

# What's the buzz?

Facilitation Time: 90-120 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.

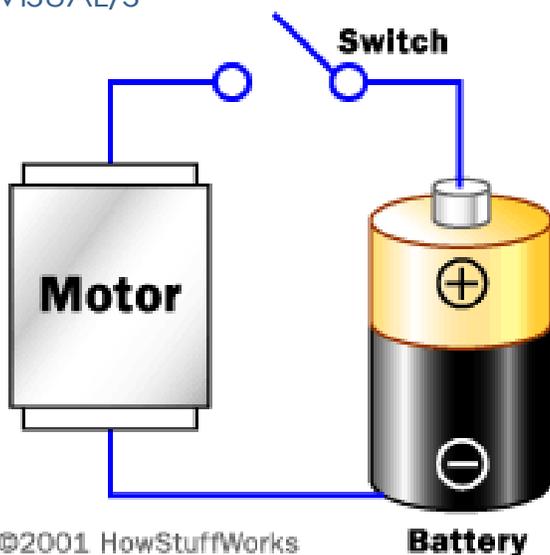
## SCIENCE STORYLINE

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 communicating. 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



## 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 hivemates 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>distinguish</u> between potential and kinetic energy	1	Illustrating potential vs. kinetic energy on their 'off' and 'on' bristle bot/within their simple circuit
<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>Identify</u> and/or <u>state</u> the basic body parts of insects	1, 2	Demonstrate how these parts are (or are not) modeled by the bee bots created by the learners.
Use the bee-bot to <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'.
<u>Explain</u> how bees act as pollinators in nature	2	Explaining while modeling honey bee waggle dance
<u>Describe</u> how the Waggle Dance is used as a way for bees to communicate	2	Orally stating while modeling honey bee waggle dance

## 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) (15-20 min)

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). Share-out observations.
3. Now, try to power the motor. Students each have their own set of materials, but can work with a partner on challenges.
4. Share out ideas, highlighting the following while drawing and labeling a diagram on the board:
  - a. Energy source (battery)
    - i. Positive/neg sides: positive side wraps around one side and edge
  - b. Motor
    - i. Pos/neg leads = conductors: allows for the transfer of energy from battery to motor
5. 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 (60-75 min)

### MATERIALS

#### Per Person:

- 1 – toothbrush tip
- 1 – mounting tape strip, 2"
- 1 – coin battery (3v) CR2032 *\*distributed during warm-up\**

### CLASSROOM SET UP

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

- 1 – small motor *\*distributed during warm-up\**
- 1 – bee 'body' or supplies to create one
- 1 – black pipe cleaner, folded into wings/stripes
- 2 – clear rubber bands
- 2 – googly eyes (plus some extra just in case)

#### Per Pair:

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

### WHAT TO DO

1. Review materials and rules/expectations.
2. Two challenges:
  - a. Build a bristle bot
  - b. Decorate it to look like/model a pollinator
3. Ask & consider the question: "how do things move?"
4. Build bot as a class, socratically.
5. Build the bristle bot (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/blue wire (neg. lead) on mounting tape.
  - d. Place negative side of battery down on the tape, directly onto 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.

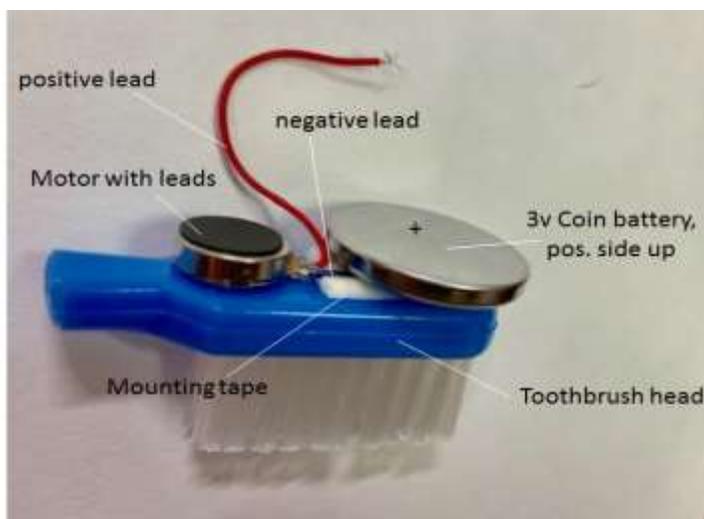


Figure 3 Placement of motor, black/negative lead, mounting tape and coin battery on tooth brush head

