HONEY BEE COMMUNICATION: DANCE LANGUAGE

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**Honey Bee Communication: Dance Language**

See [www.beeslouise.org](http://www.beeslouise.org) for more bee lessons!

**Target Audience**
Grades 4th through 8th

**Number of Class Periods to Complete Lesson**
1-2 class periods (60-120 minutes) to introduce topic, complete craft and carry out activities.

**Overview**
Honey bees are highly social insects with colonies comprised of thousands of individuals, each bee with specific tasks to carry out. As a whole, the activities of these individuals must be coordinated. Honey bees use pheromones and the dance language to communicate various messages including queen health, danger and the location of food resources. This highly social insect is an excellent model for biological studies of behavior. Additionally, our food supply greatly relies on this insect. One third of the food we eat is the product of insect pollination. Understanding the biology and behavior of the honey bee offers insight into an animal that impacts our every day life.

This 1-2 period lesson will discuss the biology of honey bees as social insects and the methods by which they communicate with one another. Students will have the opportunity to utilize the same navigation methods used by honey bees as well as the cooperation exhibited by a hive. Additionally, students will be introduced to the honey bee life cycle, adult anatomy, honey bee castes, the importance of insects to pollination and the significance of honey bee declines.

**Learning Objectives**
Each student will construct a *Nectar Navigator* and learn how to communicate using the waggle dance. Students will then use the waggle dance and work together in a group to communicate the location of an object. As a result of carrying out this activity, students will develop:

- An understanding of the classification, anatomy and life cycle of the honey bee
- An understanding of honey bee castes and worker bee duties
- An understanding of the relationship between honey bees, pollination and our food
- An understanding of the communication methods used by the honey bee
- An understanding of the dance language of honey bees
- Knowledge, skills and abilities required to work with a group

**National Science Education Standards** from [www.nap.edu](http://www.nap.edu)

- Form and function

**Life Science Standards**

- Characteristics of organisms (Levels K-4)
- Life cycles of organisms (Levels K-4)
- Organisms and environments (Levels K-4)
• Regulation and behavior (Levels 5-8)
• Structure and function in living systems (Levels 5-8)
• Diversity and adaptations of organisms (Levels 5-8)

Science in Personal and Social Perspectives Standards
• Changes in environments (Levels K-4)
• Populations, resources, and environments (Levels 5-8)

Materials Needed
1 Nectar Navigator worksheet per student (from beeslouis.org)
1 Metal page fastener per Nectar Navigator
Scissors
Colored pencils, markers or crayons

Background Information about the Honey Bee and Its Communication

Classification. Honey bees belong to phylum Arthropoda because they are invertebrates (backbone absent) with an exoskeleton, jointed legs and a segmented body. Honey bees belong to class Insecta because they have 6 jointed legs, a 3-segmented body (head, thorax and abdomen), 2 compound eyes and 2 antennae. Bees belong to the same order as wasps and ants, order Hymenoptera

Kingdom Animalia
Phylum Arthropoda
Class Insecta
Order Hymenoptera (Bees, wasps, and ants)
Family Apidae (Carpenter bees, bumblebees, sweat bees, etc.)
Genus Apis (Honey bees, 7 species)
Species mellifera (“honey-bearing”)

Bee life cycle. Bees exhibit complete metamorphosis. They begin their life cycle as a tiny white egg. This hatches into a white, worm-like larva. After feeding on pollen and nectar for several days, the larva develops into a pupa within a cocoon. Finally, a winged adult emerges. In a honey bee hive, only the Queen lays eggs. The rest of the females are workers, carrying out the many tasks of an active hive.

Bee anatomy. The bee has three body regions, as do all insects.

1. The head: this segment aids in sensing the environment and feeding. It has two large compound eyes, three small simple eyes called ocelli, two segmented antennae and a mouth with several appendages such as mandibles and a glossa (tongue).
2. The thorax: this middle segment of the body aids in locomotion. It has six legs, four wings and it contains the muscles required for flight and leg movements.
3. The abdomen: this posterior segment of the body aids in reproduction and defense. It contains the reproductive organs and, in female bees only, a stinger at the very tip.

