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Magnet Trade Books: Attracting and Repelling Concepts

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Abstract

A series of magnet trade books were analyzed against a validated list of magnet concepts (Barrow, 1990a) and their Flesch (1974) Readability was determined. These trade books were used to supplement a second grade unit on magnetism locally constructed from AIM's Mostly Magnets *(1991). All trade books accurately described how like and unlike poles behave and operation of a compass. Considerable variation in readability was noted. Suggestions are provided on appropriate use of trade books of varying concepts and readability.*

Magnet Trade Books: Attracting and Repelling Concepts

The importance of literacy ability and acquisition of new knowledge in science cannot be overestimated (Freeman & Taylor, 2006; McKee & Ogle, 2005). Unfortunately, as noted by Carlson (2005), "Reading the average science textbook, one is struck with a question: 'Why would people devote their lives to the study of a subject as dry as the Sahara Desert?'". . . For the most part, reading in science is often characterized by being ". . . full of the stuff in page-turner novels—intrigue, mystery, romance, and sometimes just dumb luck" (Carlson, 2005, p. 40). Science and language are being linked together again. Recently, the National Science Foundation sponsored the Crossing Borders: Connecting Science and Literacy Conference in 2001. A synopsis of this conference was compiled by Saul (2004), who encourages the ". . . need to promote and ensure everyone's access to science" (p. 4). She believes the understanding of science and text is essential for there to be a literary-science connection. Yager (2004), at the Crossing Borders Conference, stressed that inquiry is the key component of science instruction as recommended by the National Science Education Standards (NSES) (National Research Council, 1996); otherwise, the essence of science will be lost or hidden from the reader. Bamford and Kristo (2003), both literacy experts, also document this essential aspect of the science-literacy connection.

In addition, Johnson and Martin-Hansen (2005) fully describe this connection:

> Students in science classrooms are given numerous opportunities to read expository text in a variety of formats and for a variety of purposes. They read to solve a problem, understand the steps in an experiment, gain base knowledge about a concept, answer their own questions, compare their inquiry results with what others have found, expand their basic understanding of a concept, and for enjoyment. They read books, directions for experiments,

newspaper articles, website[s], and peer work. The reading tasks going on in science classrooms today are quite extensive and do complement efforts being made in schools to improve reading achievement. (p. 12)

Trade books have been encouraged for supplementing existing science curriculum (Ford, 2002; Madrazo, 1997) because they are more focused on a single topic (Bamford & Kristo, 2003) and can be more current than textbooks (Ford, 2004b). Ford (2004a) notes that trade books are rarely aligned with standards-based curricula. Some elementary teachers use science trade books to supplement their science units, and others use them for their literature-based science program (Fredericks, 2003). Fredericks believes the uses of nonfiction science trade books are compatible with the teaching standards of NSES (National Research Council, 1996).

There are numerous criteria an elementary teacher can use in selecting science trade books. Bamford and Kristo (2003) recommend several ways trade books can be used—reading aloud, shared reading, at-risk readers, etc. Both Bamford and Kristo (2003) and Rop and Rop (2001) identify accuracy of content as the first factor to be considered in selecting a particular trade book. Other factors include quality, age-appropriateness, integration of illustration, equitable representations of equity and gender, organizational structure, and writing style.

Wyatt (2003) recommends that science trade books must relate to the reader's experiences, have clear and simple experiments that use common materials, and contain illustrations and prose that will catch and hold the reader's interest. Duke and Bennett-Armistead (2003) report that when elementary students read a variety of genre, they become better readers. Akerson and Young (2004) also recommend that the reading level be assessed. They note that students' interests influence readability, but the trade book must be within a reasonable reading level. Sometimes, children's interests allow them to read trade books written at a higher reading level than their personal reading level.

Hepler (2003) describes concept trade books focusing on a class of objects or an abstract idea. In this article, we focus upon the concept of magnets. "Magnets" is a topic of physical science that is specifically mentioned in the K-4 NSES (National Research Council, 1996).

Magnet concepts have also been considered in various other studies besides trade books. Barrow (1987) interviewed K-6 students about their understanding about magnetism. There was no difference in their understanding whether they had studied or not studied magnets in school. Subsequently, a list of eight magnet concepts was developed and validated (Barrow, 1990a). This list of concepts has been used to evaluate elementary science textbooks (Barrow, 1990b) and elementary methods textbooks (Barrow, 2000). Dreher and Voelker (2004) note that it is not easy for elementary teachers to determine the accuracy of science concepts in resources, as many lack extensive science knowledge. A review of the literature found no study on the concept analysis of magnet trade books.

