Lesson Adaptation Activity: Asking Questions

Related MA STE Framework Standard:

MS-PS2-3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. *(Clarification Statement: Examples of devices that use electric and magnetic forces could include electromagnet, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.) (Assessment Boundary: Assessments about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking.)*

Lesson Description

Ms. Randolph's 7th grade class is in the middle of a unit on forces and interactions. In this particular lesson, students are constructing questions from data involving their use of electromagnets. Students are asking questions to try and identify the different factors that affect the strength of electromagnets. The students spent the previous lesson making electromagnets and will use their questions developed today to carry out an investigation involving their electromagnets during the next class.

Lesson Adaptation A

Ms. Randolph: Alright everyone, so yesterday we made electromagnets using a D cell battery, wire and an iron nail. We then tested the strength of our electromagnets by using them to attract paperclips. The more paperclips attracted, the stronger our electromagnets were. Today, I want us to think about the different factors that could affect the strength of our electromagnets. Let's brainstorm some different factors and then you are going to come up with questions to test these factors. So what do we think could affect the strength of our electromagnets? Think about the materials we used to build our electromagnets and what we know about electrical fields and conductivity.

Andrea: We could change the battery.

Ms. Randolph: That's good Andrea, but say more. What would you change about the battery?

Andrea: We could use a more powerful battery because if it was a stronger battery, then the electromagnet would be stronger and pick up more paperclips.

Ms. Randolph: Excellent Andrea! So I am going to start a list on the board of our different factors. Who else has an idea?

Jay: What if we used a higher quality nail.

Ms. Randolph: Alright, Jay. And what do you mean by a higher quality?

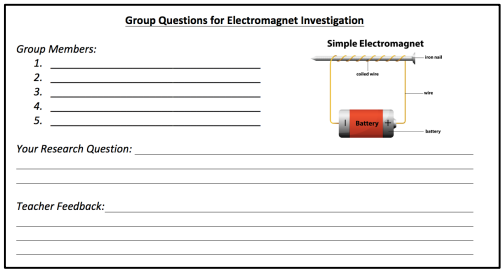
Jay: You know, like a nail that looks nicer or fancier. It would probably pick up more paperclips.

Ms. Randolph: Okay. We will put it up on the board. What else?

Mamadou: Maybe if we used a bigger nail or more than one nail. I think that would increase the conductivity of the nail, which would make the electromagnet stronger.

Ms. Randolph: Great idea and thank you for that explanation! Any other suggestions?

Colette: What if we wrapped the wire around the nail more times or used a thicker wire. Maybe that would strengthen the electrical field around the electromagnet.



Ms. Randolph: Excellent Colette. Do we have any other ideas? No? Okay then, I want each group to think about a question they could ask about one of these factors. I am going to give each group five minutes to come up with a scientific question. Please write your question on the half sheet of paper I have provided to each group. Remember that your question should contain an independent variable and a dependent variable within it. Also, if you get stuck while writing your question, look up on the board where I have written a question starter for you: *How does the _____IV_____ affect ____DV_____?* Alright go ahead!

Students work in their groups to create their scientific questions. Ms. Randolph ciruclates around the class.

Ms. Randolph: Okay, it looks like each group has come up with a question. I would like to hear from a few groups. Any volunteers? Great, go ahead.

Andrea: My group is going to ask the question: how does the number of coil turns around the nail change the strength of the electromagnet?

Ms. Randolph: Great! And how will you go about answering that question?

Andrea: We are going to see how many paperclips the electromagnet can pick up when we wrap the wire around the nail 10 times, and then 20 times, and then 30 times.

Ms. Randolph: Okay that makes sense to me. How about this group?

Jay: Our group asked the question: How is the number of paperclips picked up by the electromagnet affected by the quality of the nail?

Ms. Randolph: Alright, and how will you investigate this question?

Jay: Well, we are going to get a bunch of nails and we will rank them as a group from lowest quality to highest quality. We will then test to see which one can pick up the most paperclips. We hypothesize that the one we think is the highest quality will pick up the most paperclips because it is the nicest.