The hive and its members. Honey bees are social insects in which the young are cared for communally. A colony can contain 80 thousand or more individuals. Hives are perennial and may remain intact for several years. Each winter, most of the bees die off. A small cluster of
worker bees and the queen survive through the winter by huddling for warmth and eating the honey they produced the previous season. Once flowers, and thus food, return in the spring, the hive’s population will grow rapidly. There are 3 castes, or groups, in a honey bee colony, each with a specific role and distinct appearance:

1. Queen: Female. Under normal circumstances, there is 1 queen per hive. She is larger than the other bees, having a very long abdomen. She can live several years. The queen directs all hive activities, communicating with pheromones. Her most important function is laying eggs: 1,500-2,000 per day during the warmer months of the year.

2. Drone: Male. Drones comprise a small portion of the overall population. They are larger than worker bees, have very large eyes and do not have a stinger (they cannot sting!). Drones mate with new queens and die after doing so.

3. Worker: Female. There can be up to 80,000 or more worker bees in a hive. They are the smallest but most commonly seen bees. Workers are responsible for carrying out all tasks of the hive such as cleaning, brood care, foraging for pollen and nectar and building wax comb. Workers do not mate or lay eggs. During the summer months, they live for only 4 to 6 weeks (literally working themselves to death).

**Worker bee duties.** As a worker bee gets older, she graduates through the following roles: housekeeper (cleaning comb), nursemaid (caring for young), construction worker (building honeycomb), grocer (receive, store and care for nectar from foragers), pollen packer (tightly pack pollen balls left in cells by foragers), undertaker (removing dead bees from hive), royal attendant (feeding, grooming, caring for queen), guard (protecting hive from intruders, pests and sick bees) and forager (collecting pollen, nectar or resin).

**Honey bees and flowering plants.** Honey bees and flowering plants have a long evolutionary history. Their coevolution has resulted in a mutualistic relationship in which both organisms benefit from and depend on one another. Honey bees are excellent and efficient pollinators! Pollination is the transfer of pollen from one flower to another and is how many flowering plants produce seeds. The hairs covering a honey bee’s body (and even eyes!) have an electrostatic charge that attracts pollen and lets it stick to the body. Honey bees tend to visit the same types of flowers, ensuring pollen is passed between the same plant species. Foraging honey bees pack pollen into small balls and store them in a pollen basket on the hind legs. Pollen is a protein-rich food source used to feed the hive’s developing larvae. Nectar is a sugary liquid produced by flowers as a reward for visiting. The liquid is siphoned by a honey bee using its straw-like glossa (tongue).

**Honey bee communication.** Honey bees have two basic communication methods. The first is the use of pheromones, or chemical scents, used to mark the hive or a new home, to communicate danger, etc. The second method is the use of ‘dances’ as a means of communicating the location of nectar, pollen, water, a new home, etc. When it comes to food, honey bee foragers can communicate the direction, distance, and species of the plant, even though the world is full of flowers. The round dance and waggle dance are the two most important dances used by honey bees. It is important to note that the inside of a hive is very dark. Honey bees use touch to help them feel, rather than see, the dances. Honey bees also rely heavily on smell to communicate with one another. A honey bee’s olfactory organs (the “nose”) are located in the antennae. Using their antennae, workers in a hive can smell the scent of a
flower on a returning forager and use this information to locate the flower. The returning forager may even offer a sample of nectar from the flower.

**The round (circle) dance.** When a foraging worker bee finds food that is close to the hive (160 to 330 feet), she returns to her colony and excitedly moves (dances) in circles. This behavior is called the round dance. It lets other foragers know that if they exit the hive and continue to fly in a circular path, spiraling away from the hive, they will eventually, and quickly, find the food source.

