MAGNETS INQUIRY

Overview Magnet Inquiry
This inquiry on magnets is an example of an inquiry designed to have students do all three phases of inquiry and to learn standards-based science content on magnetism through their own investigations with magnets.

Step 1 Setting the Context	5 minutes
Step 2 Phase 1 Raising Questions from Observing Magnets	30 minutes
Step 3 Phase 1 Sorting and Categorizing Questions	20 minutes
Step 4 Phase 2 Modeling a Plan	10 minutes
Step 5 Phase 2 Planning and Investigating Questions	30 minutes
Step 6 Phase 3 Thinking about and communicating about magnets	20 minutes
Step 7 Phase 3 Synthesizing content	5 minutes
Step 8 Reflective Discussion (optional)	30 minutes

Preparation

To prepare for presenting this activity, it will help to familiarize yourself with this document, the materials and the phenomena. Begin by reading through the document. Gather the materials and do the activity as a learner. Then, go through the document again to prepare for each specific step. The words in italics are meant to be sample scripts for facilitators to say. It works best for a facilitator to read the scripts in order to understand the main ideas and then put these scripts in their own words. The sections in boxes provide conceptual information for the professional developer and can be skipped on the first reading.

Handouts and Charts
IFI map of the Classroom Inquiry: What Students are Doing
IFI map of the Classroom Inquiry: Teacher Goals for Student Learning
Science notebook (optional)

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Materials for Magnet Inquiry

Phase 1 - Materials

Starter 1
One set for each pair of students:

- 2 plastic cups (one for each student)
- 2 magnets – 1' round (one for each student)
- 1 plastic sandwich bag with any assortment of the following items
  - metal keys
  - non-metal keys
  - aluminum foil piece 4'x6"
  - paper clips 2-4
  - brads 2
  - variety of nails or screws
  - coins
  - small brass items
  - small copper items
  - small faux gold items
  - faux metal items
  - pieces of steel wool – chore ball
  - washers
- Optional: a science journal/notebook to record noticings and wonderings
- For teacher: chart paper and stand or whiteboard to chart students ideas

Starter 2
2 more magnets per pair (one more for each participant)

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Step 1 – Setting the Context (5 minutes)
The inquiry we are about to do was designed to have learners experience all three phases of inquiry in an effort to learn some science content (in Connecticut pertaining 4th grade content standards on magnetism). We're going to do what might normally be about a 3-hour inquiry on magnets (spread over 2 -3 days) designed for elementary students. However we are going to do the entire process today in about two and one half hours. For the most part, the inquiry today is the same as the one that the students have done in the classroom, the major differences are that we will stop periodically to discuss design aspects that are important to teaching the inquiry and that we will not have a break like the students might have at the end of Phase 1 and/or Phase 2.

We're going to do several short explorations with different magnets. Between the explorations, I'm going to ask you to put down your magnets and we'll talk about some of the things you noticed and some of the things you wonder about magnets. After the first two explorations, we will then take a look at the questions to determine which questions we can investigate today with the materials at hand and sort the questions into content categories. Then you will have a chance to choose a question and working with a partner investigate your question. At the end, everyone will get a chance to share what they found out.

To conclude this activity we will have a reflective discussion about inquiry and discuss some professional development issues around the magnet inquiry.

Step 2 Phase 1 – Raising Questions from Observing Magnets (30 minutes)

Exploring with one magnet (5 minutes)
Tell the group that you are going to give everyone a magnet (and each pair of participants a bag of materials). Tell them they have 5 minutes to work with their partner at their desks to see what the magnet does with the materials in the bag. Ask them to make predictions about whether an object is magnetic or not before testing the object. (Pass out a ring magnet in a clear plastic cup with the bag of materials and science notebooks – see materials list).

Depending on the level of participant, you may wish to have them make a three-column table in their notebooks, labeling the columns OBJECT, PREDICTION, and OBSERVATION.

