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Tip-to-Tail: Developing a Conceptual Model of Magnetism with Kindergartners Using Inquiry-Based Instruction

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Abstract

This study reports changes in kindergarten students' understanding of magnets after participating in a series of hands-on, inquiry-based lessons. The lessons focused on the dipole nature of magnets and employed a visual representation of a magnet as an arrow for the kindergarten students. This dipole model was used to describe how magnets interact with each other and how they interact with steel objects (i.e., magnetization). Many students adopted this dipole model of magnets and were able to use it to describe how multiple magnets would interact and how magnetized paperclips would interact with magnets and with each other.

Introduction/Background

Learning about magnetism is an important component of a physical science education. Magnetism concepts are clearly described in *Science for All Americans* as valuable for adults to have mastered (AAAS, 1989). According to the National Science Education Standards (NSES), magnetism is a key concept for K-4 grade children, and concepts such as, "Magnets attract and repel each other and certain kinds of other materials," are suggested (NRC, 1996, p. 127). NSES states that young children begin their study of matter by. . . .

> examining and qualitatively describing objects and their behavior. . . . When carefully observed, described, and measured, the properties of objects, changes in properties over time, and the changes that occur when materials interact provide the necessary precursors to the later introduction of more abstract ideas in the upper grades. (NRC, p. 126)

While there is much research on the appropriate level of instruction in magnetism for the upper grades as the NSES suggest above (Brook & Driver, 1984; Brook & Wells, 1988; Driver, Guesne, Tiberghien, 1985; Soloman, 1983, 1985), there is little research as to the type of magnetism content appropriate for the youngest of our K-12 students and how these students develop an understanding of magnetism. In sum, "Magnetism is a phenomenon that attracts people of all ages. Surprisingly, we know less about peoples' conceptions of magnetism than we do about other physical phenomena" (Hickey & Schibeci, 1999, p. 383).

This study explores this issue by examining how lessons that provided kindergarten students with a range of experiences helped the students develop a functional conception of magnetism—in particular how magnets interact with each other and how they interact with steel objects. The lessons were based on a conceptual model of a magnet as an arrow that is directed from the south pole to the north pole of the magnet. We adopted this arrow model for both pedagogical and scientific reasons. First, we felt that an arrow was a more compelling visual model to students than north and south poles, which carry no meaning outside the context of the Earth's magnetic field. For the students, an arrow is an easier picture to grasp and manipulate than two arbitrary letters of the alphabet. In addition, the arrow model fits well with the appearance of many compass needles, which are often shaped as arrows with their tips at the north pole. An arrow model is also closely aligned with the scientific understanding of a magnet as a magnetic dipole, which is often depicted using an arrow in physics textbooks.

The key scientific ideas embodied in the lessons were as follows:

- Magnets can be modeled as arrows (the N pole is the tip of the arrow; the S pole is the tail).
- Magnets are only "sticky" at the tip and tail (the poles).
- Magnets stick together tip to tail (tips repel each other, tails repel each other).
- Certain metals, such as steel, can be turned into magnets and are then described by arrows, too.

Participants/Methods

Two kindergarten classrooms in a rural/suburban elementary school are the focus of this study. The classroom teachers both have more than 20 years of teaching experience and are well-respected in the community. These teachers have been part of a partnership with the authors for over four years, where the scientist from the university (one of the authors) visited each of the four classes once a week to engage the students with science lessons about a variety of concepts. The kindergarten day was only a half day so that the class sizes were small, approximately 16 students. There were 59 students participating in this study (23 female, 36 male).

Before the lessons, a small random group of students (18) was interviewed individually to gain an overall sense of students' prior knowledge of magnetism. Three additional researchers conducted the interviews using a structured interview protocol (See Appendix). After the lessons, a random group of students (28) was interviewed individually using a post-interview protocol (See Appendix) that expanded upon the pre-interview protocol. Once this data was collected, the audiotapes were transcribed and analyzed from the grounded theory perspective (Erickson, 1986). Students' responses from before and after the lessons were compared and contrasted. Each of the researchers thoroughly read and noted the students' verbal and written responses. From iterative reading of the responses, conversations, and written work of the students, initial codes for the general underlying pattern were developed and then arranged under broad categories. These categories were used in further readings and coding of data by each of the researchers. Once all parties agreed to the codes and examples of each of the codes, assertions were developed and analyzed.

