 2	Orally stating the terms accurately and in the correct context during all activities.
<u>distinguish</u> between open and closed circuits	1	Illustrating open vs. closed circuits on their basic bristle bot
<u>create</u> a bristle bot and <u>decorate</u> it to look like a pollinator	1, 2	Bee-bots created by the learners.
<u>model</u> the 'waggle dance' and bee communication using bee-bots	2	Explaining how their bee-bot is modeling the waggle dance; zip-lining to a 'flower patch'.

## WELCOME

1. Welcome participants to the specific event and program.
2. Allow for a facilitator introduction if this is the first class with these students.
3. Excitedly introduce the storyline to the participants! This is important – it will guide the rest of the facilitation and tie all of the activities together:
  - a. Today, we're going to bee-come electrical engineers who need to create a fun model that represents how bees communicate using the Waggle Dance.

## WARM UP) (10min)

1. Introduce 1<sup>st</sup> essential question: "How do things move" and ask students to share ideas. Emphasize answers that addressed some type of force or energy.
2. Distribute a coin battery and motor to each student. Challenge them to make observations (come up with as many as possible) and to try to power the motor. Students each have their own set of materials, but can work with a partner on challenges.
3. Share out ideas, highlighting the following while drawing and labeling a diagram on the board:
  - a. Energy source (battery)
    - i. Positive/neg sides
  - b. Motor
    - i. Pos/neg leads = conductors
4. Review (use whiteboard and markers to illustrate points)
  - a. How did you get the motor to work? (powered it via battery)
  - b. When did the motor not work? (not connected to battery; not connected to each side)
  - c. Did the motor stay on the whole time?
    - i. Closed circuit = "on"
    - ii. Open circuit = "off"

## ACTIVITY ONE Build a Bee-bot (45 min)

## MATERIALS

Per Person:

- 1 – toothbrush tip
- 1 – mounting tape strip, 2"
- 1 – coin battery (3v) CR2032
- 1 – small motor
- 1 – bee 'body'
- 1 – bee wings/strips (black pipe cleaner)
- 2 – googly eyes
- 2 – clear rubber bands

## CLASSROOM SET UP

Make sure wires are stripped at tips, exposing the metal. Materials italicized (battery and motor) were distributed during warm up.

## TRANSITION

Now that we know what a circuit is, let's build a Brush-Bot!

Per Pair:

- 1 – bottle tacky glue
- 1 – scissors
- 1 – insect “eye” viewer (optional)

**WHAT TO DO**

1. Review materials and rules/expectations
2. Build bot as a class, Socratically.
3. Decorate bee body first – allow time for glue to dry:
  - a. Add pipe-cleaner stripes/wings to bee body
  - b. Let's give our bee eyes, since glue takes a long time to dry.
    - i. Review three parts of an insect's body: head, thorax, and abdomen.
    - ii. Other key characteristics of an insect: 6 legs, antennae, compound eyes.
    - iii. OPTIONAL: Have students view the world through “insect eyes” – what's different? (*many tiny versions of the same image vs. we only see one main image*)
4. Build the bristle bot next (figure 3):
  - a. Remove sticky backing from motor and place on toothbrush head with wires aligned with toothbrush head. OR attach using mounting tape.
  - b. Place strip of mounting tape on flat side of brush; trim with scissors as needed.
  - c. Place black wire on mounting tape.
  - d. Place negative side of battery down on the tape, over the negative lead.
  - e. Test the motor by touching the red wire to the positive side of the battery.
  - f. Allow kids time to adjust placement of items so their bot so it stays upright whether it's powered on or off.

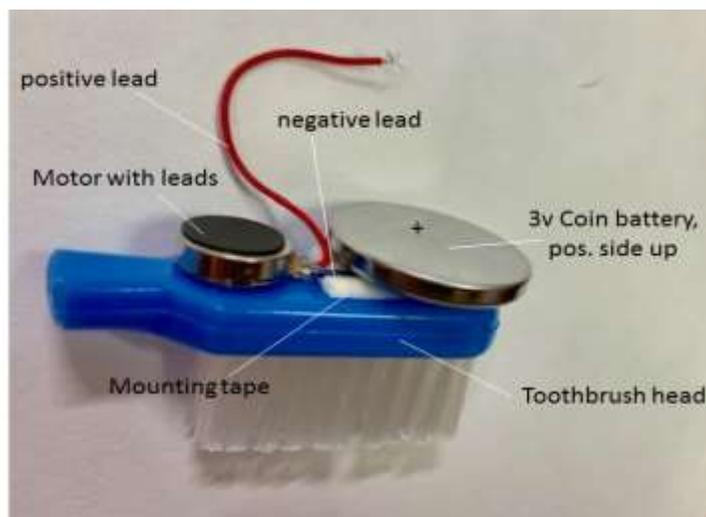


Figure 3 Placement of motor, black/negative lead, mounting tape and coin battery on tooth brush head