Method

The area public school district, consisting of 19 elementary (K-5) buildings, teaches magnetism as a second grade unit. This unit is a modified version of *Mostly Magnets* (AIMS, 1991). This modification serves to address state science frameworks with supplemental trade books. Ford (2004b) notes that physical science topics are least frequent in content area trade books. Ford (2004a) describes the problem as follows: ". . . aligning applied science topics with the concepts central to standard-based physical science can be difficult to achieve without losing focus on the big ideas" (p. 286). Table 1 features an analysis of magnet concepts found in *Mostly Magnets*. This analysis includes identified concepts, illustrations, and student reproduction pages. The identified concepts generally align with the magnet concepts (Barrow, 1990a) except uses. Regarding poles, *Mostly Magnets* concentrates upon ceramic magnets and fails to identify where the poles are located (flat surfaces). The illustrations include ceramic, horseshoe, bar, and Earth as a magnet. The student pages address all concepts except uses and poles from *Mostly Magnets* concept 1.

Table 1. Magnet Concepts in AIMS' *Mostly Magnets*

	Concepts	Illustrated	Student Pages
1. Magnets always have two poles where they exert the greatest force.	Yes	No	Yes
Poles at end	No	Yes	No
North and south poles	Yes	Yes	No
Strongest at end (poles)	No	No	No
2. Iron materials are attracted to magnets.	Yes	No	Yes
3. When magnets are brought together, unlike poles attract and like poles repulse.	Yes	No	Yes
4. Magnet has a force field, which goes through things.	Yes	No	Yes
5. Compass points to magnetic north.	Yes	Yes	Yes
6. Moving electric current creates a magnetic field/electromagnet.	Yes	Yes	Yes
7. Magnets come in a variety of sizes and shapes.	Yes	Yes	Yes
Earth is a magnet.	Yes	No	Yes
Loadstone/magnetite	Yes	Yes	Yes
Horseshoe	Yes	No	Yes
Bar	Yes	Yes	No
Ceramic/circular	Yes	Yes	Yes
8. Magnets have a variety of uses.	Yes	Yes	Yes
Motors	Yes	Yes	Yes
Telephones/burglar alarms/door bells	No	No	No
Tapes, disc player, microphone, TV	No	No	No
Computers	No	No	No
Magnetic train/MRI	No	No	No
Post on refrigerator	No	No	No
Electromagnet in salvage yard	No	No	No
Compass	Yes	Yes	Yes
Can opener	Yes	No	Yes

Since *Mostly Magnets* was designed for use in grades 2-8, several sections are inappropriate for second grade use in the local school (e.g., domains, induction, temporary versus permanent magnet, measuring magnetic force in newtons, and percent error of measurement). *Mostly Magnets* focuses upon the concept of magnetic interaction between magnet and attracted iron materials or non-attraction of non-iron materials and attraction of unlike poles and repulsion of like poles. Safety consideration, proper storage, historical perspective, and a 33-item glossary are included in this teacher resource. Surprisingly, there is a three-page student section on cow magnets, but refrigerator magnets are omitted, thereby, overlooking students' common magnet experiences. The teacher's materials accurately use north and south seeking poles, but student materials are inconsistent in their use of poles. They do distinguish between magnetic and north poles.

In addition to the kit resources, each school's media center and public library provided the magnet trade books used in this study. A variety of types of trade books [e.g., informational texts (fiction and nonfiction), and activity books] exist. No picture books, biographies, or how-to books were found on magnets. A content analysis of magnet trade books, using the existing validated matrix (Barrow, 1990a) is the focus of this study. In addition, the readability level is determined by the second Barrow using Flesch (1974).

Table 2 provides Barrow, title, year published, genre, and readability level for the magnet trade books. A summary is provided for each of the trade books. Each trade book is identified by its genre, analysis of the illustrations, common features present or absent, and analysis of student investigation(s) if included. This analysis is summarized in Table 3.