The following three research questions guided the development of the interview protocols and the lessons:

1. To what extent do the students employ the arrow model in their reasoning?
2. How well can the students apply the "tip-to-tail" rule to interactions between magnets?
3. How well can the students apply the arrow model and "tip-to-tail" rule to the magnetization of steel objects?

Student Ideas About Magnets Before Lessons

Before the lessons, students strongly associated magnets with metal and refrigerators. For example, nearly all students listed metals and refrigerators when asked what magnets stick to. Just over one-third of the students also mentioned other magnets, and a similar number mentioned other metallic objects (e.g., a flagpole, metal legs of a chair, the metal heater in the classroom). Very few students indicated that magnets don't stick to all metals—as one student said, "only sticky metals" (but did not name them) and another student said "not all metals" but didn't know which kinds stick to magnets. No students mentioned iron or steel. In addition, in discussing what happens when a paperclip is brought near a magnet, all the students predicted that the paperclip would stick to the magnet; half said that the paperclip would stick because it is metal; and a few said it would stick because both the paperclip and the magnet are magnets. (Most of the other students did not give reasons why the paperclip would stick.)

Nearly all of the students knew before the lessons that magnets can attract one another ("stick together"), but none of the students demonstrated any consistent rule in determining in what circumstances two or more magnets would attract each other. Several students also knew that magnets could repel but once again did not articulate or demonstrate any rule for when magnets would repel one another. In addition, none of the students in the pre-interviews mentioned *north*, *south*, or *poles* in their discussion of magnets.

Description of Lessons

Six 30-minutes lessons were taught by the scientist to the four kindergarten classes in the middle of the spring semester. The lessons were structured using the 5E learning cycle model (Bybee & Landes, 1988) and employed hands-on activities and class discussions about the activities. The lessons also focused on the science process skills of sorting and peer review. In the Explore phase of most of the lessons, students worked in pairs to sort objects into "yes" and "no" categories. The class discussion in the Explain phase revolved around drawing conclusions from the similarities in the groups' results and resolving differences among groups.

In the first lesson (The Arrow Magnet), students explored what kinds of objects stick to magnets; each group sorted a pile of objects in things that stick ("yes") and things that don't stick ("no") to magnets. At the beginning of the lessons, the students were nearly unanimous in stating that all metal objects stick to magnets. They were surprised that was not the case and learned that only certain metals (such as steel) stick to magnets. The Extend phase for this lesson consisted of determining that even steel objects will only stick to certain places on magnets (e.g., the ends on a bar magnet). At this point, the arrow model was introduced, and students were given the vocabulary of *tip* and *tail* to describe the locations where steel objects stick to a magnet.

In the second lesson (Tip-to-Tail), students explored with bar magnets to discover that magnets stick tip to tail. Each group received a set of colored cards depicting various arrangements of arrows; using bar magnets, the students sorted these cards into ones that showed ways that magnets would stick together ("yes") and ones that showed ways magnets would not stick together ("no"). The class discussion introduced the "tip-to-tail" rule based on the students' observations. The students then learned the first verse of a magnet song that discussed how magnets stick together tip to tail. In the third lesson, the students worked with a different kind of bar magnet ("flat magnets," on which the arrow points along the shortest rather than the longest length of the magnet), and used their knowledge of the tip-to-tail rule to predict which cards showed arrangements of flat magnets that would stick together and which would not. The students tested the arrangements after they made all their predictions. In the fourth lesson (Many Magnets), the students applied the tip-to-tail rule to multiple magnets—from 3 to 20. The students sorted cards showing arrangements of 3 magnets and then used paper arrows to show ways that 4, then 6, then more magnets could stick together. The other students peer-reviewed the arrangements proposed by each student.

The final two lessons explored what happens to a steel object when it is brought near a magnet. The fifth lesson (The Paperclip Magnet) showed how a steel paperclip becomes a magnet when brought near another magnet. In particular, focus was given to how a magnetized paperclip is described by an arrow, too, and that the direction of the arrow is set by the magnet (since the paperclip magnet is attracted to the magnet, they must be sticking tip to tail). In this lesson, and the next lesson (The Tambourine Magnet), the students saw how two magnetized paperclips can attract or repel one another depending on whether they are connected tip to tail. A second verse to the magnet song was introduced that dealt with how a paperclip becomes a magnet when brought near a magnet. In the sixth lesson, the students also started working on a magnet book that summarized concepts about magnets from the lessons and included jokes about magnets.

