

# Are Inservice Elementary Teachers Prepared to Teach Fundamental Concepts of Magnets and the Behavior of Magnets?

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# Study Rationale

- ▶ Magnets and magnetism are key concepts in elementary science (AAAS, 1993; NRC, 1996)
- ▶ Is magnetism a concept that is widely understood?
- ▶ Research literature indicates individuals from broad age range have difficulty understanding magnetism  
(Hickey & Schibeci, 1999; Atwood & Christopher, 2000; Finley, 1986; Constantinou, Raftopoulos & Spanoudis, 2001)
- ▶ If elementary students are expected to understand fundamental concepts of magnetism and magnets, are elementary teachers prepared to teach magnetism?

# Methods: Participants

- ▶ 20 inservice elementary teachers
- ▶ Self selected for inservice physical science summer institute
- ▶ Represented four central Appalachian region school districts
- ▶ Completed assessment instrument before institute instruction

# Methods: Instrument

- ▶ Multiple choice instrument with popular non-scientific concepts included in distractor options
- ▶ Five questions on magnetism
- ▶ Three-part questions
  - Multiple choice content question
  - Rationale for selecting response
  - Confidence rating for option selected
- ▶ Frequencies calculated for each option
- ▶ Explanations and confidence levels
  - supplemented quantitative data
  - Uncovered difficulties in understanding

1. The most likely reason magnets stick to refrigerator doors is because they are interacting with

- A. iron in the doors.
- B. the plastic or ceramic coating on the doors.
- C. a lightweight metal, such as aluminum, in the doors.
- D. a heavy metal, such as lead, in the doors.
- E. electric charge on the refrigerator doors.

Option	Frequency
A	7*
B	0
C	8
D	3
E	2



## 2. You may use a magnetic compass to find your way,

- A. since the compass needle will always point in the direction you are facing.
- B. during the day but not during the night.
- C. since the compass needle aligns in a north/south direction.
- D. if there aren't too many trees or mountains nearby.
- E. because compass needles don't move.

Option	Frequency
A	4
B	0
C	15*
D	0
E	1



### 3. A bar magnet

- A. has the strongest magnetic effect in the middle of the bar.
- B. interacts with all metallic objects.
- C. will not influence a magnetic compass.
- D. can repel any other magnet.
- E. interacts with heavy metals like lead, brass, and gold.

Option	Frequency
A	5
B	5
C	3
D	5*
E	2



4. Which of the following statements about bar, horseshoe, and round refrigerator magnets is most accurate?

- A. Large magnets are stronger than small magnets.
- B. Magnets have a N-pole and a S-pole.
- C. Horseshoe magnets are stronger than bar magnets which contain the same amount of material.
- D. Round magnets have *only* a N-pole or *only* a S-pole.
- E. A bar magnet will pick up more paper clips than a round refrigerator magnet.

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Option	Frequency
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A	3
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B	12*
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C	4
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D	0
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E	1
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## 5. Consider the diagram below

S Magnet N

A Object B

The N-pole of a bar magnet is brought near end A of an object that looks very similar to the bar magnet in shape, size, and color. If end A of the object is attracted to the N-pole of the magnet, you could

- A. be sure that the object is another bar magnet and A is the N-pole.
- B. be sure that the object is another bar magnet and A is the S-pole.
- C. conclude that the object is either a bar magnet and A is the N-pole or the object is not a magnet but contains iron or a material that magnetically behaves like iron.
- D. conclude that the object is either a bar magnet and A is the S-pole or the object is not a magnet but contains iron or a material that magnetically behaves like iron.
- E. not make any of the conclusions in A. – D.

Option	Frequency
A	1
B	4
C	2
D	12*
E	1



# Conclusions

- ▶ Teachers not prepared to teach concepts on magnets
  - 51 of a possible 100 answers were incorrect
  - Correct responses often paired with low confidence rating
  - Few explanations supported a scientific understanding
- ▶ Troublesome concepts
  - Ferromagnetic materials attracted to magnets
  - Magnetic attraction strongest at poles (regardless of size and shape)
  - Earth's magnetic effects on a compass

# Implications

- ▶ Are magnets addressed in teacher preparation programs?
  - If not, are other concepts deemed more important?
  - Inadequate science preparation for elementary teachers?
- ▶ Results inform
  - professional development planning in Central Appalachian
  - Higher education faculty developing elementary teacher preparation education programs

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# Task 1 Explanations Organized by Option and Confidence Rating

