Using trade books in teaching elementary science: Facts and fallacies

Trade books can be a valuable addition to the science curriculum, if teachers know how to select good ones.

One day while waiting for a colleague in reading education to complete a phone call, I picked up a children's trade book lying on her desk and casually began to glance through it. After her call, she noted my interest in the book. She explained to me how wonderful it was and suggested that it would be a good book to use in teaching elementary science. As a science educator, I disagreed because of inaccuracies I had noticed in the book.

We embarked on a discussion, almost a debate, about using trade books in science teaching. This dialogue continued over the next several weeks and eventually sparked our collaboration on a research project to explore the use of trade books in science classes. Specifically, we wanted to look at whether or not children develop accurate science concepts from trade books used in science instruction.

Using trade books in teaching science: A growing trend

For generations, trade books have been a rich part of childhood. Most of us remember reading with a parent before bedtime or hiding under the covers with a flashlight, trying to finish those last few pages of a captivating story or novel. Many of us remember anticipating the next exciting chapter in the book our teacher was reading to us during quiet time after lunch each day. The titles may vary but the memories are quite similar.

Though trade books have remained a staple of pleasure reading for elementary children, the role of trade books in elementary instruction has expanded, particularly in the content areas. In science classes, trade books or "library" books were initially used as supplements to science instruction (Blough, 1973). As more teachers adopted an integrated approach to teaching, the range of trade books that found their way into the science curriculum broadened to include not only science informational books, but also fiction, science fiction, and even poetry (Casteel & Isom, 1994; Ediger, 1995; Lamertino, 1995; Nordstrom, 1992; Short & Armstrong, 1993). Recently, trade books have even begun to replace science texts in some elementary science classes (Armbruster, 1993; Ross, 1994).

While the use of trade books in teaching science has grown increasingly popular, there is very little quantitative support for their use in science classes (Royce & Wiley, 1996). A number of important questions remain unanswered. What evidence is there that children are learning "good science" from trade books? Is the content in trade books accurate enough to serve as a substitute for content provided by traditional science texts? If not, what is an appropriate role for trade books in the elementary science class?

Using trade books in teaching science: The right reasons

There are many pragmatic reasons for the growing popularity of trade books in teaching elementary science. One is their widespread
availability from local bookstores, professional sources, and commercial catalogs (Kralina, 1993). The number of trade books published each year has increased tenfold since 1900 (Lynch-Brown & Tomlinson, 1998). This geometric growth has resulted in over 120,000 children’s books in print today (Lynch-Brown & Tomlinson, 1999). Because trade books are so easily integrated into whole language and thematic curricula, they have become “readily accepted by educators and heavily promoted by publishers” (Mayer, 1995, p. 16).

Problems with science texts have been a major force driving the trend toward using trade books in elementary science. Not only are trade books more widely available (Kralina, 1993; Lynch-Brown & Tomlinson, 1999; Walpole, 1999), they are generally more up to date than the science texts found in many elementary classrooms (Moss, 1991; Ross, 1994; Tyson & Woodward, 1989). Science texts can be daunting for many children, particularly those who have reading problems. Texts often contain unfamiliar vocabulary (Casteel & Isom, 1994; Short & Armstrong, 1993; Tyson & Woodward, 1989) and tend to cover a large number of topics (Lamartino, 1995; Tyson & Woodward, 1989).

Trade books, on the other hand, tend to be more focused and provide an in-depth look at single concepts (Cullinan, 1981; Moss, 1991; Ross, 1994). Teachers find trade books to be an attractive option because trade books can accommodate differences in reading abilities of students (Carlile, 1992; Gee & Olson, 1992; Lamartino, 1995; Nordstrom, 1992; Ross, 1994) and also provide for differences in learning styles (Madrazo, 1997).