**OPPORTUNITY FOR INQUIRY**

How can we attach the motor and battery to the brush? (*tape*)

Where should the motor and battery go (front/back)? (*let kids discover what works for them*)

Who remembers the difference between a closed circuit and open circuit? (*varies*) How can we have a closed circuit? (*connect motor leads to the battery, pos-pos and neg-neg*) How can we have an open circuit? (*disconnect one of the leads from battery*)

How can we complete our bee body? (*add wings to the body*)

How can we connect the bee to the bot? (*rubber bands*)

Does your bee decoration change how the bot works? (*varies*)

**TIPS FOR TEACHERS**

Do not allow both wire leads to touch one side of the battery; this could create a short circuit, and the bot won't work. This is why the negative side of the battery is faced-down on the mounting tape; the positive side of the battery wraps all around the edges of the battery.

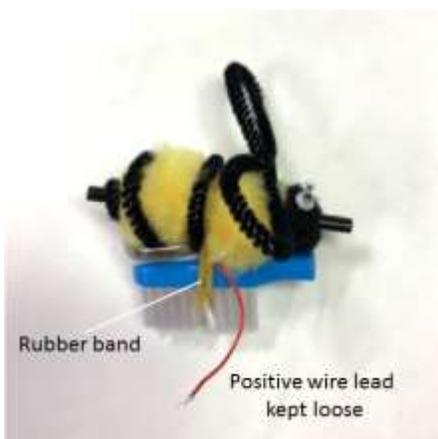


Figure 4 Adding decorated bee body to bot

5. Now that we know how to operate our bots, what's next?  
(*decorate as a bee – figure 4*)
  - a. Secure bee body to bristle-bot using rubber bands
6. Clean up.

Students may need help adding the pipe cleaner wings/stripes. They may also need help securing their bee body to their completed brush bot with the small rubber band/s.

## WHAT'S HAPPENING

We created a bristle bot to explore circuit basics and then decorated the bot to look like a bee. The basic parts of a circuit explored were: power (battery), load (motor), and conductors (wire leads from motor). The switch is incorporated by removing contact between the red lead and the positive side of the battery. Students explored basic principles of balance as well, in order to get their bot to remain upright. Adding the bee body to the bristle bot, allows for an opportunity to address basic bee anatomy: head/thorax/abdomen; compound eyes, 6-legs (older students can analyze how anatomically correct their models are). When the bee bot is powered on, it moves in a circle, which is similar (but not exact) to what bees look like when they do the Waggle Dance.

## ACTIVITY TWO Waggle Bots (25 min)

### MATERIALS

#### Per group:

- 1 – artificial flower bunch
- 1 – fishing line “zip line” (tie to the flower bunch)
- 4 – bee-bots, 1/student (created in the prior activity)

#### Per class:

- 1 – computer with internet access
- 1 – projector with speaker

### CLASSROOM SET UP

Make sure the flower bunches have a length of fishing line secured to a stem. Place the flower bunches at different spots around the room.

### TRANSITION

Now that we've created our buzzing bee-bots, let's see how they can model bee communication!

## WHAT TO DO

1. Show this ~3 minute waggle dance video:  
[https://www.youtube.com/watch?v=LU\\_KD1enR3Q](https://www.youtube.com/watch?v=LU_KD1enR3Q)
2. Have groups discuss how their bee bot might be a good model for the waggle dance.
3. Groups gather at the end of a line connected to a flower bunch.
4. Have one student in the group have their bee bot do the waggle dance (Close the circuit to power the motor and move the bot). Then, the other members of the group place their bee-bots on the fishing-line so they can “fly” (via ‘zip-line’) to the flowers.
  - a. Bees do not need to be “on” or buzzing down the line, but can be if students want them to.
  - b. Repeat for other members of the group who want to have their bot do the waggle dance while other members of the group zip-line to the flowers.
  - c. Continue as long as time allows.
5. Allow time for a quick share-out of the kids' experiences and any ideas they develop and wish to share.
6. Clean-up and debrief.

### OPPORTUNITY FOR INQUIRY

What is modeled well in our bee bots? (*buzzing, three body parts, “stinger”, coloration, wings*). What is missing/not quite accurate from our model? (*can't go in a figure eight, bees don't have a straw through their bodies, bees can actually fly, compound eyes, bees have 6 legs/not brushes, bees have antennae, etc.*)

Ask – Who remembers what the name of the special dance is that bees do to communicate? (*Waggle dance*). What does it mean? (*helps a scout bee communicate the location of a flower patch to the rest of the hive*)

### TIPS FOR TEACHERS

The fishing line/zip-line works best via gravity (have the starting point angled higher than where the flowers are so it's angled downward).