Table 2. Magnet Trade Books, Genre, and Readability

Barrow	Title	Year Published	Genre	Flesch Readability
Ardley, N.	*The Science of Magnets*	1991	Nonfiction	5.5
Branley, F.	*What Makes a Magnet?*	2002	Fiction	6.3
Edom, H.	*Science with Magnets*	1985	Activity	5.6
Fitzpatrick, J.	*Magnets*	1985	Nonfiction	2.7
Fowler, A.	*What Magnets Can Do*	1995	Nonfiction	3.0
Parker, S.	*Fantastic Facts: Magnets*	2002	Nonfiction	12.0
Rosinsky, N.	*Magnets Pulling Together, Pushing Apart*	2003	Nonfiction	5.2
Taylor, B.	*Electricity and Magnets*	2001	Nonfiction	5.1
Tocci, S.	*Experiments with Magnets*	2001	Nonfiction	2.3
Whalley, M.	*Experiments with Magnets and Electricity*	1994	Activity	5.0

Table 3. Structural Components for Magnet Trade Books

Barrow	Activity	Results Given	Storage of Magnets	History	Index	Glossary	Parent/ Teacher Notes	# of Pages	Side Bars	Other Trade Books Listed	Websites
Ardley	X	X	X					29	X		
Branley				X				32			
Edom	X				X		X	24			
Fitzpatrick	X		X		X			30			
Fowler	X	X			X	X	X	32			
Parker	X			X	X			64	X		
Rosinsky	X	X		X	X	X		24		X	
Taylor	X				X	X		32			
Tocci	X	X						46			
Whalley	X		X	X	X	X		32			

Results

Each of the magnet concepts were analyzed separately and across the trade books (See Table 4). Only three of the trade books (e.g., Ardley, 1991; Taylor, 1990; Whalley, 1994) identified that all magnets have two poles and that this is the region of the greatest force. All trade books, except Branley (1996), Fowler (1995), and Tocci (2001) incorrectly reported that the poles are always at the end of the magnet. In addition, Branley (1996) and Tocci (2001) included ceramic magnets in their trade books, thereby, promoting this misconception about location of the poles. All trade books, except Edom used north and south poles in their prose. Books by Ardley (1991), Branley (1996), Fitzpatrick (1985), Parker (2002), and Whalley (1994) noted that poles are the area of greatest force at the end of the magnet.

Table 4. Magnet Concepts in 11 Magnet Trade Books

Concepts	Ardley	Branley	Edom	Fitzpatrick	Fowler	Parker	Rosinsky	Taylor	Tocci	Whalley
1. Magnets always have two poles where they exert the greatest force.	+							+		+
Poles at end	+		+	+		+	+	+		+
North and south poles	+	+	+		+	+	+	+	+	+
Strongest at end	+	+		+		+				+
2. Iron materials are attracted to magnets.	+	+	+	+	+	+	+		+	+
3. When magnets are brought together, unlike poles attract and like poles repel.	+	+	+	+	+	+	+	+	+	+
4. Magnet has a force field, which goes through things.	+		+	+		+	+	+		+
5. Compass points to magnetic north.	+	+	+	+	+	+	+	+	+	+
6. Moving electric current creates a magnetic filed/electromagnet.	+		+	+	+	+		+	+	+
7. Magnets come in a variety of sizes and shapes.										
Earth is a magnet.		+			+	+			+	+
Loadstone/magnetite	+	+	+			+	+		+	+
Horseshoe	+	+	+	+	+	+	+	+	+	+
Bar	+	+	+	+	+	+	+	+	+	+
Ceramic/circular		+	+			+	+	+	+	+
8. Magnets have a variety of uses.										
Motors	+		+	+	+	+	+	+	+	+
Telephones/burglar alarms, door bell	+				+		+			
Tapes, disc player, microphone, TV	+		+		+				+	+
Computers	+				+				+	+
Magnetic trains/MRI	+					+				+
Post on refrigerator	+	+	+	+	+	+	+	+	+	+
Electromagnet in salvage yard	+						+	+		
Compass				+				+		
Can opener						+				

Only Taylor (1990) failed to report that iron materials are attracted to magnets. All trade books accurately identified that unlike poles attract and like poles repel. Regarding the concept of the ability of a magnetic force field to pass through things, several trade books (Branley, 1996; Fowler, 1995; Tocci, 2001) ignored this concept. All trade books discussed that magnetism causes a compass to operate. Electromagnets were ignored only by Branley (1996)and Rosinsky (2002).

Regarding shapes and sizes of magnets, horseshoe and bar magnets were either discussed and/or illustrated by all trade books; however, the world's largest magnet—the Earth, was ignored by Ardley (1991), Edom (1985), Fitzpatrick (1985), Rosinsky (2003), and Taylor (1990). All trade books with the exception of Fitzpatrick (1985), Fowler (1995), and Taylor (1990) mentioned natural magnets (lodestone or magnetite). Ardley, Fitzpatrick, and Fowler ignored ceramic/circular magnets.