**The waggle (wagtail) dance.** When a foraging worker bee finds food that is far from the hive (more than 330 feet), she must use the more complex, figure-8 shaped waggle dance to communicate the direction and distance of the food source. The outer loops are simply walked. The bee waggles where the dance path line is curvy. When a bee waggles, she rapidly shakes her abdomen side to side. The waggle contains a lot of information. *Distance* is conveyed by the speed of the waggle dance. If the dance is fast, then the food source is not very far. However, the slower the dance, the further away the food source. Keep in mind that honey bees will fly a few miles to reach a food source. *Direction* is conveyed in relation to the sun. Remember, the inside of a hive is dark and bees are carrying out their dances on the wax comb, which is perpendicular to the ground. So gravity is an important force used to communicate the direction of a food source. Dancing straight upwards on the comb, *against* gravity, is equivalent to flying towards the sun (see example 1 below). Dancing straight downwards, *with* gravity, communicates that the food source is in the opposite direction of the sun (see example 2 below). If a bee finds flowers that are in the direction of the sun, she will: 1) waggle while moving straight upwards, 2) stop waggling and walk in a circle to the right, 3) waggle again while moving straight upwards, and 4) stop waggling and walk in a circle to the left. She will continue this until other bees pay attention. Bees can convey more than “in the direction of” the sun. For example, if a food source is 20 degrees to the right of the sun, the bee will waggle in the upward direction but 20 degrees to the right. Use the Waggle Dance Worksheet below to help student work through the details of the waggle dance (see example 3 below). Treat it like a secret language, with a key to decode it!
Waggle Dance: Example 1

Waggle Dance: Example 2

Waggle Dance: Example 3

Round Dance
**KWL Strategy:** What I **K**now, what I **W**ant to learn and what I did **L**earn

The KWL strategy is a great way of getting students oriented to the lesson, forming individual goals within the group and recapping the lesson. It may be helpful to use a chalkboard or white board to make 3 columns for each component to gather and organize questions and ideas.

- The **K** component serves the purpose of brainstorming. Have the students work as a group (or individually followed by sharing) to drum up what they already know about bees and how they communicate. Questions listed below can be used to guide students through this process.
- The **W** component questions provide the students with lesson goals. They can also give each student the opportunity to come up with their own inquiries and concentrate on something they are curious about. Students can write these questions down and find the answers before, during or after the lesson.
- The **L** component questions help the students synthesize the lesson and the information covered. Questions may be completed in writing or discussed as a group.

**K Component Questions:**
- What comes to mind when you think of bees?
- What is a honey bee?
- Why are honey bees important?
- Where do honey bees live?
- What kinds of honey bees are there in a hive?
- What do honey bees eat?
- How do honey bees communicate with one another?
- What tasks do worker bees have?
- Can all honey bees sting?
- What happens to a honey bee after it stings?
- What are the stages of metamorphosis in bees?

**W Component Questions:**
- What does a worker bee do?
- How does a worker bee communicate the location of a nearby food source?
- How does a honey bees communicate the location of a distant food source?

**L Component Questions:**
- What method of communication was explored in today’s activity?
- What dance is used when a food source is near by?
- What are some jobs of worker bees?
- What advantage is there to living in a hive?
- What is a disadvantage of living in a hive?
- What challenges and/or threats do honey bees face?

**T-Chart**

The T-Chart is a simple pre-assessment method to determine what information students already know about bees, and whether it is factual or biased. This method asks two questions to the class and encourages group discussion. Answers can be pooled in two columns on a blackboard.
An example for this lesson is *What do you know about bees and how they communicate?* and *What questions do you have about bees and how they communicate?*

If any incorrect ideas are presented while answering *What do you know about bees and how they communicate?*, write them down anyway and revisit them at a later time. Let students go back over the Column 1 list and determine if the ‘facts’ are correct.

### Making the Nectar Navigator

The *Nectar Navigator* uses two dials to help communicate where a food source is. It is recommended that each student make their own.

1. Color in the *Nectar Navigator* with markers, crayons or colored pencils.
2. Carefully cut out each circle dial (2 total) with scissors.
3. Place the smaller cut out, face up, on top of the larger cut out (see below).
4. Push a metal page fastener through the center of both pieces.
5. You’re ready to navigate!

### Warm Up and Round Dance

**Level: Easy**

Have students start with this warm up to break the ice and get them moving.