Ms. Randolph: Interesting idea, but what if the nail you think is the poorest quality is the one I think is best.

Jay: That won't happen because we will rank them the right way, so you will agree with us.

Ms. Randolph: Alright. I am interested to see how your experiment turns out tomorrow! Let's hear from another group.

Aleah: We want to see the effect of battery on the strength of the electromagnet. We came up with the question: How does the strength of battery influence the strength of the electromagnet?

Ms. Randolph: Very interesting. And how will you test this question?

Aleah: We are going to use different powered batteries and see how it changes the number of paperclips the electromagnet can pick up.

Ms. Randolph: Sounds good, thank you for sharing! Anyone else want to share? Alright. Before you leave today, please make sure your group hands in your half sheet to me so I can review your question. We will start testing your questions tomorrow!

Lesson Adaptation B

Ms. Randolph: Alright everyone, so yesterday we made electromagnets using a D cell battery, wire and an iron nail. We then tested the strength of our electromagnets by using them to attract paperclips. The more paperclips attracted, the stronger our electromagnets were. Today, you are going to work with your group to brainstorm some different factors that could affect the strength of your electromagnets. When brainstorming, think about the materials we used to build our electromagnets and what we know about electrical fields and conductivity. After you brainstorm, your group is going to come up with a scientific question to test one of these factors. In the center of each table is a piece of chart paper and a marker. You are going to use the chart paper to record the different factors you brainstorm, and to write your final questions. Remember when you are coming up with your question that it should contain two variables within it and should be answerable using data from an investigation. Also, your question should not contain a value judgment. What you think is the best may not be what everyone thinks is the best. Keep your questions scientific! Last, if you get stuck while writing your question, look back in your notebooks to some of the scientific questions we asked in our past investigations. Alright go ahead!

Ms. Randolph circulates around the room as each group brainstorms different factors and constructs their scientific questions. Ms. Randolph stops at one table and listens in to their discussion.

Jay: I think if we used a thicker nail then the electromagnet would be stronger.

Karina: Like the diameter of the nail?

Jay: Yeah the diameter of the nail. I think if the nail is thicker it will conduct electricity better.

Karina: Okay, I will write it down. What else?

Zach: What if we used a different material for the nail? Maybe like a steel nail would be a better conductor and make a better electromagnet.

Karina: Alright. So the diameter of the nail, and the type of metal.

Jamie: I think if we used a stronger battery, then it would make the electromagnet more powerful.

Zach: Yeah, like a stronger voltage battery.

Karina: That makes sense. So I will write battery voltage. Any other ideas?

Jay: The thickness of the wire. If we used thicker wire it might make the magnet stronger.

Jamie: Yeah, it could increase the flow of electricity.

Karina: Okay. Anything else?

Mya: I think we should write our question now.

Karina: I think you are right. What factor should we pick for our question?

Zach: I think we should investigate the type of metal. We could get an iron nail, a copper nail, a steel nail, maybe even a gold nail!

Jamie: Yeah that would be cool! But they would all have to be the same shape and size.

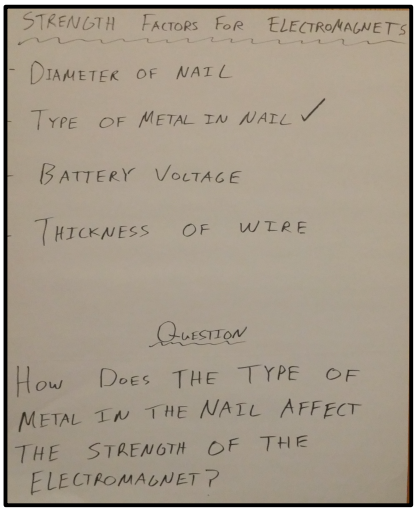
Karina: Jamie is right. Those factors need to be held constant. So the material will be our independent variable and we are measuring the strength of our electromagnet.

Jay: So our question could be: how does the type of metal in the nail affect the strength of the electromagnet?

Ms. Randolph continues to circulate around the classroom until each group has written their question.