Magnets have a large number of uses in our modern society. The trade books had considerable variation in uses, except all noted the posting of things on the refrigerator door. All trade books but Branley (1996) noted the use of magnets in motors. Telephones, burglar alarms, and/or door bells were mentioned in some trade books (i.e., Ardley, 1991; Fowler, 1995; and Rosinsky, 2003). Tapes, disc players, microphones, and/or TV were mentioned by Ardley, Edom, Fowler, Tocci, and Whalley. Computers were mentioned by the same authors (except Edom). Magnetic trains/MRI were mentioned by Ardley, Parker, and Whalley. Use of an electromagnet in a salvage yard was discussed/illustrated by Ardley (1991), Rosinsky (2003), and Taylor (1990). Only Fitzpatrick and Taylor identified that magnets influence how a compass operates. Only Parker mentioned that a magnet prevents the lids from dropping when you use a can opener (See Table 4).

Discussion

Elementary teachers of science need to be selective in the trade books they use for the study of magnetism. If the trade books are being used to supplement a unit of instruction like in the area school district, this presents a different concern than when the trade book(s) are used as the primary resource. For students to develop understanding of magnetism (NSES, 1996), teachers need accurate resources that will challenge their students' misconceptions. In preparing to teach a unit on magnets, teachers need to compare the accuracy of both the primary and secondary resources for the major magnet concepts used in this study. Rather than using all of a trade book, specific pages/sections could be used for a particular concept, like uses of magnets. According to Owens (2003), children consider all formations and illustrations conveyed in trade books to be accurate unless teachers clarify the inaccuracies.

Readability values for this series of magnet trade books are mainly at the elementary level; however, many exceeded the second grade level of the magnet unit. The trade books were being used as supplemental resources. For slower readers, who are not interested in magnets, specific illustrations could be noted with question(s) to help students develop an understanding about magnets.

The original eight magnetism concepts (Barrow, 1990a) were developed for K-6 science curriculum; therefore, it would not be expected that a one-time exposure to magnets would provide students with a total understanding of magnetism. For example, the connection between magnetism and current electricity would be best left to intermediate level or later. Consequently, the use of electromagnets in salvage yards, magnet trains, and MRI only becomes possible after the study of current electricity. Unless students have studied about cardinal directions, the use of the compass and how it operates will be confusing to them.

Mostly Magnets addresses the vast majority of the eight magnet concepts except uses. Children's personal experience with magnetism can be used to build understanding. For example, to determine what materials (i.e., iron, nickel, and cobalt) are attracted to a magnet, students can use a ceramic magnet and test various objects so they can generate attributes of things attracted and not attracted to a magnet. Students should note what part of the magnet the object sticks to. To be able to see the concept of repulsion requires two magnets. Sometimes students might consider non-attraction as repulsion if they only have one magnet. The inexpensive ceramic magnets allow individual students to have individual experiences with magnets (Barrow, 1990a). Teachers might consider the use of the K-W-L chart (Ogle, 1986) or its modification by Crowder and Cannon (2004).

Saul (2004) stressed the importance that resources must be accurate. In this study of magnet trade books, we found that all trade books accurately described how like and unlike poles behave and that a compass points to a magnetic north pole. Other concepts were not uniformly developed in some of the trade books. We recommend that science concepts, like NSES (National Research Council, 1996) or state standards, be used to evaluate the accuracy of science concepts in the trade books. A validated concept matrix, like that used in this study (Barrow, 1990a), should be used to evaluate potential trade books.

Of equal importance to the concepts, the trade books should be reflective of current effective teaching strategies of students' learning (Bransford, Brown, & Cocking, 2000) and teaching standards of NSES (National Research Council, 1996). Yager (2004) stresses the inquiry aspects of science as reflected in NSES. All of the magnet trade books had a student activity (except for Branley); however, some trade books (i.e., Ardley, 1991; Fowler, 1995; Rosinsky, 2003; Tocci, 2001) provided the results directly in the book. How would this motivate students to want to investigate/inquire? If these trade books are used, conducting the activity could be done before the trade book was introduced, thereby, motivating the students' interest. Subsequently, after reading the trade book, additional investigations could be developed by an individual or groups of students, thereby, promoting their personal inquiry about magnets.

In this article, the authors have tried to summarize the strengths and weaknesses of trade books dealing with the topic of magnets. Despite the fact that in some cases, these books had serious limitations, it should be remembered that this should not limit the use of this type of material by the effective science teacher. For many students, the opportunity to read a variety of trade books, whether it be on magnets or other scientific topics, opens the door of inquiry into the wide world of science. As can be seen in our discussion in this article, books on magnets are available in a wide variety of reading levels and writing styles. In the hands of a competent teacher, they frequently are the "doorway" to not only further reading in science in the classroom but also exploring the wide world of literacy beyond the school. Science teacher educators should model effective use of trade books to include specific content strengths and weaknesses of science trade books.