6. Now that we know how to operate our bots, what's next? (decorate as a bee – figure 4)
  - a. Fold pipe cleaner into wings/stripes, if needed

### TRANSITION

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

### 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.

You may wish to create the bee body first – allow time for glue to dry.

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.

- b. Create bee body (stick poms onto straw, toothpick, cardstock, craft stick, etc.)
  - c. Add pipe-cleaner stripes/wings to bee body
  - d. Glue on bee eyes, while glue is drying, address:
    - 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*)
  - e. Secure bee body to bristle-bot using rubber bands or other method
7. Clean up.

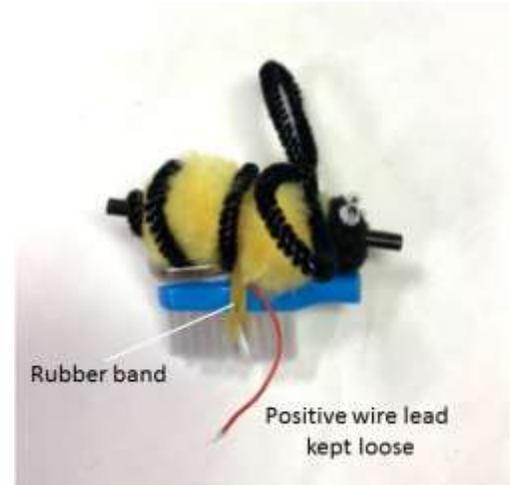


Figure 4 Adding decorated bee body to bot

## 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 (15-25 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

### WHAT TO DO

1. Remind students of 2<sup>nd</sup> essential question: "how can we model the role that bees play in flower pollination?"
2. Show this ~1 minute waggle dance video: <https://www.youtube.com/watch?v=-7iil-g4iHg>
3. Have groups discuss how their bee bot might be a good model for the waggle dance.

### THESE NEXT STEPS ARE OPTIONAL BUT FUN

4. Have small groups (4-5 students) gather at the end of a length of fishing line connected to artificial flowers.
5. Have one student in the group have their bee bot do the waggle dance (i.e. close the circuit to power the motor)

### CLASSROOM SET UP

For optional zip-line activity: make sure the flower bunches have a length of fishing line secured to a stem/flower. Place the flower bunches at different spots around the room, low to the ground. It may help to flag the end of your fishing line with tape to locate it easily, but remove prior to zip-line activity.

### TRANSITION

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

### 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

and cause the bot to move). Then, the other members of the group place their bee-bots on the open end of 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 prefer this.
  - b. Repeat for other members of the group who want to have their bot do the waggle dance followed by other group members having their bots “fly” (via zip-line) to the flowers.
  - c. Continue as long as time allows.
6. Allow time for a quick share-out of the kids' experiences and any ideas they develop and wish to share.
  7. Clean-up and debrief.

### 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).

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 height well-above the point where the flowers are so it's angled pretty sharply downward).

If your students didn't use a hollow straw for the fishing line to go through, have them try using the wing loop of the pipe cleaner although, this may have varying degrees of success given the texture of the pipe cleaner as compared to the hollow straw – embrace trial and error by testing this idea from higher heights/bigger angles to take advantage of gravity.

No model is ever a perfectly accurate representation of an entity or phenomenon, so please have a conversation with your students about the nature of and limitations of models.