1. Pick a direction and have the students practice waggling (shake their abdomens!) while moving around. This is an extremely important part of the waggle dance.
2. Have students practice doing a Round Dance. Remind them that this dance is used when a food source is near to the hive.

### The Waggle Dance

**Level: Moderate**

*Note: People cannot move upwards against gravity! So explain that students can face the entrance of their hive instead of moving upwards, thus:*

- Dancing towards entrance = dancing upwards in a hive = “fly towards the sun”
- Dancing away from entrance = dancing downwards in hive = “fly away from the sun”

The waggle dance is a bit more complex. It is left to the instructor’s discretion as to what level to take their students. Work through these steps as a group before continuing on to “The Foraging Game.”

1. Designate an area to be the hive and an area to be the entrance. The entrance can be marked with tape or other objects if needed.
2. Designate an object to be the sun and another object to be a food source. Two students may be designated to play these roles.

3. Place the sun far away from and in front of the entrance. Place the food source in between the entrance and the sun.

4. To warm up, have students do the waggle dance together, waggling in the direction of the food source. They should be waggling towards the hive entrance.

5. Split the class into two groups: the Foragers and the Finders. Finders will remain inside the hive. Foragers will leave the hive.

6. Move the flowers to the right of the sun at the 2 o’clock position. You may have the students do the waggle dance towards the flowers now.

7. Have the Foragers step out of the hive, take out nectar navigators and do the following:
   a. Point the sun logo towards the sun.
   b. Holding the nectar navigator in this orientation, students should turn the upper dial to the right until the arrow points at the food source.

8. The Foragers can now return to and enter their hive. They should point the sun on their Navigator at the entrance and then waggle in the direction of the arrow (waggle to the right towards the 2 o’clock direction).

9. Finders should have their Nectar Navigators ready, and use the dance to figure out how their Navigators should look. They should point the sun of their Navigator at the entrance. Holding the navigator in this orientation, they should turn the upper dial to the right until it is pointing in the direction that the Foragers are waggling.

10. Once Finders have oriented their Nectar Navigators, they can exit the hive. They should line the sun on their Nectar Navigator with the object designated as the sun in the room. Once they do this, the arrow on their navigator will point to the food source.

11. Move the food source to a different location, (ex. 10 o’clock position). Have students switch roles (Foragers are now Finders and vice versa) and try again.

The Foraging Game

Level: Difficult

This role-playing game will challenge the students and will get them to use the Nectar Navigator to communicate the location of a good food source. Challenge them to a no-talking rule. This activity can be done indoors or outdoors (where more room may be available).

1. Designate one student as the sun, two to three students as flowers, one as a foraging worker bee and the rest as the hive workers.

2. Change the placement of the hive’s entrance so that it is not in line with the sun.

3. Place ‘flowers’ at the 10 o’clock, 12 o’clock and 2 o’clock positions.

4. Place the ‘sun’ somewhere between the flower groups

5. Have the Forager secretly pick one of the flowers. They should visit each source before deciding. Then they should let each flower know whether or not they have chosen them—but the rest of the hive cannot know!

6. The Forager must determine the orientation of their waggle dance. Help them if needed.

7. The Forager should return to and enter the hive and prepare to communicate to (DANCE!) the rest of the bees where the food is.

8. Using their Nectar Navigator, the Forager should waggle in the direction of the food source.
9. The rest of the hive should point the sun on their Nectar Navigator towards the hive’s entrance and turn the upper dial in the direction that the Forager is dancing. They now know the direction that the food is!

10. The hive bees should exit the hive and point the sun on their Nectar Navigator at the sun in the room. Once they do this, the upper dial should be pointing at the correct food source.