Results

The post-lesson interviews with the students showed that they embraced the arrow model, and nearly all became proficient in their use of it in determining how or where magnets will stick together. A significant number of students were also able to articulate how steel objects interact with magnets. The results are summarized in the following themes: What Magnets Stick To, Use of Arrow Model of Magnets, What Part of a Magnet Is "Sticky"?, use of "Tip-to-Tail" Rule, and Magnetization: Paperclips Becoming Magnets.

What Magnets Stick To

In the post-interviews, most students (21/28) mentioned steel as a material that was attracted to magnets (nearly all other students just stated "metal" or assorted metallic objects). Over half (17/28) listed steel exclusively or mentioned metals or metallic objects and then specified steel in a follow-up question. The following dialogues illustrate this idea:

I: What does a magnet stick to?
S: Steel.
I: Do they stick to anything else?
S: They stick to refrigerators.
R: What do you think the refrigerator is made of?
S: Steel.
R: Do you know anything else magnets might stick to?
S: They might stick to bikes. (Jackie)

I: What does a magnet stick to?
S: Steel. Paperclips. Refrigerators. Screws.
I: What's a refrigerator made of?
S: Steel, but they're painted white. (Richard)

Note that not only are students adopting the vocabulary of the lesson (*steel*), they are also employing what they learned to characterize objects in their experience (e.g., refrigerators).

Use of Arrow Model of Magnets

In both the pre- and post-interviews, the students were first asked to draw a magnet. In the pre-interviews, students drew rectangles, horseshoes, or decorative refrigerator magnets, but none indicated poles in their diagrams. In the post-interviews, over half of the students showed how they adopted the arrow model by drawing an arrow in their magnet. The remaining students drew rectangle or horseshoe shapes but with no arrow or poles indicated. The following exchanges and student drawings illustrate the kinds of descriptions given by students who drew arrows in their diagrams—first for a bar magnet and then a horseshoe magnet.

I: Can you draw a magnet for me?
S: (See Figure 1.)
I: Can you describe what you drew?
S: It's a magnet. It's a rectangle with an arrow inside. (Timothy)

Figure 1. Timothy's Magnet

I: Can you draw a magnet for me?
S: (See Figure 2.)
I: Can you describe what you drew?
S: A horseshoe magnet.
I: And what's inside?
S: An arrow. Tip and tail. (Zeb)

Figure 2. Zeb's Magnet

Note, the important change in the students' diagrams was the use of the arrow in the drawing, regardless of the shape or size of magnet.

What Part of a Magnet Is "Sticky"?

The arrow model was first introduced to help explain the students' observation that a steel object will only be attracted to two locations on a bar magnet—the poles, or the *tip* and *tail* in the arrow model vocabulary. In the post-interviews, students were asked where things will stick on a magnet. Many of the students interpreted this question to refer to two magnets sticking together; of those students who interpreted the question to mean where steel will stick on a magnet, over half (60%) indicated that (steel) objects will only stick at the tip or tail, and several more students (15%) indicated that objects won't stick everywhere but were vague as to the location(s). The following post-interview exchanges illustrate how two students articulated this idea:

I: Can you tell me what you know about magnets?
S: It sticks to the wall. They only stick to steel. They only stick tip to tail.
I: Will things stick anywhere on the magnet?
S: On the tip or the tail. (Michael)

I: If I gave you a magnet, will things stick anywhere on the magnet?
S: No. Tip and tail.
C: Will it stick anywhere else?
S: No. (Carie)

These quotations demonstrate how the students use the arrow model and its vocabulary of *tip* and *tail* to explain where objects stick to magnets.

Use of Tip-to-Tail Rule

None of the students in the pre-interviews articulated a rule for how magnets stick together or was able to consistently predict how two or more magnets would stick together. It was clear during the teaching of the lessons, however, that the students grasped the tip-to-tail rule, and this was evident in the post-interviews. For example, nearly all of the students in the post-interviews articulated under what conditions two magnets will attract one another, and many of the students (18/28) also articulated under what conditions two magnets will repel one another:

C: What happens if you put a magnet near another magnet?
S: They stick together.