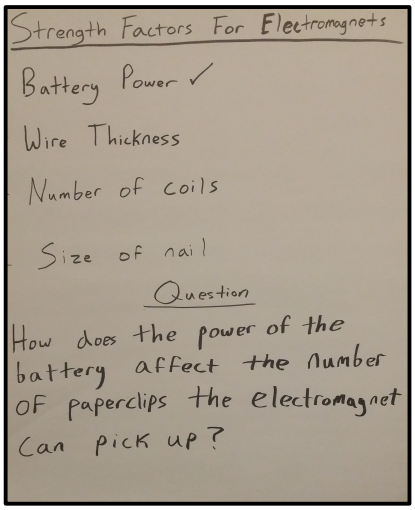
Ms. Randolph: Okay. It looks like each group has come up with a question. Now you will get the opportunity to share your questions with your classmates. I am going to give each group some post-it notes with sentence starters to write feedback to your classmates. You are going to walk around to each groups' chart paper and evaluate their question. Please try to include both positive and constructive feedback of their question. (Sentence starters include: I like…, I like how you…, Good job…., One thing you might change…)

The students circulate around to each poster and begin to place post-it notes by each question. Ms. Randolph stops by two groups' posters and reads the feedback given.



Feedback from the students on the question on the left:

- I like that your research question is so unique.
- Good job including the independent and dependent variables in your question.
- One thing I might change is to be more specific with what you are measuring in your question. Maybe you could say the number of paperclips the electromagnet can attract instead of the strength of the electromagnet.



Feedback from the students on the question on the left:

- Good job writing a question that can be answered using data from an investigation.
- I like how you were specific in how you were going to measure the strength of your electromagnet in your question.
- One thing I might change is the wording you used for your independent variable. Instead of saying the power of the battery, you could say the voltage of the battery. That is how strength of a battery is measured.

Lesson Adaptation C

Ms. Randolph: Alright everyone, so yesterday we made electromagnets using a D cell battery, wire and an iron nail. We then tested the strength of our electromagnets by using them to attract paperclips. The more paperclips attracted, the stronger our electromagnets were. Today, I want us to think about the different factors that could affect the strength of our electromagnets. Let's brainstorm some different factors and then we are going to come up with questions to test these factors. So what could affect the strength of our electromagnets? Think about the materials we used to build our electromagnets and what we know about electrical fields and conductivity.

Andrea: We could change the battery.

Ms. Randolph: That's good Andrea! A more powerful battery could produce a more powerful electrical current. Who else has an idea?

Mamadou: Maybe if we used a bigger nail or more than one nail. That would make the electromagnet stronger.

Ms. Randolph: Yes! That would work because it would conduct electricity better. Great! Any other suggestions?

Colette: What if we wrapped the wire around the nail more times. You taught us that that would make the electromagnet stronger because the electricity would be more concentrated.

Ms. Randolph: Excellent Colette and thank you for that explanation. What else?

Zach: We could use a thick wire. That would increase the flow of electricity through the wire, which would make a more powerful electrical field. I remember you saying that a more powerful electrical field can increase the strength of the electromagnet.

Ms. Randolph: Fantastic Zach! I love how you use the correct terminology in your explanation. Let's now think about some questions we could ask about these factors. Remember, these factors that we came up with are going to be manipulated in our investigations. This means we will change them to see their effect on our electromagnets. Can someone remind me what we call a factor that is being manipulated?

Colette: The independent variable, and the dependent variable is what is being measured.

Ms. Randolph: Very nice Colette. So let's think about our list and what we are trying to do with our investigations tomorrow. What will be our independent variables in our investigation tomorrow?

Deion: The voltage of the battery could be an independent variable.

Ms. Randolph: Great! Any more?

Grant: The number of coils around the metal nail.

Ms. Randolph: Yes, and I think we came up two more. What are they?

Andrea: The number of nails in the electromagnet and the thickness of the wire.

Ms. Randolph: Fantastic! Now what are we measuring?

Jay: The number of paperclips that can be picked up by the electromagnet.