Trade books are generally more interesting and less confusing for children than texts (Ross, 1994). Butzow and Butzow (2000) pointed out that children’s books have story lines that help children understand and remember concepts better than textbooks that tend to present science as lists of facts to be memorized. Trade books contain colorful pictures and the graphics are superior to many texts for explaining abstract ideas (Kralina, 1993). Trade books also provide a context for understanding difficult science concepts (Dole & Johnson, 1981). Both fiction and non-fiction can be used to support the inquiry approach to teaching science (Nordstrom, 1992; Short & Armstrong, 1993), to facilitate the development of problem-solving skills (Daisey, 1994; Ediger, 1995), to introduce the scientific method and the excitement of discovery (Janke & Norton, 1983), and to enhance creativity and thinking skills (Kralina, 1993).

Many children simply find science textbooks too boring (Dole & Johnson, 1981; Moss, 1991). In contrast, trades are fun to read (Kralina, 1993; Nordstrom, 1992), are more interesting and relevant to students’ lives (Butzow & Butzow, 2000; Dole & Johnson, 1981; Hammond, 1992; Kralina, 1993; Maria & Junge, 1993; Stiffler, 1992), and less intimidating (Carlile, 1992; Casteel & Isom, 1994; Crook & Lehman, 1990; Dole & Johnson, 1981). They have been shown to positively affect self-esteem and social skills (Kralina, 1993) and have also been cited as presenting a more human side of science than do textbooks (Huck as cited in Short & Armstrong, 1993; Kralina, 1993; Ross, 1994).

Advocates of trade books also point to the more positive view of women and minorities that trade books communicate. Unlike science texts that have been criticized for the absence or poor representation of women and minorities (Potter & Rosser, 1992), trade books “view and celebrate diversity of achievement” (Daisey, 1994, p. 133). The dearth of females and people of color in science texts suggests that only certain people can be scientists and promotes stereotypes. Ultimately, large numbers of females and minorities feel alienated from science (Daisey, 1994). The number of students in these groups who are considered science illiterate is, in fact, disproportionately large (Glynn & Muth, 1994). As a result, women and minorities continue to be underrepresented in graduate and undergraduate science programs and science careers (Clark, 1999; Hill, 1999; Milbourne, 1999; Rosser & Kelly, 1994).

Lamme and Ledbetter (as cited in Ross, 1994) provided some indication of the growing status of trade books in elementary science today. Promoting the use of trade books over texts, they observed, “Textbooks in the content areas simply cannot match the flexibility, depth or quality provided by trade books” (p. 7). Walpole (1999) expressed an even stronger view in suggesting that “new science text books aspire to match the trade book models” (p. 358).
Many books; many children

"Children's trade books today are often a child's first introduction to science" (Barlow, 1991, p. 166). In fact, trade books offer a solution to the lack of textbook support for science for young children (Stiffler, 1992). Yet, many of the benefits of using trade books in teaching science are not reserved for younger children. Trade books have also been recommended for teaching science in middle and high school (Daisey, 1994; Lapp, Flood, & Ranck-Buhr, 1995; Pottle, 1996).

As I have indicated, more integrated approaches to teaching encouraged the extension of the range of trade books in the science curriculum beyond nonfiction, such as biographies of scientists, science information books, and activity books. Pottle (1996) suggested that fiction trade books on science topics are an excellent vehicle for interdisciplinary studies because they are available on such a wide variety of topics. Many others in reading and science education have advocated the use of fiction for a variety of reasons (see, for example, Barrow & Salesi, 1982; Butzow & Butzow, 1988, 2000; Casteel & Isom, 1994; Dole & Johnson, 1981; Ediger, 1995; Fisher, 1980; Nordstrom, 1992; Ross, 1994; Short & Armstrong, 1993; Smado, 1982). Poetry is a genre also recommended more frequently today for science classes (Madrazo, 1997; Short & Armstrong, 1993).