C: Do they always stick together?
S: Yea. Only if you have another magnet.
C: Would they ever push apart?
S: Yea. If you put tip to tip and tail to tail, they won't stick.
C: How do you put them so they'll stick?
S: Tip to tail. (Dena)

I: What happens if you put a magnet near another magnet?
S: It'll stick.
I When will they stick?
S: When they're tip to tail.
I: Will they ever push away?
S: Yea. When tip to tip . . . or when they go tail to tail, too. (Timothy)

Note that these students, like nearly all of the students surveyed, initially focused on the attraction of magnets.

Several questions in the post-interviews (see Appendix) asked the students to do a task or solve a problem using the tip-to-tail rule, and nearly all students correctly answered these questions. The tasks/problems and the summary of results for each is given below:

Arrow Cards (questions 7 and 8): When given two or three cards with arrows on them, every student could correctly orient two cards to show how two magnets would stick together (either as →→ or ↑↓), and all but one student could correctly orient three cards to show how three magnets would stick together.

An example of this is represented in the following dialogue:

I: (Shows two bar magnet arrow cards) Let's pretend that each of these cards is a magnet. Can you show me how these magnets will stick together?
S: Yes. I can show you how all of them will stick together. (Arranges them as →→.)
I: (Shows two flat magnet arrow cards) Now I'm going to show you these two. Can you show me how these two magnets will stick together?
S: (Arranges them as →→.)
I: Very good. (Shows three bar magnet arrow cards) What if you had three magnets? How will these magnets stick together?
S: (Arranges them as →→→.)
I: Why did you position the magnets that way?
S: So they will stick.
I: And they will stick because . . . . ?
S: They're tip to tail all the way to the top.
I: When we did the other ones before, why did you position those that way? Remember when we did these?
S: So they would also stick.
I: And why would they stick?
S: Because they're tail to tip. (Jackie)

Sorting (question 9): Twenty-six (of 28) students correctly sorted four cards showing different arrangements of two or three magnets into "Yes" (the magnets would stick together that way) and "No" (the magnets would not stick together that way). The other two students correctly sorted three of the four cards (each missed one of the three-magnet cards).

An example of this can be seen in the following transcript:

I: (Shows four colored magnet cards and a Yes/No sorting mat) Can you show me how to sort these? Put a "Yes" on the cards that show how magnets stick together, and put a "No" on the cards that show ways magnets won't stick together. [Student sorts the cards into "Yes" and "No" on the sorting mat.] So in the "Yes," we have the orange one and the blue one. In the "No," we have the pink and the purple. So can you tell me why the orange one's in the Yes? [The orange card shows three arrows making a triangle.]
S: Because it's tip to tail, tip to tail, and tip to tail.
I: How about the blue one? [The blue card shows two flat magnets aligned ⇉ , but vertically.]
S: It's tip to tail, tip to tail.
I: Why is the pink one in the "No"? [The pink card shows three bar magnets aligned ↑↑↑.]
S: Because it's tip to tip, tip to tip, tail to tail, tail to tail.
I: What about the purple one? [The purple card shows two flat magnet aligned ↓↓.]
S: Because it's tail to tail, tip to tip. (Nicholas)

Identifying Mislabeled Magnets (questions 10 and 11): The students were shown two flat magnets labeled with arrows (both were correctly labeled) and then several bar magnets labeled with arrows (one was incorrectly labeled). Just over two-thirds of the students were able to tell that the magnets were correctly labeled in the first case and incorrectly labeled in the second case and to give reasonable arguments in terms of the tip-to-tail rule. Even when students could correctly identify that the magnets were incorrectly labeled in the second case, the students often had difficulty with the logical analysis required to determine which magnet was incorrectly labeled.

For example, . . .

I: (Shows two flat magnets) My friend who labeled these two magnets is worried that he/she got one wrong. Are they both correct, or do you think one of them is wrong?
S: They labeled them right.
I: How do you know?
S: Cause they're sticking. Tail to tip and tip to tail.
I: Is that how you know they're labeled the right way?
S: Yep.
I: (Shows three bar magnets) My friend who labeled these three magnets is worried that he/she got one wrong. Are all three magnets correct, or do you think one of them is wrong?
S: He labeled them right.
I: Why do you say that?
S: Because . . . . He labeled them wrong.
I: How do you know?