## WHAT'S HAPPENING

The act of bees flying to flowers to get nectar in order to make honey results in pollen from one flower getting stuck to the body of the bee. As the bee flies to the next flower, some of that pollen falls off, pollinating the second flower. This continues as long as the bee is flying from flower to flower to get the nectar. Once a flower is pollinated, fruit can develop on that plant. We modeled the action and function of the Waggle Dance and discussed how that relates to pollination. This mechanism of bee communication relating to pollination and honey production is the **Waggle Dance**, which is a precise way for scout bees to inform their hivemates where a food source (e.g. flower patch) is located (Dyer, 2002; von Frisch, 1967).

## CHECK FOR UNDERSTANDING (5 min)

1. Debrief the whole lesson. Probe students extracting important concepts.
2. Ask questions to:
  - a. Review concepts.
    - i. Circuits and energy transfer
      1. Energy source
      2. Conductor
      3. Load
      4. Switch (open/closed circuits)
    - ii. Pollination
      1. Bees are important pollinators
      2. Pollination results in the production of fruit on a plant
    - iii. Modeling
      1. Sometimes there are limits to our models, but we do the best we can to model something we are interested in.
      2. How did our models work today? (strengths/weaknesses)
  - a. Student reflections
    - a. Opportunity for students to reflect, comment and ask questions.

## TERMINOLOGY

**Circuit** – a closed loop through which energy/electricity can travel in order to power a load.

**Energy** – the ability to do work; in a circuit, this could be provided via stored energy in a battery.

**Load** – the part of a circuit that is powered by a battery and does something, such as a light, or motor.

**Switch** – a part of a circuit that allows it to be turned on/off (open vs. closed).

**Pollinator** – an animal, such as an insect, that helps transfer pollen from one plant to another.

## STANDARDS

**NGSS-2-LS2-2.** Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants

**NGSS-3-PS2-2.** Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

**NGSS-4-PS3-4.** Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

## REFERENCES/RESOURCES

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3. Smithsonian Channel (2016). *What's the Waggle Dance? And Why Do Honeybees Do It?*. [video] Available at: [https://youtu.be/LU\\_KD1enR3Q](https://youtu.be/LU_KD1enR3Q) [Accessed 9 Feb. 2018].
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5. Askabiologist.asu.edu. (n.d.). *Bee Dance Game*. [online] Available at: <https://askabiologist.asu.edu/bee-dance-game/index.html> [Accessed 11 Sep. 2019].
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## MATERIALS

ITEM NAME	PICTURE OF ITEM	DESCRIPTION	VENDOR	TOTAL AMT	UNIT	RATIO
SCISSORS				10		1/pair
ARTIFICIAL FLOWERS			Amazon, craft store	5		1/group
HEAVY DUTY SCISSORS OR SAW		To remove handles from toothbrushes	Hardware store	1		Adv prep
AWL		To puncture pom poms	Amazon, craft store	1		Adv prep
COMPOUND EYE VIEWERS		optional	amazon	10		1/pair
CRAFT GLUE		Pen-style are nice	Amazon, craft store	10		1/pair
<b>REUSABLE ABOVE // CONSUMABLE BELOW</b>						
MOTOR, VIBRATING, 3V		10,000-12,000 rpm; 10mmx2mm	Xump, amazon	20		1/student
BATTERY, CR2032			Xump, amazon	20		1/student
TOOTHBRUSH		Cut handles off	Fisher	20		1/student
RUBBER BAND			Amazon, craft store	40		2/student
POM POM, YELLOW, 1"			Amazon, craft store	40		2/student
POM POM, BLACK, 1/2"			Amazon, craft store	20		1/student
DOUBLE-SIDED FOAM TAPE			Amazon, craft store	1	Roll	1/class
PIPE CLEANER, BLACK			Amazon, craft store	20		1/student
GOOGLY EYES, MINI		Have extra; they are small and can get lost easily	Amazon, craft store	40		2/student
STRAW, COFFEE		Cut in half Cut into 10-15ft lengths and secure each of one bunch of flowers	Amazon, restaurant supply	10		1/pair
FISHING LINE			Amazon, craft store	5		5/class
WAX PAPER		To prep mounting tape, 12"x12" peice	Amazon, craft store	1	Piece	1/class

## ADVANCED PREP

- Cut coffee straws in half
- Use an awl to puncture pom-poms and insert a cut coffee straw into opening for two yellow pomp oms and one small black pom pom.
- Cut off the handle of toothbrushes. File off excess as needed.
- Cut foam tape into small, ~3/4" strips, place on wax paper until needed.
- Connect ~10-15ft of fishing line to several bunches of artificial flowers to create 'zip-lines' for groups.
- Fold pipe-cleaners into wings/coil for stripes (see pic →)