The growing acceptance of trade books, both fiction and nonfiction, as a resource in teaching science is very much in evidence. Teachers who have recently been involved in textbook adoptions will have noticed that in promoting their elementary science series, many publishers are including trade books among the many products to accompany recent editions of elementary science texts. For example, Houghton Mifflin has identified over 100 trade books for use with their series, Science Discovery Works, including a wide variety of fiction, fables and tales, biographies, and science informational books. In addition, a number of popular elementary and early childhood science methods texts (see for example, Gega, 1994; Harlan & Rivkin, 2000; Martin, 1997; Wollfinger, 2000) as well as resource books for teachers (Butzow & Butzow, 2000; Cerullo, 1997; Fredericks, 1997) identify trade books that can be used in lessons integrating reading, language arts, and science, or otherwise be incorporated into science lessons.

Using trade books in teaching science: A theoretical perspective

In recent years, changes in the philosophical stance of a large part of the science education community have resulted in a convergence of theoretical perspectives in science and reading. As a result, the pragmatic reasons for using trade books in science described previously are not without theoretical support from both fields. Rosenblatt's (1991) transactional view of reading as an act in which the reader's prior experience, knowledge, and personality interact with the text to create meaning is in tune with many of today's teaching practices (Lynch-Brown & Tomlinson, 1999). It is also in accord with the constructivist view of teaching and learning science that has emerged as the predominant perspective in science education over the past 20 years. This perspective holds that learners actively construct their own meaning when new information is linked to prior knowledge (Duschl, 1990). With the widespread adoption of this interactive constructivist view, science educators now seem more open to the potential of alternative teaching strategies such as using trade books (Armbuster, 1993).

Examination of these theoretical underpinnings may also provide some insight into the failure of science to embrace females and people of color and, concomitantly, to suggest why expanding reading in science may increase access to the field for these groups. Rosenblatt's (1991) theory holds that there are two stances to reading: the efferent relating to the factual, analytical aspects of reading and the aesthetic, or emotional, aspect of the reading process. Science, as it has traditionally been taught, has generally failed to address the aesthetic component of reading in favor of the efferent. Contemporary constructivist views of teaching and learning science appreciate more fully the importance of both stances. Similarly, trade books are more likely to promote both stances than are texts that tend to evoke efferent responses. Since women and minorities tend to respond to the emotional, more relevant, more personal, and real-world aspects of the nature of science (Beane, 1988; Rosser &
Kelly, 1994) this increased appreciation for the aesthetic component of reading has the potential to help open laboratory doors to these underrepresented groups.

**The quality of science content in trade books: The story of Mr. Blueberry**

Without a doubt, trade books have much to contribute to science instruction and their inclusion as a part of the regular science curriculum is becoming more common. However, there has been little consideration of the quality of science content in these books. An examination of the literature in both science and reading education finds little research on the nature of the relationship between quality of content in trade books and the development of science concepts. A handful of studies comparing the effects of trade books and traditional texts on science achievement and attitude toward science can be found (see for example, Fisher, 1980; Lamartino, 1995; Lytle, 1982; Maria & Junge, 1993). Findings in these studies were generally inconclusive, but suggested that the children learned at least as much from trade books as they did from science texts.

Mayer (1995) provided a rare look at how trade books influence the development of science concepts. In a simple but revealing study, Mayer read *Dear Mr. Blueberry* (James, 1991), a fiction trade book about whales, to 16 children from kindergarten through third grade. After she read the book to each child, Mayer asked the child to retell the story and to answer 10 questions about what had been learned from the story. Mayer had chosen this topic because whales are a popular subject in children’s literature and this particular book in part because she felt that it described whales “fairly and adequately.” In addition, it is a trade book intended for children “in preschool through second grade, an age group that is a common target for teaching science with children’s literature” (pp. 16–17).

In the book, the character of Mr. Blueberry directly addresses and corrects misconceptions about whales in a series of letters exchanged with a little girl. Apparently, Mayer’s choice of *Dear Mr. Blueberry* was also based on the assumption that the direct contrast between inaccuracies and correct ideas about whales would leave little room for confusion. Her findings indicated that the children learned relatively few new facts about whales from this book. Indeed, Mayer found that several new misconceptions were unintentionally communicated to the children. That whales jump from ponds to oceans and have either white or yellow bottoms were two of the “pseudofacts” children reported in interviews. That is, the children were remembering the erroneous ideas held by the little girl instead of the correct information Mr. Blueberry was providing. Some of the children actually thought the whale was a person, perhaps a reflection of the anthropomorphic view characteristic of children of this age.