Ms. Randolph: Great, so that will be our dependent variable in all our investigations. It measures how strong the electromagnet is. Now that we know the variables being used, let's predict what will happen in these experiments. I am going to write several questions on the board. I want you to predict what will happen if we investigated each question. Let's start with battery voltage: How does the voltage of the battery affect the strength of the electromagnet?

Mya: As the voltage of the battery increases, the electromagnet will pick up more paperclips.

Ms. Randolph: Okay, and what about the number of coils? How will the number of coils around the metal nail affect the strength of the electromagnet?

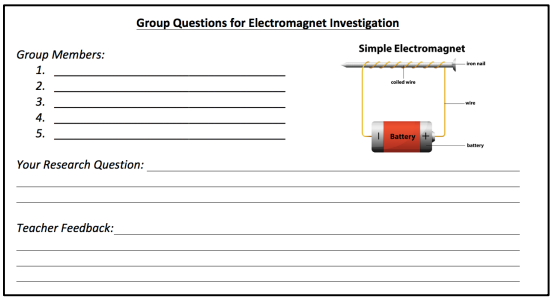
Jon: The more coils, the more paper clips the electromagnet will pick up.

Ms. Randolph: That seems right to me. What about the number of nails? How will the number of nails affect the strength of the magnet?

Mamadou: The more nails, the stronger the magnet.

Ms. Randolph: Great, so now I want you to discuss with your group and pick one of the scientific question to investigate tomorrow. Please write your questions on the half sheet of paper I have provided to each group.

Ms. Randolph circulates around the classroom listening in to each group as they decide on their scientific questions.


Group Questions for Electromagnet Investigation

Group Members:
1. _____
2. _____
3. _____
4. _____
5. _____

Simple Electromagnet
iron nail
coiled wire
wire
Battery
battery

Your Research Question: _____

Teacher Feedback: _____

Ms. Randolph: Alright, I want to hear from some of the groups. What scientific questions did you pick?

Deion: Our group is going to investigate the question: how does the battery voltage affect the number of paperclips the electromagnet can pick up?

Ms. Randolph: Great! So are you going to use different strength batteries and see how it changes the number of paperclips the electromagnet can pick up?

Deion: Yeah that is what we planned to do.

Andrea: My group is going to ask the question: how does the number of coil turns around the piece of metal affect the strength of the electromagnet?

Ms. Randolph: Interesting. You can measure the number of paperclips your electromagnet can attract when you have varying numbers of wire coils around the nail. How about this group?

Jay: Our group picked the question: how does the number nails used affect how many paperclips the electromagnet can pick up?

Ms. Randolph: Great question! How many nails will you test?

Jay: Our group is going to test one nail, then two nails, and then three nails.

Ms. Randolph: Very nice. And then you will compare the number of paper clips each is able to pick up. Anyone else have any different questions? Okay then, before you leave please make sure your group hands in your half sheet to me to review, and you will start testing your questions tomorrow!

Lesson Adaptation D

Ms. Randolph: Alright everyone, so yesterday we made electromagnets using a D cell battery, wire and an iron nail. We then tested the strength of our electromagnets by using them to attract paperclips. The more paperclips attracted, the stronger our electromagnets were. Today, you are going to work with your group mates to brainstorm some different factors that could affect the strength of your electromagnets. When brainstorming, think about the materials we used to build our electromagnets and what we know about electrical fields and conductivity. After you brainstorm, your group is going to come up with a scientific question to test one of these factors. In the center of each table is a piece of chart paper and a marker. You are going to use the chart paper to record the different factors you brainstorm, and to write your final questions. Remember when you are coming up with your question that it should contain two variables within it and should be answerable using data from an investigation. Also, your question should not contain a value judgment. What you think is the best may not be what everyone thinks is the best. Keep your questions scientific! If you get stuck while writing your question, look up on the board where I have written a question starter for you: *How does the _____IV_____ affect ____DV_____?* Alright go ahead!

Ms. Randolph circulates around the room as each group brainstorms different factors and constructs their scientific question. Ms. Randolph stops at one table and listens in to their discussion.