While they explore, walk around and listen for questions they ask spontaneously or demonstrate with their behavior (participants repeatedly testing something usually indicates they have a question) – in particular questions which may pertain to your content goals.

Again, in accordance with their level, you may suggest a "T-chart" in their notebooks to record their "I Noticed" and "I Wonder".

After 5 minutes say, *I want you to put the magnet in the cup while we talk about what you observed.*

Charting noticings and wonderings (10 minutes)

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Tell the participants that you want to know what they noticed about the magnets and what they might wonder about now, what questions they have.

For now, their magnets should be in the cup.

Ask what they noticed and have them share out verbally. You can chart what they share out on large pieces of chart paper. You may want to write I Notice in large letters at the top so the students later can tell which statements were observations from the questions they do later.

Then say, some of you may have questions or things you wonder about magnets. I want to hear some things you wonder. Write I WONDER in large letters on top of chart paper.

Record as many questions as you can during this 10 minutes.

Exploring with 2 ring magnets (5 minutes)
Tell the participants that you're going to give everyone another magnet for them to explore how two magnets work together. They will have another 5 minutes to explore magnets with your partner. After 5 minutes we'll stop and share more questions and things people noticed.

Listen for questions while they explore – again in particular those they may relate to your content goals.

Charting their additional questions (10 minutes)
Ask participants to put both of their magnets inside the plastic cup at their desk. Ask for more of their questions and chart them. (You can add questions you heard them ask during their explorations). They may share observations, things they noticed. This is okay and you can either go back and add a few to the first I Notice chart or ask if that noticing raises in questions for the student.

Step 3 Phase 1 Sorting and Categorizing Questions (20 minutes)
Discussing questions that can be investigated. 15 min

Tell them that we want to see if we can try to answer some of these questions by investigating.

Pick one of the investigable questions and read it out loud.
Tell the participants, *Here's a question that maybe we could investigate.* ***EG. Does a bigger magnet hold more than a smaller one?*** *Let's talk about how we might answer this question.*
Ask the class if anyone can think of a way to find out the answer. If they don't include these in there answer, prompt them to think about:

- what materials they would need
- what would they do to try to answer the question

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If it's unclear how their plan would answer the question, ask something like, "How would doing that tell you … (the answer to the question – that the size of the magnet does make a difference and does hold more)?"

Go through some of the questions with the class to see which ones they think they could investigate. You may want to write a big "I" next to the ones they could investigate and a big "N" next to the ones they cannot do under these circumstances.

At the end, tell them that they will get to do some investigating to try to answer some of the questions.

Reviewing investigation questions (5 minutes) These can be sorted by the teacher from the charted "I wonder" questions into two, three or four class questions. Questions usually fall out into natural categories.

Some Categories for Sorting Magnet Questions:

Strength of Magnets
Pushing and Pulling with Magnets
Magnets working through different Materials
Size of Magnets

You can use these categories to group students' questions according to content goals. You could choose representative student questions for each of the categories, thereby limiting the number of investigations. Or you could choose one question from the pool of student questions for each category. Each of these sorting strategies honors that the investigations are based on student questions but allows for the teacher to have some control over the investigations as well. We have used each of these techniques with success, but recommend giving students a range of questions in each category because you get to the same content goal but get to see it from different perspectives.

Strength
How much does one magnet hold?
Does more than one magnet hold more things?
Does a bigger magnet pull more than the smaller one?

Pushing and pulling
I wonder what direction the magnet has to be to sometimes push the magnet away and sometimes pull towards it?
When do magnets flip over when they touch?

Magnets pulling through things
What materials does a magnet pull through?
Does a magnet pull through really thick things?
Does a magnet work in water?

Size of Magnets
Do bigger magnets hold more than smaller magnets?

Review the questions they can choose from.

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Tell the class that today, they'll choose a question and make plan as to how they might investigate their question and then do an investigation.