Mayer’s (1995) findings supported the work of Jetton whose 1992 study (as cited in Maria & Junge, 1993) demonstrated that second graders remembered story ideas rather than the science information even when they had been told that the purpose of reading the book was to learn more about whales. The trade book in the Jetton study combined elements of fantasy with science concepts.

Mayer (1995) concluded that a number of elements in *Dear Mr. Blueberry* actually interfered with the development of science concepts. Misrepresentations and illustrations in the book apparently confused some of the children. Mayer also suggested that the “children’s own gender bias and understanding of animal behavior” (p. 17) were influenced negatively by the way in which the girl and the whale interacted in the story. She reported that the children she interviewed thought that the little girl in the story looked silly. This response demonstrates how children can take away quite unexpected views of characters in trade books that are surely not the intent of the author.

Unfortunately, Mayer’s (1995) study is only a single example of empirical research designed to address the specific question of how children’s ideas in science are affected by the content in trade books. Obviously, one study does not provide conclusive evidence and is surely not a basis for crying “the sky is falling” with regard to trade books in the elementary science classroom. However, Mayer’s work raises important issues. The first is a concern with accuracy of content in trade books that are used in teaching science. There is also the question of how content, whether accurate or not, affects the development of children’s science concepts.
From fireflies to fungi

It was shortly after our first discussion about using trade books that my reading colleague noticed the Mayer (1995) study cited in an article on reading in science. We found the results of Mayer’s research eye-opening and her study provided a focal point for our own research.

The first phase of our project was to carry out a content analysis of a sample of trade books addressing science concepts that are commonly found in elementary classrooms. Of the 50 books we selected, many were written by popular authors of children’s literature such as Ruth Heller, Jerry Pallotta, Eric Carle, and Tomi dePaola. Twenty-eight of the books in our sample were categorized as science trade books, 19 as fantasy books, and three as realistic fiction (Rice & Rainsford, 1996). The question guiding our research was, “How accurate is the science content in children’s trade books?”

The trade books we examined communicated misinformation about science concepts in a variety of ways, in text as well as in drawings and artwork. This finding supported Mayer’s (1995) suggestion that misrepresentations in both text and illustrations confused some children. We also discovered that while many errors in content are explicit, some of the misinformation is more implicit or may be inferred from text and illustrations.

A detailed description of the numerous examples of misinformation we identified in the sample of 50 books is beyond the scope of this discussion. A few examples of what we found include seeds fly high enough to be burned up by the sun (The Tiny Seed, Carle, 1987), fireflies dance around the moon (The Grouchy Ladybug, Carle, 1996), and crocodiles can walk on two legs (Cornelius, Lionni, 1983). In The Quicksand Book (dePaola, 1977), the drawings depict jungle scenes with children dressed like Tarzan and Jane, implying that quicksand is found only in jungles—which is not true. Slugs, snail-like creatures, are identified as “bugs” in Bugs (Parker & Wright, 1987). “Bug” is actually a term reserved for a specific group of insects and is not an appropriate name for slugs, which are members of the mollusk group of animals.

In The Mixed Up Chameleon (Carle, 1975), A Color of His Own (Lionni, 1975), and The Yucky Reptile Alphabet Book (Pallotta, 1989), the chameleon, a reptile whose skin changes color in response to environmental conditions, is shown changing to hues such as bright red, yellow, or white. Chameleons are limited in the colors to which they can change, generally from shades of green or yellowish-green to shades of brown. Even the more brightly colored chameleons cannot change to bright red, yellow, blue, or white, just because the environment around them is one of these colors. A similar bit of exaggeration is found in How to Hide a Butterfly (Heller, 1992) where, as an example of camouflage, a spider is shown changing “to yellow and then to pink or white, depending on the flower that she decides is right.”

