NYC Companion Lesson

Reading About Non-Touching Forces

Overview

Building on students' hands-on investigation of magnetic and electrostatic forces in the previous lesson, this set of three articles introduces the concept of fields as it relates to non-touching forces. Each article features a non-touching force and an organism: "Magnetic Force and Rainbow Trout," "Gravity and Bats," and "Electrostatic Force and Bees." Following the Active Reading approach, students first read and annotate one of the articles on their own, then they discuss their annotations with a partner. Groups of three then use the jigsaw technique to share, so each student hears about all three articles. Students deepen their understanding of fields by revisiting one part of the article they read and making a connection to their observations from the hands-on investigation. The purpose of this lesson is for students to learn that forces can exist between objects even though they are not touching, and these forces can be explained by fields.

Recommended Placement: *Harnessing Human Energy*, after Lesson 3.3 and after New York City Companion Lesson: Investigating Non-Touching Forces
Suggested Time Frame: 60 minutes (first and second reads can be spread across two class periods)

NYS P–12 Science Learning Standards

Performance Expectations

- **MS-PS2-3:** Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.
- **MS-PS2-5:** Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

Disciplinary Core Ideas	• **PS2.B: Types of Interactions:**
	  ° Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. (MS-PS2-3)
	  ° Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively). (MS-PS2-5)

Science and Engineering Practices	• **Practice 1:** Asking Questions • **Practice 8:** Obtaining, Evaluating, and Communicating Information
Crosscutting Concepts	• Systems and System Models • Cause and Effect

Vocabulary

- electrostatic force
- field
- force
- gravity
- magnetic force

Materials & Preparation

Materials

For the Class

- Reading About Non-Touching Forces copymaster
- Annotation Tracker
- 1 large index card*
- marker*

For Each Student

- Student Edition:
  - Magnetic Force and Rainbow Trout" article
  - "Gravity and Bats" article
  - "Electrostatic Force and Bees" article
- student sheets*
  - Reading About Non-Touching Forces

Materials (continued)

- Second Read of "Magnetic Force and Rainbow Trout," "Gravity and Bats," or "Electrostatic Force and Bees"

*teacher provided

Preparation

1. **Print Reading About Non-Touching Forces copymaster.** Locate the Reading About Non-Touching Forces copymaster on the New York City Resources webpage: www.amplify.com/amplify-science-new-york-city-resources. Make one copy of all pages for each student.
2. **Create and post vocabulary card on the classroom wall.** With a marker, write "field" in large print on a large index card. Post this card on the classroom wall.
3. **Prepare for Active Reading.** Before class, read through all three articles as preparation for modeling Active Reading. You will model one aspect of Active Reading for each article:
   - **Connecting.** Make a connection to the previous lesson's hands-on investigation with "Magnetic Force and Rainbow Trout."
   - **Asking questions.** Ask a relevant question with "Gravity and Bats."
   - **Attending to visual representations.** Use the diagram of electrostatic fields in "Electrostatic Force and Bees" to model asking a question or making a connection.

   For a full description of preparing for an Active Reading day, see *Harnessing Human Energy* Lesson 1.4, Lesson Brief, Preparation.
   Note: In order to achieve the full benefit of Active Reading, it is highly recommended that students use sticky notes to annotate the Student Editions directly.
4. **Print one copy of the Annotation Tracker for each class.** A blank copy is available in your digital teacher's guide in *Harnessing Human Energy* Lesson 1.4, Lesson Brief, Digital Resources. If you plan to use the Annotation Summary Sheet to track students' annotations or wish to review the Annotation Tracker Instructions, these are also available in Lesson 1.4, Digital Resources.
5. **Make sure the Active Reading Guidelines are clearly visible.** If they are not posted on your classroom wall, write them on the board before class. (See Active Reading Guidelines on the Reading About Non-Touching Forces student sheet.)