Step 4 Modeling a Plan – (10 minutes) One way to help students develop and improve the skill of planning and controlling variables is to model the process for them. If your students have never planned an investigation before you may want to model a simple plan for them. You could start with a question that you have not made available to them to investigate but is from their list of questions.

Model a plan for your participants. Tell them this is how you would model for students. On chart paper, have the question already written and write down as you go along what it is you expect to be part of a plan. One student question we have used is – Are rusty metals magnetic? Show them that a plan includes:

My question – Are rusty metals magnetic?
My first step will be…
My next step(s)…
Materials needed

Ask participants what they might do to answer this question and what they might need, It is helpful to do this on large chart paper so they can see what you are writing as a plan. Walk them step by step through a plan, charting as you go along.

Step 5 Planning and Investigating Questions

Planning investigations (10 minutes)
Get the participants into investigation groups- we recommend groups of 2-3, any larger can be difficult. Have each group choose a question they want to investigate and write down a plan of what they will do that includes the question they've chosen, the materials they'll need and what they'll do with them.

Investigating (20-30 minutes)
Tell the participants they'll have about 20-30 minutes to investigate their question. Show them the materials they'll have available. Encourage them to record what they do and what the see in their journal. Especially encourage them to draw pictures of what they do and see.

Facilitation Hint for helping groups move towards content:

- Stickers for thinking about the two different sides of magnets - you may want to check the poles on your magnets before you recommend they put on the stickers. When students start to think that there are differences in the sides, you might ask, would a sticker help you to find

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out more about what is going on? We give students a small sticker dot to put on one side of the magnet – so they can tell the difference when testing.

- To answer the question about materials and thickness, you may want to start students with a variety of materials of similar thickness, preferably fairly thin (less than 1/4 inch) and then after students have tested a few things add some thicker items, pieces of wood, stacks of cups, etc…We find it helpful to give them items they can stack and count so they can begin to quantify differences, e.g. it works through 4 cups but not 5, 3 pieces of wood but not 4, 4 styrofoam meat trays but not 4. Then they might see trends in thickness and perhaps move to other kinds of measurement.

Step 6 Phase 3 - Thinking about and communicating what you learned (20 minutes)

Reflecting on their investigation (15-20 minutes depending on the number of groups)
Ask the class to work in their groups to think about what they found out and to prepare to share their findings with the class for the next session. If you think it's useful, pass out a template to help them to reflect and share out, or post one on the whiteboard or chart paper. Tell them how much time they will have – usually about 1 minute per group. The template or chart might say:

Share your question
Share what you did
Share what you found out
You have 1 minute to share

Have participants share out according to the questions they've worked on – by categories. This helps them to see themes in investigations and gives some order to the sharing out. Remind them that they can show drawings, do demonstrations, or describe their data to explain what they have found. Chart what they have found out on chart paper as they share out.

For upper grades: In addition, as a teacher with content goals you can ask students clarifying questions or overall conclusions. For example, if a group says we found the magnet could pull things through 3 pieces of plastic but not 4, and the same for pieces of wood. You could ask them, so what does that tell you about magnets in general?

Step 7 Phase 3 Thinking about and Communicating what you learned: Synthesizing Content (5 minutes)

Synthesis of magnet investigations
After all the groups have shared, do a synthesis of the big ideas that they learned through their investigations. Review with the class the content ideas that they found out with their investigations. (While not necessary, it is nice to connect students' investigations directly to the

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content goals that it related to during the synthesis. One could say, for example, Group 1 and 2 that did x helped us learn that more magnets hold more materials.)