Andrea: The battery would affect the strength of electromagnet. If it we used a stronger battery, then the electromagnet would pick up more paperclips.

Ryan: That's good, write battery power on the paper, Chris. Also, what if we used thicker wire? I think the current would be stronger then, so the magnet would be stronger.

Chris: Okay. So battery power and wire thickness.

Sam: I think if we wrapped the wire around the nail more times it would make the electromagnet stronger.

Andrea: Why?

Sam: The electricity would be more focused in one area.

Ms. Randolph: That's right! The current would be more concentrated around the nail.

Jacinda: Maybe a bigger nail also?

Andrea: Yeah, that makes sense. Write the size of the nail, Chris. So now we have a battery power, wire thickness, number of coils, and size of nail. Let's think about what our question is going to be.

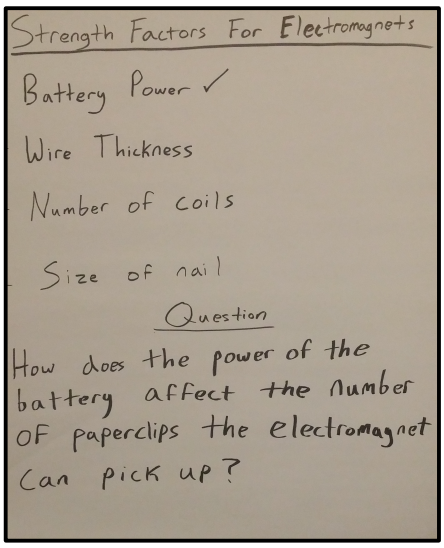
Ryan: Well, what factor do we want to investigate? I think it would be cool to use a bunch of different batteries and see how they affect the strength of our electromagnet.

Sam: Yeah, like we could see how many paperclips could be picked up by each battery.

Andrea: Okay, so what is our question going to be? I think we should use the format that Ms. Randolph gave us. So what is our independent variable. What is going to change?

Jacinda: I think it is the battery because we are going to change the battery strength and see how many paperclips our electromagnet can pick up.

Sam: Yeah, you are right. And that makes the number of paperclips the dependent variable because that's what we are measuring.



Andrea: Okay. So I think our question should be: how does the power of the battery affect the number of paperclips the electromagnet can pick up? Does that make sense?

Ryan: Yeah, I think that is good. Chris, write that down.

Ms. Randolph continues to circulate around the classroom until each group has written their question.

Ms. Randolph: Okay, it looks like each group has come up with a question. I would like to hear from a few groups. Any volunteers? Great, go ahead.

Andrea: My group is going to ask the question: how does the power of the battery affect the number of paperclips the electromagnet can pick up?

Ms. Randolph: Great! And how will you go about answering that question?

Andrea: We are going to use different strength batteries and see how it changes the number of paperclips the magnet can pick up.

Ms. Randolph: Okay, seems like a good plan. How about this group?

Aleah: Our group asked the question: How does tightness of the wrapping of the wire affect the strength of the electromagnet?

Ms. Randolph: Okay, and how will you investigate this question?

Aleah: We are going to wrap the nail with the wire loosely and see how many paperclips the electromagnet can pick up. Then we are going to wrap the nail tightly with the wire and see how many paperclips it can pick up again.

Ms. Randolph: Interesting idea! Let's hear from another group.

Jay: We are going to look at the number of coils. Our question is: how does the number of coils affect the number of paperclips our electromagnet can attract?

Ms. Randolph: Alright, and how are you thinking about testing this question?

Jay: We are going to see how many paperclips out electromagnet can attract when we wrap the wire around the nail 10 times, and then 20 times, and then 30 times.

Ms. Randolph: Sounds good, thank you for sharing! Anyone else want to share? Ok then, everyone please leave your chart paper in the middle of your tables so I can look over your questions and leave post-it notes with feedback. Tomorrow you will address this feedback and you will start testing your questions!

Ordering of Adaptations

Directions: Order the four adaptations (A-D) along the Science Practice Continuum (Levels 1-4) for the Asking Questions practice.

	Level 1	Level 2	Level 3	Level 4
Adaptations				