11. Hive bees can go to the flower and determine if if they have found the right flower.

### The Foraging Competition

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<th>The Foraging Competition</th>
<th>Level: Difficult and Competitive</th>
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| This version of the Foraging Game requires that the class be split into two or more competing “Hives”, each with Worker bees and a Forager. Each hive should come up with its own name.  
1. Determine which flowers are going to be the food source for each hive. The flowers can know, but the hives cannot!  
2. Worker bees of each hive must turn away from the food sources.  
3. Foragers of each hive can then exit their hive and visit each flower to quietly determine which food source belongs to their hive. No talking!  
4. Foragers must then determine the orientation of their waggle dance using their Nectar Navigator and the sun’s location.  
5. Foragers must return to their hive and properly carry out the waggle dance. No talking!  
6. Worker bees must follow the dance to determine interpret the Forager’s message.  
7. The first hive to have worker bees figure out which flower source is theirs, WINS! |

### Student Assessment and Worksheet Answer Keys

Assessments have been designed to meet the National Science Assessment Standards. It is left to the instructor’s discretion which of these techniques to use and how to weigh them as part of a total assessment. The following assessments have been provided below, followed by answer keys, where appropriate:

- Vocab. Review: 3 different crossword puzzles; in student packet (pp. 2-4), answers below
- Essays: 7 essay questions to choose from; provided in student packet (p. 5)
- Quiz: 3 multi-point questions; provided in student packet (p 6), answers below
- L component questions: use for writing or discussion purposes.
Crossword Puzzle Answer Key
Level: Easy and Moderate

Level: Difficult

Honey Bee Communication
Quiz Answer Key

Directions: Read and answer each question carefully.

1. Circle the names of the honey bee castes:
   - Regent
   - Queen
   - Drone
   - Abdomen
   - Thorax
   - Worker
   - Pupa

2. Below, write the stages of the honey bee in order.
   - Egg ▶ Larva ▶ Pupa ▶ Adult

3. You are a bee working in your hive. A forager returns and does the waggle dance, *slowly* waggling downwards and to the left (7 o’clock position). Answer the questions below about her dance.

   a) She is dancing the waggle dance. What does this communicate about the distance of the food source (ie. why isn’t she using the round dance)?

   The round dance is used for food sources that are close to the hive. Thus this food source is far away.

   b) She is dancing *slowly*. What does this communicate about the distance of the food source?

   The speed of the dance helps convey the distance of the food source. The slower the dance, the further away the food source is. Thus this food source is very far.

   c) Draw the path of her waggle dance below. Be sure to draw the sun and a flower.

Vocabulary

Abdomen: the last (hind) body segment of an insect.
Antenna (antennae, plural): a sensory appendage of the head used for taste, smell and hearing.
Caste: a structurally distinct group within a species, having a specific task(s). There are 3 castes in the honey bee species: queen, worker, drone.
Coevolution: the joint evolution of two or more species in which their behavior and/or anatomy changes to benefit one another.
Complete metamorphosis: a four stage life cycle seen in most insects, including bees, in which the larvae have a radically different appearance from adults. Larvae enter a non-feeding pupal stage during which metamorphosis occurs and adult characteristics (such as wings) are developed.
Corbicula (corbiculae, plural): a pollen basket made of long coarse hairs located on the hind legs of a bee; stores pollen during flight.
Defensive behavior: a behavior used to avoid predation or harm.
Drone: a male bee.
Egg: the first, white, oval-shaped stage in the bee life cycle.
Exoskeleton: the hard, outer covering of insects; an external skeleton.
Glossa: the tongue of a bee; used to siphon liquids.
Larva (larvae, plural): the second, worm-like stage of the bee life cycle.
Metamorphosis: the structural changes that occur through a bee’s developmental stages.
Mutualism: a coevolutionary relationship in which interactions between two organisms are mutually beneficial.
Nectar: a sugary, liquid produced by flowers.
Ocellus (ocelli, plural): simple eye that is light-sensitive; bees have three such eyes.
Pheromone: a chemical produced by bees to communicate with one another.
Pollen basket: the pollen collecting structure of bees made of stiff hairs.
Pollination: the transfer of pollen between plants.
Pupa: the third, non-feeding stage of the bee life cycle.
Queen: the only egg-laying female bee in a hive that directs all hive activities.
Round dance: a dance used by honey bees to communicate the location of a nearby food resource.
Thorax: the middle body section of an insect where wings and legs are attached.
Waggle dance: a dance used by honey bees to communicate the location of a distant food resource in relation to the sun.
Worker: a female bee in a honey bee colony that carries out many duties including foraging & cleaning.

References & Further Reading