Carle’s “mixed up chameleon” is, in fact, shown in a more natural green on the last page of that particular book. However, as Mayer’s (1995) study clearly demonstrated, when both inaccuracies and science facts are presented in the same book, children do not necessarily remember the correct information.

The first time I read one of these books, the misinformation communicated about chameleons hit home for me as an elementary science methods teacher. In my university classes, both undergraduate and graduate, more than one student has responded in surprise when I’ve pointed out that chameleons, at least those native to our area, don’t turn scarlet or bright blue!

Using words such as “icky” (The Icky Bug Alphabet Book, Pallotta, 1986) and “yucky” (The Yucky Reptile Alphabet Book, Pallotta, 1989) reinforces negative stereotypes of science as a messy, smelly, repulsive experience. Such images, often communicated by parents and teachers, encourage negative attitudes toward science. These attitudes affect all children, but particularly reinforce cultural stereotypes that discourage girls’ development of greater interest in science (Ballou, 1986).

Another example of how subtle stereotypical images may be communicated is found in the following passage from The Ocean Alphabet Book (Pallotta, 1986): “E is for eel. Eels are slimy. Eels are long and thin like snakes. If you do not like to hold snakes, then you probably would not like to hold eels.” This analogy reinforces the common misconception that snakes are slimy, when they are actually dry and cool to the touch.
A glaring error is found in the popular children’s trade book, *The Reason for a Flower* (Heller, 1983). In the closing pages of the book, a picture of a mushroom is accompanied by the statement, “Plants that have no flowers are fascinating, too.” For me, a former life science teacher, this reference is particularly disconcerting. Fungi were reclassified decades ago and placed in a different kingdom. Mushrooms, which are examples of fungi, are not plants.

**What science are children learning from trade books?**

It was clear from our research that many of the trade books that teachers might select for science classes contained questionable content. Next, we followed Mayer’s (1995) lead and explored what scientific information, or misinformation, children take away from trade books. Like Mayer, we chose whales as our topic because of the popularity of whales with elementary children and the availability of trade books on the subject.

We identified 10 books on whales commonly found in elementary media centers. Content analysis of these books revealed a number of scientific inaccuracies or misconceptions. In order to focus on a smaller and more manageable number of concepts, we narrowed the sample to five books. We then developed a set of five or six true or false questions for each story. Each set of questions included at least two questions related to errors in content that we had identified.

Two classes of second graders and one fourth-grade class participated in our study (Rice & Rainsford, 1997; Rice & Snipes, 1997). To the second graders, we read *Whale Song* (Johnston, 1987), *The Whales* (Rylant, 1996), *Dear Mr. Blueberry* (James, 1991), *I Wonder If I’ll See a Whale* (Weller, 1991), and the chapter, “The Three Gray Whales” in *Animals Who Have Won Our Hearts* (George, 1994). We read the fourth graders *Whale Song*, *The Whales*, and *Dear Mr. Blueberry*.

Answer sheets required the children to simply circle “yes” or “no” in response to each question. For the younger children, “smiley” or “frowning” faces were used on the answer sheets. Regardless of grade level, the questions were read aloud to the children to reduce the impact of differences in reading level. Unlike Mayer (1995) who questioned the children about the content of *Dear Mr. Blueberry* only after she read them the book, we asked the children the same set of questions before and again after we read the book. These procedures allowed us to explore children’s prior knowledge and to pinpoint specific changes in children’s science concepts as a result of exposure to the trade book content.

We assessed the children’s prior knowledge by counting the number of correct responses on the pretests. Pretests based on the five stories read to the second graders resulted in an overall score of 58% correct. Fourth graders scored an average of 76% correct on the pretests on the three stories read to them (Rice & Snipes, 1997). It was apparent that the children had some prior knowledge about whales and their behavior.