S: Because tip to tip and tail to tail. Supposed to be like this, but it's pushing away. (Donald)

Magnetization: Paperclips Becoming Magnets

Many of the students learned that a paperclip brought near a bar magnet becomes a magnet (an arrow), too. There were several levels of understanding of magnetization among the students: recognizing the paperclip becomes a magnet, determining the direction of the arrow of the paperclip magnet, and explaining how two magnetized paperclips interact. Over half of the students (18/28) articulated at least this first level of understanding in the post-interviews, with the following exchange being typical:

I: What do magnets do?
S: If they touch a paperclip, the paperclip turns into a magnet.
I: What happens when you get a paperclip near a magnet?
S: It sticks. (Elizabeth)

> Note that this student uses the critical key phrase "turns into." Some students answered that the paperclip was a magnet but made no reference to the paperclip having been "turned into a magnet" (or similar phrase) by the magnet; we interpreted these responses to mean that the student did not have this first level of understanding of magnetization.

A more sophisticated understanding was shown by some students (12/28) who in addition to saying that paperclips became magnets also determined the direction of the arrow that characterizes the magnetized paperclip. For example, these post-interview exchanges illustrate students who demonstrate at least this second level of understanding:

I: What will happen to this paperclip if I bring it near this magnet?
S: It sticks.
I: Why did that happen?
S: Because paper clips are steel. It becomes a magnet.
I: So it became a magnet. Can you tell me what the arrow looks like on the paperclip?
S: That's a tail and that's a tip. You want to stick on this side. (Chase)

I: What will happen to this paperclip if I bring it near this magnet?
S: It would stick together. Let me do it.
I: What has happened to the paperclip?
S: It sticks to it.
I: Why did that happen?
S: Because it . . . this is the tail, and this is the tip, and they stick together.
I: Is the paperclip just an ordinary clip now, or no?
S: It's a magnet now. (Selena)

Notice how the students not only articulate that the paperclip is a magnet, but also use the tip-to-tail rule to determine where the tip/tail of the paperclip is.

Some students (9/28) were able to apply the arrow model to a more complicated magnetization case in which two adjacent paperclips are magnetized the same way and thus repel one another. Understanding this situation requires one to apply the tip-to-tail rule to determine how the paperclips were magnetized and then again to determine how the magnetized paperclips will interact with each other.

I: On my stick, I have two paperclips close together. I put them right over like that. What happened to those?
S: They pushed away.
I: Why did the paperclips push apart from each other?
S: 'Cause they're tip to tip and tail to tail.
I: Can you tell me anything else about that? Why those paperclips are separated?
S: 'Cause they become magnets.
I: Okay, since those are magnets, which way are the arrows? So these are separated, which way are the arrows pointing?
S: Tip to tip and tail to tail. (Josh)

I: What happens to the paperclip when it gets near the magnet?
S: It becomes a magnet.
I: I've got another magnet and some paperclips. Watch what happens. What happened?
S: They're moving. They stick.
I: What do they do to each other?
S: They wiggle.
I: Are they staying together there?
S: No.
I: No? What are they doing?
S: Moving away.
I: Why are they doing that?
S: Because tail to tail and tip to tip. (Annie)

I: [Brings paperclip near a bar magnet] What has happened to the paperclip?
S: It sticks. The paperclip became a magnet.
I: Why did that happen? How did the magnet make the paperclip a magnet? Can you tell me what the arrow looks like on a paperclip?
S: It's up.
I: Same way as a magnet is up? I've got one last thing we're going to look at. Another kind of magnet. Now I've got some paperclips on a stick. Watch what happens. What happens?
S: They pulled apart.
I: Why did the paperclips push apart from each other?
S: Cause they're tip to tip.
I: What's tip to tip?
S: The paperclips together. (Julian)

Note how the students are using the tip-to-tail rule throughout their discussions of magnetization.

Conclusions

The experiences provided by the lessons helped the students adopt the arrow model for magnets and use it to gain a greater understanding of magnetism. Many of the students showed how they had adopted the arrow model in their drawings of magnets and in articulating where on a magnet a steel object would stick. All the students grasped the tip-to-tail rule at some level, and most were able to apply the rule to a variety of situations with multiple magnets. Finally, many of the students were able to apply the arrow model to magnetization of a paperclip, and even identify the tip/tail (poles) of a magnetized paperclip, as well as explain why two magnetized paperclips repelled one another.