### 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)
3. Review Essential Questions
  - a. How do things move?
  - b. How can we model the role that bees play in flower pollination?
4. 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

1. Dryer, Fred C. (2002). The Biology of the Dance Language. Annual Review of Entomology. Vol. 47:917-949. Available at: <https://www.annualreviews.org/doi/full/10.1146/annurev.ento.47.091201.145306> [Accessed 11, September, 2019].
2. Monsanto Company (2017). *Brush Bots in 90 Seconds*. [video] Available at: <https://www.youtube.com/watch?v=latJLiDpb4c> [Accessed 9 Feb. 2018].
3. Bientanz GmbH (2006). *Bee Dance (Waggle Dance)* [video] Available at: <https://www.youtube.com/watch?v=-7ijl-g4jHg> [Accessed 6 April. 2021].
4. von Frisch K (1967) The tail-wagging dance as a means of communication when food sources are distant. In: The dance language and orientation of bees (von Frisch K, ed) pp 57–235. Cambridge, MA: Harvard UP.
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].
6. Christopher M. Jernigan. (2017, June 12). Bee Bonanza. ASU - Ask A Biologist. Retrieved September 11, 2019 from <https://askabiologist.asu.edu/explore/honey-bees>
7. Brennan, John. 2018. Limitations of models in Science. Sciencing.com. Available at: <https://sciencing.com/two-benefits-using-models-represent-scientific-processes-10590.html> [Accessed 12, Sept. 2020]
8. Lewontin, R.C. n.d. Biological Models. Encyclopedia of Ideas. Available at: <https://sites.google.com/site/encyclopediaofideas/science-and-nature/biological-models> [Accessed 9, April. 2021]

<b>MATERIALS</b>							
ITEM NAME	PICTURE OF ITEM	DESCRIPTION	VENDOR	TOTAL AMT	UNIT	RATIO	
SCISSORS				10		1/pair	
WIRE STRIPPERS		Make sure they match the gauge of the motor wires					
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	<a href="#">amazon</a>	10		1/pair	
CRAFT GLUE		Pen-style is nice	<a href="#">Amazon</a> , craft store	10		1/pair	
<b>REUSABLE ABOVE // CONSUMABLE BELOW</b>							
MOTOR, VIBRATING, 3V, WITH WIRE LEADS		10,000-12,000 rpm; 10mmx2mm the longer the wires, the better.	Xump, <a href="#">amazon</a>	20		1/student	
BATTERY, CR2032			Xump, <a href="#">amazon</a>	20		1/student	
TOOTHBRUSH		Cut handles off w/ heavy duty shears	Fisher, <a href="#">amazon</a>	20		1/student	
RUBBER BAND			<a href="#">Amazon</a> , craft store	40		2/student	
POM POM, YELLOW, 1"			<a href="#">Amazon</a> , craft store	40		2/student	
POM POM, BLACK, 1/2"			<a href="#">Amazon</a> , craft store	20		1/student	
DOUBLE-SIDED FOAM TAPE			<a href="#">Amazon</a> , craft store	1	Roll	1/class	
PIPE CLEANER, BLACK			<a href="#">Amazon</a> , craft store	20		1/student	
GOOGLY EYES, MINI		Optional; have extra; they are small and can get lost easily	<a href="#">Amazon</a> , craft store	40		2/student	
STRAW, COFFEE		Optional; cut in half substitutes: toothpick, craft sticks, cardstock, etc.	<a href="#">Amazon</a> , restaurant supply	10		1/pair	
FISHING LINE		Optional; cut into 10-15ft lengths and secure each to one bunch of flowers	<a href="#">Amazon</a> , craft store	5		5/class	
WAX PAPER		To prep mounting tape, 12"x12" piece	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 pom poms and one small black pom pom. Alternatively, use a toothpick to puncture or connect the poms; if toothpick (or other material such as craft stick or cardstock, etc) is used, zip-line activity may be limited.

- Cut off the handle of toothbrushes using heavy-duty shears. File off to smooth rough edges 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 as many groups as you have.
- Fold pipe-cleaners into wings/coil for stripes (see pics →)