Big Ideas

- Magnets have two different sides — (You can point out that they have learned that magnets have poles - you can also tell them they learned that they attract sometimes and repel sometimes depending on your learning goals. Some students have talked about one side being a plus and the other a minus – even coming up with statements like opposites attract or when plus is with minus they pull and when plus is with plus or minus with minus they push)
- Magnets work (are magnetic/attract) through different materials, but only if the materials are not too thick
- Magnets do not work (attract each other) if they are too far apart or if they are separated by thick materials
- In general, larger magnets can hold more things than smaller magnets*

  * There are so many cases where this is not accurate that you may want to consider not using this for a big idea. While this is true for magnets that were made of the same materials under the same conditions and have had the same experiences, it is not neccessarily true for magnets made of special materials or for magnets that have been demagnetized by use, wear or simply age. One idea that holds without exception is that any two magnets stuck together are stronger than either one separately - see next idea)
- More magnets (magnets stuck together) hold more things.

Step 8 Reflective Discussion (30 minutes)

You might want to begin the reflection with a journal prompt and a few minutes for participants to journal their ideas. You might start with this prompt:

Based on the personal experience of inquiry you just had, what have you learned about the process of inquiry. Take 2-3 minutes to write down some of your ideas in your journal (or on a piece of paper).

Give participants a few minutes, if there is still a lot of writing going on you may want to extend the time by a minute or two. Always give participants a thirty second warning to allow them to finish their writing before starting the conversation.

To start the conversation you may want to establish some norms for discussion.
Insert norms here.
Tell them you will be charting some of their responses.

Begin the conversation by restating the prompt and telling the group that whoever wants to start can just speak up.

Try to get responses from a mix of people from the group. If people have difficulty in starting or jumping into the conversation, you might add some ideas of your own about what you observed going on during the inquiry or some things you remember as being important from your own personal experiences of inquiry. This may help to get the conversation flowing.

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Remember to summarize some of the main points of the discussion at the end. Some of the key ideas you wanted to come up and perhaps some unresolved issues that may be productive to pursue in future discussions.

Step 9 Professional Development

Choose whatever Professional Development supports you think will help the teachers make meaning of the activity in a way that will most support your goals.

For instance, you may want to use this activity to help teachers get a vision of a short inquiry. You may want to help teachers focus on particular skills. You may want to help teachers prepare to do an inquiry such as this, and focus on practical management skills.

Whatever your goal, you will want to choose the Professional development support(s) that focus the teachers on that goal.

For instance, after the reflective discussion, you may want to show the video to point out some of the strategies that helped support any of the process skills or helped get to content.

UbD Guide for Planning an Inquiry Investigation

This guide is based on the Exploratorium's Institute of Inquiry & modified by Wallingford Public Schools.

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Lesson Name: MAGNETS INQUIRY – Professional Development

Related CT State Content Standard(s):	Related CT State Expected Performance(s):

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Energy Transfer and Transformations – What is the role of energy in our world? 4.4 Electrical and magnetic energy can be transferred and transformed • Magnets can make objects move without direct contact between the object and the magnet.	B16. Describe the properties of magnets, and how they can be used to identify and separate mixtures of solid materials.
Related Enduring Understanding(s):	Related Essential Question(s):
• Science is the method of observation and investigation used to understand our world. (K-12) • Inquiry is the integration of process skills, the application of scientific content, and critical thinking to solve problems. (K-12) • Magnets produce a force that can vary in strength and this force can move certain objects and not other objects.	• How does science use inquiry to further understanding? • What are properties of magnets? • How does the size and strength of a magnet affect its ability to push and pull? • Can magnetic forces work through different materials?
What simple **content objectives**/goals do you want to accomplish with this investigation? (see district curriculum documents)	What simple **process skills** do you want to improve with this investigation?
Students will understand that • Magnets produce a force that some things respond to and some things do not. • Magnets exert a force at a distance/they can push or pull without touching. • Magnet pull is greatest when the magnet pull is closest to the magnet. • A magnetic force can hold a limited amount of weight. • Magnets possess various degrees of strength. • Magnets can exert a force through materials.	Raising Questions Observation Planning Data collection, organization, and display Presentation/Sharing

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