6. **Plan to model Active Reading.** To model the Active Reading approach, you will need to have students follow along as you read aloud the title and first few sentences of each article. If you have a document camera in your classroom, consider projecting and annotating the article as you read aloud. Alternatively, you can project the articles from the PDF available on the New York City Resources webpage.
7. **Prepare for On-the-Fly Assessment.** The second read section of this lesson provides an opportunity to informally assess students' understanding of fields and non-touching forces. Refer to the On-the-Fly Assessment in the Assessment section of this lesson for details about what to look for and how you can use the information to maximize learning by all students.
8. **Immediately before the lesson, have on hand the following materials:**
   - "Magnetic Force and Rainbow Trout" article
   - "Gravity and Bats" article
   - "Electrostatic Force and Bees" article
   - student sheets
   - Annotation Trackers

Science Background

Magnetic force, electrostatic force, and gravity are all non-touching forces—forces that act between objects, even when the objects are not touching. All three forces decrease in strength as distance between objects increases. The magnetic and electrostatic forces may be attracting or repelling, but the force of gravity is only attracting, never repelling. Magnetic force occurs between a magnet and other magnets or objects made of certain metals, electrostatic force occurs between objects with an electric charge, and the force of gravity occurs between all objects. Magnets may be of different strengths and stronger magnets exert stronger forces. Objects may have more or less charge, and those with more charge exert stronger electrostatic forces. Objects with more mass exert a stronger gravitational force. The force of gravity exists between any two objects, but on (or near) the surface of Earth, we only observe the effects of gravity between Earth and other objects. This is because Earth is so much more massive than any other object on the surface of our planet. No object on Earth has enough mass to exert a force of gravity that can be observed. For example, there is a force of gravity between a car

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and a house, but the force is much too small to affect the car or the house. Every force acts between two objects and affects both objects; however, the more massive an object is, the less it is affected by a given force. You can see this if you think about the force of gravity acting between Earth and a falling rock. An equal force is exerted on Earth and the rock, but since Earth is vastly more massive than the rock, Earth does not move, while the rock does.

A field is an area in which a non-touching force (magnetic force, gravity, or electrostatic force) acts on objects. It would be more accurate to say that there is only one magnetic field, only one gravitational field, and only one electrostatic field in the universe, since there is no limit to the distance at which these forces can be exerted. However, because the strength of each force diminishes with distance, it is easier to speak of fields as if they are distinct systems centered around a particular object or set of objects. For example, scientists often refer to Earth's gravitational field. Scientists make field maps in order to create models of these forces. A model of a field may show information about the strength and/or direction of forces at different locations in the field.

Many organisms are adapted to make use of and/or overcome these non-touching forces. Many organisms, including trout, some birds, bats, and insects, sense magnetic forces in order to navigate. Bees use electrostatic force to collect pollen. Some organisms, including bees, sharks, platypuses, and some fish sense electrostatic force as a way to locate objects around them, such as food sources. Many animals must counteract the force of gravity as they fly, jump, climb, or hang. Some have specialized body parts that detect the direction of gravity. This can aid balance (a human's inner ear) or help with underwater orientation (statocysts in jellies).

Instructional Guide

First Read of "Magnetic Force and Rainbow Trout," "Gravity and Bats," or "Electrostatic Force and Bees"

1. **Introduce the articles and make a connection to students' background knowledge.**

   We conducted investigations of magnetic and electrostatic forces—two non-touching forces. Today, you will select and read one article from a set of three—each is about one of the non-touching forces, the two you investigated and another non-touching force, gravity.

   Have students locate the three articles in their Student Editions: "Magnetic Force and Rainbow Trout," "Gravity and Bats," and "Electrostatic Force and Bees."

2. **Review the vocabulary word *force*.**

   Remember that a force is a push or a pull that can change the motion of an object. The forces you will read about—magnetic force, electrostatic force, and gravity—are all non-touching forces.