Option	Confidence Rating				
	1	2	3	4	5
A		Magnets do not stick to B, C-Lead is not put in refrigerator doors and E is almost silly.	Magnets have to attract to metal or iron.	I believe magnets stick to iron. A	
		B - Magnets will stick to iron.	NR	Magnets are attracted to iron. A	
		Magnets are attracted to iron. A			
B					
C	Light wt. since in doors. C	Refrigerator doors are lightweight material. C	Not sure.	This is magnetic. Choice: C	Guess: logic alum pie pan as magnet?
	Magnets stick to magnetic surfaces.	There must be some type of metal for the magnet to stick.	Magnets will stick to other metal.		
D		Magnets stick to metal. D	It would take a heavy metal to attract the magnet through the coating. D	Guess	
E				The magnets electrons are attracted to the electrical charge.	Magnets and electric charges are related. E



## Task 2 Explanations Organized by Option and Confidence Rating

	Confidence Rating				
Option	1	2	3	4	5
A		A compass tells you the direction you are facing.	Based on true north/south the needle will point the way you are facing.	Compasses show you what direction you are traveling in. A	Guess
B					
C	Magnets align W/N/S poles.	Compass needles always point North. (Magnetic) C	The compass needle is attracted to the polar North	Not sure, this could have been answer A. C	NR
	poles/polarity principle. C	Compass needles always align N/S		Guess	
	The compass always points north/south.	Compass needle points north so you can always know which way north is. C			
		C-the compass will always point to the north regardless of your position.	NR		
		A compass will show you the North because of magnetism at the poles. C			
		Uses poles to align itself. C			
		I think? C			
D					
E			The compass will move but the needle will stay the same		



# Task 3 Explanations Organized by Option and Confidence Rating

Option	1	2	3	4	5
A	more area=stronger hold.		Strongest where the N/S come together?		Guess
			A-process of elimination, I think.		I am not sure. I used an educated guess.
B		A magnet interacts with metal no matter what shape.	Because its magnetic.	B seemed like the only one that could be true.	
		A bar magnet has two [charges],+ and -.		?	
C		The opposite poles will attract and similar poles will not.		NR	?I guessed.??
D			Guess	Process of elimination.	
				Guess	
				They will repel if turned correctly.	
				Has + and - charged ends.	
E			attracts all metals.		Guess



# Task 4 Explanations Organized by Option and Confidence Rating

Option	Confidence Rating				
	1	2	3	4	5
A	>=mae [more] magnetism.	Guess		A larger magnet should pick up more regardless of shape.	
B	All magnets have 2 poles. On ref. magnets, one pole is glued to the decoration.	I think I learned that in AMSP.	NR	All magnetic contain a S-pole & N-pole.	Guess
		All magnets have a N/S pole.	B-magnets have an N and S pole regardless of shape.		
		Magnets have 2 poles.	Magnets have a N and S pole no matter what size.		
		Heard it before.	In order to attract this is true.		
		Magnets must have N/S poles in order to align.			
C			I just seems stronger.		Guess - no idea.
					Guess
					Has 2X force on object.
D					
E					This one seems to be the most accurate.





# Task 5 Explanations Organized by Option and Confidence Level

	Confidence Rating				
Option	1	2	3	4	5
A					I'm not sure.
B		Opposites attract.			Guess
		Opposite poles attract, as the electrons will align/bond.			Guess
C			Guess	Opposite poles repel each other.	
D	Opposites attract and iron attracts to magnets.	Opposites attract.	Opposite ends attract or it has to be a material that attracts as a magnet.	The bar magnet should attract to the other magnet.	Opposites attract.
	Opposites attract.		N attracts S		Guess
	Metal will stick to the bar magnet and so will the S pole of another magnet.		D-n and s poles are attracted to each other.		
	D is more correct.		Opposite ends of magnets attract.		
E			NR		



# Summary of Option Frequencies

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Task	Options					Total
	A	B	C	D	E	
1	7*	0	8	3	2	20
2	4	0	15*	0	1	20
3	5	5	3	5*	2	20
4	3	12*	4	0	1	20
5	1	4	2	12*	1	20

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\*Denotes correct response.

# Confidence Levels Where 1 is lowest and 5 highest Confidence

Task	Confidence Levels				
	1	2	3	4	5
1	2	6	5	6	1
2	3	8	4	3	2
3	1	3	5	7	4
4	2	6	5	2	5
5	4	3	6	2	5
1-5	12	26	25	20	17