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Appendix: Descriptions of Trade Books

Each of the 10 trade books' organization is described in subsequent paragraphs. Concepts that are not appropriate for the elementary level (Barrow, 1990a, 1990b) are noted.

***The Science of Magnets* (Ardley, 1991)**
Ardley's book is a series of one- and two-page activities with sidebars of detailed information. Each of the 14 activities has detailed procedures with photographs and results in prose. This 29-page book lacks an index, glossary, and table of contents. Procedures for proper care of magnets are provided at the front of the book. Caution about dropping a magnet, which can result in loss of magnetic force, and proper storage procedure of bar magnets are included. Induction of magnetic force, magnetic field theory, and aurora borealis, due to Earth's magnetic field, are beyond the elementary level.

***What Makes a Magnet?* (Branley, 1996)**
Branley's book is mainly a fiction trade book that also provides a historical perspective. Short sections provide an induction of magnetic force and domain theory of magnetism, which are both beyond the elementary level.

***Science with Magnets* (Edom, 1985)**
Edom's book is a 24-page activity book. This resource provides notes to parents/teachers who provide answers to the activities. The proper storage procedure for bar magnets is included. Inducing a magnetic force and domain theory of magnetism, both beyond the elementary level, are described.

***Magnets* (Fitzpatrick, 1985)**
Fitzpatrick's work is a 30-page activity book with interspersed prose. Illustrations and drawings with the answers to the activities' questions are provided. Safety procedures and equipment to be used are provided at the start of the book. The last page provides more detailed suggestions on the care and storage of the magnets. A detailed index identifies use of terms throughout the book besides the page where it is defined. A safety note is given on keeping magnets away from digital watches and calculators because magnets will alter the display. Proper storage procedures, how hitting destroys a magnet, and induction of magnetic force are mentioned.

***What Magnets Can Do* (Fowler, 1995)**
Fowler's work is a 32-page nonfiction book. There are limited activities included with most of the answers included in the prose. A unique glossary that uses pictures to define terms is included, and a separate index is provided on the last page. Inducing of a magnetic force is covered.

***Fantastic Facts: Magnets* (Parker, 2002)**
Parker's work is a resource book. Throughout the 64 pages, facts are included in side bars. Also, activities are interspersed without specific answers. Several additional concepts about magnets are included: domains of magnetic theory, permanent versus temporary magnets, inducing a magnetic force, history of

magnets, destruction of magnets, and magnetic poles of the Earth and their reversal of poles over geological time. Because of readability, this trade book could be better used as a teacher's resource. The illustrations have a variety of uses and could facilitate a magnet unit.

Magnets Pulling Together, Pushing Apart **(Rosinsky, 2003)**
Rosinsky's book is a combination of fiction, activities, and nonfiction side bar structure (fun fact). Illustrations rather than photographs are used throughout the 24-page trade book. The table of contents provides broad headings with the largest section devoted to how magnets work. Five experiments/activities are found at the end of the book. Within each experiment, a description is provided of the expected results. A six-word glossary (without pronunciation key) and index are found on the last page. Additional library and web resources are also identified. The history of magnetism and induction of magnetic force are also included.

Electricity and Magnets **(Taylor, 1990)**
Taylor's (1990) 32-page book on electricity and magnets addresses current and static electricity and magnetism. The study of magnets begins on page 18. The magnet section is nonfiction with photographs illustrating various types of magnets with two activities (making a compass and electromagnet). Safety aspects are also discussed. The book concludes with several activities (without procedure), "did you know" trivia page, glossary, and detailed index.

Experiments with Magnets **(Tocci, 2001)**
Tocci's book is a 46-page activity trade book in which the answers to each activity are on subsequent pages. Inappropriate elementary concepts include induction of a magnetic force and atom arrangement in the magnets.

Experiments with Magnets and Electricity **(Whalley, 1994)**
Whalley's (1994) 32-page book begins with magnets for the first 11 pages then includes information about static and current electricity. This book intersperses activity questions (without detailed procedures) with nonfiction. The photographs selected will promote interest in studying about magnets. Proper storage and harmful aspects are noted. The book begins with a table of contents and concludes with a detailed glossary and index. Keeping magnets away from audio and video electrical equipment to avoid distortions and proper storage of bar magnets are mentioned. Also, the induction of magnetic forces and aurora borealis, both above the elementary level, are included.