   Remind students that they can also find the definition in the glossary at the back of their Student Editions.

3. **Assign articles.** Within each group of three, assign each student one article in the set, or have groups of three decide among themselves who will read which article. Let students know that after they read, they will each be responsible for sharing a short summary of their article with the other group members.

4. **Model Active Reading.**

   - **"Magnetic Force and Rainbow Trout."** Read the title and first paragraph of "Magnetic Force and Rainbow Trout" aloud. Model the Active Reading process by making a connection to the investigation in the previous Companion Lesson: Investigating Non-Touching Forces.
   - **"Gravity and Bats."** Read the title and first paragraph of "Gravity and Bats" aloud. Model the Active Reading process by asking a question.
   - **"Electrostatic Force and Bees."** Read the title of "Electrostatic Force and Bees" and point out the electrostatic field diagram. Model asking a question or making a connection that is related to the diagram.

5. **Review Active Reading Guidelines.** Before students begin reading, point out the Active Reading Guidelines on the classroom wall.

6. **Distribute the Reading About Non-Touching Forces student sheets.**

7. **Prompt students to read and annotate independently.** Redirect students to their assigned articles. Circulate as students read, providing support as needed.
8. **Review the process for discussing annotations.** When most students have finished reading and annotating, explain that students will choose one or two annotations to share with a partner who read the same article. They should select questions or connections that they find interesting or those that will help them better understand what they read.
9. **Provide a moment for students to select the annotations that they will share with their partners.**
10. **Pair students who read the same article.** Make sure each student has a partner (or group of three) who read the same article.
11. **Prompt partners to discuss annotations.** Circulate as pairs discuss, using the Annotation Tracker and listening for questions and connections that you would like to invite students to share during the class discussion.
12. **Prompt students to prepare to rejoin their original groups.** Ask them to choose an interesting or unanswered question or connection that they would like to share with the class. Explain that they can discuss the same annotations that they just shared if the questions are still unresolved. Remind students that they will also be sharing a short (one or two sentence) summary of the article in their groups, so everyone knows a little about all three articles.
13. **Groups of three that read different articles discuss.** Have students return to their original groups of three. Have each student take a turn and briefly describe what they read about and share one of their annotations.
14. **Facilitate a brief class discussion about annotations.** Invite students to share their questions and connections. Encourage students to respond to one another and to look back at the article in order to answer their peers' questions.
15. **Highlight exemplary or noteworthy annotations.** Refer to your Annotation Tracker and invite students to share those annotations you noted. Provide specific positive feedback as students share, noting when annotations show evidence of Active Reading. Examples might include annotations that make a connection to science ideas, use vocabulary from the unit, or instances in which students were able to answer their own questions.

Second Read of "Magnetic Force and Rainbow Trout," "Gravity and Bats," or "Electrostatic Force and Bees"

16. **Set purpose for rereading.** Explain that students will share expertise about the non-touching force they read about within their groups. Together, they should figure out what the force they read about has in common with the other two forces that the other group members read about.
17. **Direct groups to complete Part 1 of the Second Read of "Magnetic Force and Rainbow Trout," "Gravity and Bats," or "Electrostatic Force and Bees" student sheets.** Students should first reread and highlight on their own, then groups should discuss and agree on the answers that each student will record.
18. **Lead a brief class discussion about Part 1.** Ask students to share information that they found. Highlight responses that refer to fields.
19. **Introduce the vocabulary word *field*.**

    When you hear the word *field*, you might think of a large grassy area or a field for playing sports, but you read about a different kind of field.

    In each article, you read about one type of field: magnetic field, electrostatic field, and gravitational field.

    For any type of non-touching force, a field is the space around an object in which that object can exert a force.

    Point out that the vocabulary word is posted on the classroom wall. Students can also find the definition of the word *field* in the glossary at the back of their Student Editions.
20. **Connect article diagrams to fields and scientific models.** Remind students that each article contained a diagram of a type of field.

