Magnets: Attracting Student Wonderings

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Our first grade students were seated in a circle ready to share during our science talk.
"I could make Erin's magnet jump with my magnet," was the first response.
"Tell us more about it," we replied.
"You have to use the bar magnets and find the two sides that don't like each other, and when you do, you can make the other magnet jump."
"You used the bar magnets, but do you think we could do that with other magnets?" we asked. A chorus of "yeses," " no's" and "maybes" filled the room.
"Should we add that to our wonderings?" we asked.
And so: *Do all magnets have sides that "like" and don't " like" each other?* was added to our list of wonderings that we would test.

In recent years, we have been thinking about and using more scientific inquiry in our science teaching. We found that scientific inquiry helps students gain insights and increase their understanding of scientific principles (Minstrell, 1989). As we approached our science unit on magnets, we decided that we would use an inquiry approach and design **all** our lessons around our students' wonderings. Studies have shown that inquiry-based teaching leads to positive attitudes towards science (Shymansky, Kyle and Alport, 1983). We agree with this, but were concerned that our first graders rarely posed wonderings as testable questions. In addition, we had district content that had to be included. Through this experience, we learned that by restructuring our science lessons, using science talks and listening to our students, we were able to shift their surprises and wonderings into testable questions and their questions were closely tied to what our district wanted us to teach.

What's My Rule

We wanted our students to feel ownership of the unit from the beginning and needed to set some conditions to get them to think and wonder about magnets. We had been doing a great deal of sorting in math and thought that a sorting activity would be a good way to get our students interested in magnets. For this lesson, students worked in pairs, each with a bin of materials made of paper, plastic, wood and metal, from around the classroom. Each bin was different, but all had a magnet and a few things that were magnetic. The students were asked to create a rule to sort the materials. As the students worked, we walked around listening to their ideas and asking questions. For instance, one pair was sorting by "heavy and light". We asked them to explain how they decided if something was heavy or light. They designed a test to make the determination. By asking the students to think, test and explain, we were getting them ready to "be scientists". At the science talk that followed, the students shared their rules. As we expected, half the groups used "magnetic" as their rule. This led to a discussion about magnets and the students decided that they would like to learn more about them. This lesson set the tone for the rest of the unit. Our students felt that they were scientists, their questions mattered and they had some voice in what they would study. As Jody S. Hall (1998) states, "Allowing children to work on a problem they have chosen for themselves confirms their ideas and actions. It validates them as learners."(p.65)

Listening In

Because we wanted the students to be in charge, we began with a "free exploration" with magnets. Students made predictions and then tested what classroom items would and would not "stick" to a magnet. As the students worked, we walked around watching and listening. We learned that one way we could get to their wonderings was by **listening for their surprises.** When Charlie was surprised that the magnet stuck to the metal table, but not the metal chair, we helped him turn that statement into the wondering: *Do magnets stick to all metals?* When Jessica noticed that she could make a paper clip stick through a book, we helped her turn that into the wondering: *What can magnets "stick" through*?

It was apparent that the students understood that magnets only stuck to metal objects, but needed to refine their misconceptions as to why. We used their wondering: *Do magnets "stick" to all metals?* to set up a lesson where everything they tested was metal. We used many similar items and in most cases there were two items where one was magnetic and the other wasn't, such as two spoons, two paintbrushes and two coins. Again we asked students to predict and then test what would "stick". This dichotomy brought out many student misconceptions and by **listening for their misconceptions** we were able to generate a new list of wonderings. When Steven said that the apple corer didn't stick because it was too heavy, we turned that into the wondering: *Does weight matter?* When Susie said that the magnet stuck to one toy car but not another because one was painted, we turned that into the wondering: *Does paint matter?* When Elizabeth said that the paintbrush wouldn't stick because it was too rusty, we were able to add: *Does rust matter?* to our list. We also learned that we needed to **listen for the question**. While the students were testing their predictions, Timmy came up complaining that Katherine's magnet could pick things up in the air and his couldn't. We helped him turn this into the wondering: *Are some magnets stronger than others?*

Multiplying Their Wonderings

After two science periods, we had a list of many testable questions and were ready to begin our in depth study of magnets. In the past, our science lessons often involved students rotating through a series of stations with experiments around different concepts, with this unit we would be using a KLEW chart (Hershberger, Zembal-Saul & Starr, 2006) to document our learning. Our students would need to gather sufficient data so that they could make claims and support them with multiple pieces of evidence. To do this **we restructured our science lessons to focus on one question at a time.** We also **restructured our choice of experiments.** In the past, we would provide the experimental design, but now we wanted our students to have a voice in how we could go about answering their wonderings. To do this, we organized the wonderings into a logical progression then presented one to the class and had the students decide how we could answer it. Their ideas provided opportunities for multiple experiments around a single concept. What we, as teachers, discovered was that these multiple representations, using many materials and different types of magnets, led not only to our students clarifying their understandings, but also to developing new wonderings. When we were experimenting with the wondering: *Can anything break the magnetic field?,* the students tested many items from around the classroom before they discovered that another magnet would work. What surprised us was that they weren't ready to stop after they found out the bar magnet worked. They wanted to try other types of magnets and magnets of different strengths. Often while working on one question, students would notice something that would lead to another wondering. During our investigation to answer the question: *Are some magnets stronger than others?,* Haley noticed that paper clips stuck to the end of her horseshoe magnet and not the middle. This led to a new wondering: *Are some parts of the magnet stronger than others?* Our list of testable questions grew throughout the unit. The more the students learned, the more they wondered.