Implications for Teaching and Learning

The conclusions above suggest several important implications for teaching and learning science in the early grades:

- Kindergarten students are capable of developing a basic understanding of magnetism if they are provided hands-on experiences and a simple conceptual model to explain these experiences.
- Providing students "catch-phrases" to serve as cognitive hooks, such as "Tip to Tail," can aid them in grasping and retaining science content (Van Hook, Huziak, & Nowak, 2005).
- Multi-sensory activities (e.g., the magnet song, writing about magnets, magnet jokes) that reinforce the conceptual model are important for students to internalize the vocabulary (arrow, tip, tail) and cognitive hooks (tip-to-tail) of the conceptual model.
- The synthesis of these elements—inquiry-based lessons blending hands-on activities with class discussion, a simple conceptual model, succinct cognitive hooks that capture key concepts, and reinforcement through multisensory activities—is an effective method of teaching early childhood science.

Each of these elements together aid student learning when dealing with abstract concepts and new scientific vocabulary. Development of this kind of instruction requires collaboration among early childhood educators and scientists to develop conceptual models and cognitive hooks that capture key scientific principles and yet are compelling and meaningful to early childhood students, and then to design inquiry-based, multisensory instruction around them.

Future Directions for Research

We are currently studying/plan to study how older students are able to apply the arrow model to higher-level concepts in magnetism: the role of magnetic domains in magnetization, what happens when a magnet is broken, and how a magnet aligns with an external magnetic field. We are examining whether the model of a magnet as an arrow, rather than just a bar with N/S poles, will aid in the visualization and understanding of these concepts.

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Appendix: Kindergarten Magnetism Interview Protocol

This protocol was used for both the pre- and post-lesson interviews. Questions 5, 9, and 10 were asked only in the post-interviews, and question 14 was asked only in the pre-interviews.

1. [Provide the student with paper and a pencil.] Can you draw a magnet for me? Can you describe what you drew?

2. Can you tell me what you know about magnets?

3. What does a magnet do?

4. What do magnets stick to? (If student says, “metals,” ask, “Do they stick to all metals?” If student says, “refrigerator” or other object, ask, “What do you think the refrigerator is made out of?”)

5. Show a bar magnet with an arrow on it. Will things stick anywhere on the magnet? [post-interview only]

6. What happens if you put a magnet near another magnet? [If student says, “attract” or similar word, ask, “When will they attract? Will they ever push away?”; similar for “repel” or similar word; If student says both, then ask, “When do they attract or push away?”]

7. [Show two bar magnet arrow cards.] Let’s pretend that each of these cards is a magnet. Can you show me how these magnets will stick together? [Show two flat magnet arrow cards.] Can you show me how these two magnets will stick together? [Ask student why he or she positioned the magnets the way he or she did.]

8. [Show three bar magnet arrow cards.] How will these magnets stick together? [Ask student why he or she positioned the magnets the way he or she did.]

9. [Show set of four magnet sorting cards with various arrangements.] Can you show me how to sort these cards into cards that show how magnets stick together and cards that show ways magnets won’t stick together? [post-interview only]

10. [Give the student two flat magnets labeled with arrows.] My friend who labeled these two magnets is worried that he/she got one wrong. Are they both correct, or do you think one of them is wrong? Why do you say that? [Let student explore with the magnets if he or she wishes. Have student explain how he or she arrived at his or her answers since that is most important.] [post-interview only]

11. [Give the student three bar magnets labeled with arrows.] My friend who labeled these magnets is worried that he/she got one wrong. Are all three magnets correct, or do you think one of them is wrong? If wrong, can you figure out which magnet is marked wrong? [Show a paperclip and a bar magnet labeled with an arrow.] What will happen to this paperclip if I bring it near this magnet?

12. [After doing it, then ask, “What has happened to the paperclip? Why did that happen?”]

13. [Show two paperclips hanging next to each other on a horizontal wooden dowel. Also show a flat magnet labeled with an arrow nearby.] What will happen to these two paperclips if I bring them both near this magnet? [Lower paperclips towards the magnet, and ask, “Why did the paperclips push apart from each other?”]

14. What do you get if you break a magnet in half? [pre-interview only]