    Scientists make diagrams as models of a field. These models can give information about the strength or direction of forces in the field.
21. **Direct students to complete Part 2.** Have students work independently to complete the questions in Part 2 of Second Read of "Magnetic Force and Rainbow Trout," "Gravity and Bats," or "Electrostatic Force and Bees."
22. **On-the-Fly Assessment: Students' Understanding of Fields.** For further suggestions on how to support students' understanding of fields and non-touching forces, refer to the On-the-Fly Assessment in the Assessment section of this lesson.
23. **Lead a brief class discussion.** Ask students to share their ideas about fields and non-touching forces.

On-the-Fly Assessment: Students' Understanding of Fields

Look for:

Students should be building the understanding that forces that act at a distance can be explained by fields that extend through space and that these fields can be mapped by their effect on a test object. In students' responses to the questions in Part 2 of Second Read of "Magnetic Force and Rainbow Trout," "Gravity and Bats," or "Electrostatic Force and Bees," students should describe that when they were investigating the different objects in the previous lesson, there was a field around the magnets and a field around the balloon. Also, look for students to explain that if a magnetic force makes magnetic objects move near Jupiter's moon, it would show that a magnetic field is present.

Now what?

If students aren't showing an understanding of forces and fields, remind students of their investigations with magnetic and electrostatic forces in the previous New York City Companion Lesson: Investigating Non-Touching Forces. Bring out the materials from the previous lesson and talk through the investigations. Ask the following questions:

- What happens when you hold a magnet near something magnetic? Can the magnet still attract it even if they're not touching? How can the concept of fields help you explain that?
- What happens when you give a balloon a charge with cloth and hold it near a foam peanut? Can the balloon still attract it even if they're not touching? How can the concepts of fields help you explain that?
- What happens when you lift an object up and then release it? Which way does it go? Does it always go that way? How can the concept of fields help you explain that?

Possible Student Responses

Reading About Non-Touching Forces

1. Read and annotate one of the three articles: "Magnetic Force and Rainbow Trout," "Gravity and Bats," or "Electrostatic Force and Bees."
2. Choose and mark annotations to discuss with your partner. Once you have discussed these annotations, mark them as discussed.
3. Now, choose and mark a question or connection, either one you already discussed or a different one that you would like to discuss with the class.
4. Answer the reflection question below.

Rate how successful you were at using Active Reading skills by responding to the following statement:

As I read, I paid attention to my own understanding and recorded my thoughts and questions.

- ☐ Never
- ☐ Almost never
- ☐ Sometimes
- ☐ Frequently/often
- ☐ All the time

Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

Second Read of "Magnetic Force and Rainbow Trout," "Gravity and Bats," or "Electrostatic Force and Bees"

Part 1

Reread paragraph 2 of the article you just read. Then describe what you read to each of your group members. As a group, decide which information to highlight. You're looking for information that helps you understand what the force you read about has in common with the other two non-touching forces that your group members read about. This information will help you answer the questions in Part 2.

What do gravity, electrostatic force, and magnetic force have in common?

All three forces act without objects touching. They all get weaker as the objects get farther apart. All these forces happen where there is a field.

Possible Student Responses

Second Read of "Magnetic Force and Rainbow Trout," "Gravity and Bats," or "Electrostatic Force and Bees" (continued)

Part 2

1. Think back to the investigations you did in class about non-touching forces. What new information from the article can you use to explain one of the investigations?

We investigated forces between magnets that weren't touching and between charged objects (a balloon and foam packing peanuts) that weren't touching. I also read about a force between objects that aren't touching, and the area where these forces act is called a field. There must have been a field around the magnets that we investigated and around the balloon.

2. A space scientist wants to figure out if a magnetic field is present on one of Jupiter's moons. What could she do to gather evidence about this question?

She could send magnetic objects to the moon and see if magnetic forces make the objects move.