Co-constructing the Wonderings and Science Concepts: A Community of Wonderers

Every science lesson was followed by a science talk. This was our opportunity to come together as a class and share what we learned. It was at these science talks that students made their claims to address our wonderings, and supported their claims using the evidence they gathered through their experiments. This environment encouraged them to learn from one another and strengthen their understandings of the concepts, (National Reasearch Council, 2000). These talks were also an important time for the students to share what they noticed or were surprised by. While investigating the wondering: *Are some parts of the magnet stronger than others?,* some of the students made chains of paper clips on different parts of the magnets. Michael noticed that when he took the magnet away, the paperclips seemed to still stick together. He brought this to the science talk and demonstrated it for the class. The “oohs” that followed indicated that although some of his classmates had seen the same thing, many others hadn’t and were eager to try it. We then asked if anyone saw this happen with any other materials. When it was clear that no one had, we asked if they thought they could make it work with other things. This led to the class wondering: *Can you turn other things into magnets?* It was important for us to have the materials on hand during these science talks. It was usually easier for the students to show than to tell. By showing the whole class what they noticed, everyone could share the surprise and together we could frame the wonderings into testable questions.

Student Wonderings Meet District Objectives

When we embarked on this unit, we were worried that our students would have trouble posing wonderings that would be testable. We learned that their wonderings covered our district content and more.

District Content	Our Wonderings
Magnets attract some objects.	What metals do magnets stick to?
Magnets attract objects through many materials.	Can magnets work through things?
Magnets are strongest at the poles.	Are different parts of the magnet stronger?
Like poles repel, unlike poles attract. All magnets have a north and south pole.	Do all magnets have sides that like and don’t like each other?
The north pole of a magnet points to the magnetic north pole of the earth.	Can we find the north pole on a magnet?

Magnets are useful to man.	
There are many kinds of magnets. They must be handled with care.	Are some magnets stronger than others?
	Can we make other things into magnets?
	Can we break a magnetic field?

We also learned that as we questioned and listened to our students, we pushed and helped them to clarify their thinking. This led to deeper understanding of content. This was evident after an exchange with Susan and Jim. We spent an entire class period around the wondering *What sticks to a magnet?* Susan and Jim were in a quandary because their magnets stuck to one metal bell, but not another. Jim said he thought that some magnets stick to some metal and other magnets stick to other metals. We brought them a collection of magnets. They tried and discovered that all the magnets stuck to one bell and none stuck to the other. When asked, ‘Now, what do you think,” Susan questioned, “Are there different kinds of metals?” Jim informed her that there were. Her face lit up and she replied, “I get it! Some kinds of metals stick to magnets and other kinds don’t.” Given the time to test this wondering with multiple trials, the students were able to make a claim and support it with evidence. We were confident that they understood the concept because we had taken the time to listen and find a way to clarify their thinking. The ‘ah-ha” for us as teachers was that in the past our students could say that magnets stuck to some metal and not others, but we never took the time to hear their explanations of why this was, which could have been filled with misconceptions.

We also discovered that by using their questions, we empowered our students to become scientists. They learned that their questions were important and they could work to answer them. As the unit progressed, students asked richer questions and provided more in-depth explanations. As a result of this unit, our students not only learned the content but how to ask questions, how to talk to their peers, the process of science and they all developed a love (or at least a keen interest!) for science.

As teachers, we learned we needed to take time to allow students opportunities for multiple representations around a single concept.   We also learned that by having science talks, listening to our students and asking questions, we could use student wonderings to guide the unit and still meet district and state content. And we became better teachers of science!

Content standards for Science as Inquiry	
Abilities necessary to do scientific inquiry	**Understandings about scientific inquiry**
Asks questions about objects, organisms and events in the environment.	Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.
Plan and conduct a simple investigation.	Scientists use different kinds of investigations depending on the questions they are trying to answer.
Employ simple equipment and tools to gather data and extend the senses.	Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).
Use data to construct a reasonable explanation.	Scientists make the results of their investigations public.
Communicate investigations and explanations.	Scientists review and ask questions about the results of other scientists' work.

References

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magnets strongly attract steel, iron, nickel, cobalt, gadolinium. magnets slightly attract liquid oxygen and other materials. magnets slightly repel water, carbon and boron. The mechanics of how do magnets work really breaks right down to the atomic level. When current flows in a wire a magnetic field is created around the wire. Current is simply a bunch of moving electrons, and moving electrons make a magnetic field. This is how electromagnets are made to work. Around the nucleus of the atom there are electrons. Magnet schools and programs attract students from all over Marion County, not just surrounding school attendance zones. Admission is application-based, and some schools and programs require minimum testing levels and auditions. Admission may also depend on majority-to-minority enrollment figures and space availability. For more information on any of these opportunities, contact the respective school at the numbers provided. MAGNET SCHOOLS Dr. N. H. Jones Elementary Technology reaches every student at Dr. N.H. Jones Elementary because it s fully integrated into all academic areas. Each classroo How Magnetism Works. Understanding magnetism is essential if you want to know why some metals are attracted to magnets and others arenâ€™t. The motion of electrons in an atom produces a small magnetic field, but ordinarily, this field is cancelled out by the motion of other electrons and their opposing magnetic fields. However, in some materials, when you apply a magnetic field, the spins of neighboring electrons align with one another, which produces a net field across the whole material.