We next characterized changes that the children made in their answers from pretest to posttest. If a change resulted in the correct answer on the posttest, we identified that change as a “correct” change. Likewise, a change from a correct to an incorrect answer on the posttest was labeled “incorrect.” An analysis of the children’s answers revealed that for the majority of the questions, children did not change their answers from pretest to posttest. When they did change answers, however, the posttest answers very closely mirrored the information in the book that had been read to them, whether the information in the book was correct or not. Two examples illustrate what we observed.

One of the questions we developed for *The Whales* (Rylant, 1996) was, “Do whales have a sense of smell?” The correct answer was “no.” The science content in *The Whales* clearly indicates this: “But a rose is lost on them, for they haven’t any sense of smell.” (In whales, areas of the brain for olfaction are greatly reduced, or more often nonexistent, indicative of the lack of a sense of smell. Though not demonstrated it is possible that baleen whales, which eat plankton, have some sense of smell [see Fontaine, 1998].)

On the pretest, about half of the children in both second and fourth grades got this question wrong, answering “yes.” With the exception of one child, all of the children who had answered incorrectly on the pretest changed their answers on the posttest. This “correction” of the children’s ideas was clearly based on information in *The Whales*. 

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We also found that children changed answers to reflect incorrect information (Rice & Snipes, 1997). For *Whale Song* (Johnston, 1987), we asked the question, “Do whale babies (calves) sleep?” The correct answer is “yes” (see Payne, 1995). However, *Whale Song* contains the following statement: “Softly she sings, six, six, six. *But does her calf sleep? No!* He just laughs and sings seven!” (Emphasis added.) It is easy to see how children might infer that baby whales do not sleep. Nineteen of the second graders gave the correct answer, “yes” on the pretest, but on the posttest this number dropped to nine. Fourth graders responded similarly to the reading of *Whale Song* with 13 of 25 students changing their posttest answers to “no.” These responses indicated that the children apparently took the book quite literally and based their “incorrect” posttest answers on the book’s content.

These examples reflect a trend that we observed with both second and fourth graders in the study. If children changed their answers, their posttest answers generally reflected the information in the book, whether it was accurate or not. As others have reported (see for example, Lamartino, 1995; Mayer, 1995), children can and do learn science from trade books. But, not surprisingly, children cannot always discriminate between accurate and inaccurate science content. As Mayer warned, what children learn from trade books is not always “science concepts, but...science misconceptions” (p. 43).

**Misconceptions and trade books**

Misconceptions are alternately referred to in science education literature as naïve conceptions, preconceptions, alternative conceptions, or children’s science. These ideas, held by both children and adults, are science concepts that are “at variance with current scientific knowledge” (Wandersee, Mintzes, & Novak, 1994, p. 179). There is a large body of evidence indicating that misconceptions may inadvertently be introduced by textbooks or teachers (Cho, Kahle, & Nordland, 1985; Gauld, 1997; Iona, 1989, 1994; Wandersee et al., 1994). Miller, Steiner, and Larson (1996) pointed out that without the accompaniment of correct scientific explanations, children’s literature and storytelling can also lead to misconceptions. Compounding the problem, a vast body of research on misconceptions indicates that erroneous ideas can be very tenacious and resistant to extinction (see for example, Miller et al., 1996; Shymansky, Yore, & Good, 1991; Wandersee et al., 1994) and interfere with subsequent learning in science (see for example, Holiday, Yore, & Alvermann, 1994; Wandersee et al., 1994).

Many assume that the science misconceptions that children develop in the early years will be tested and corrected as children mature, have more life experiences, and complete higher level science courses in middle and high school (Johnston, 1991). However, the research in science education suggests just the opposite, that we cannot assume that children’s ideas in science will become more sophisticated (Duschl, 1990). In fact, periodic surveys of randomly selected American adults over the past 20 years have shown that many adults retain naïve and erroneous ideas in science. Over the past decade, the results of the national “Survey of Public Attitudes Toward and Understanding of Science and Technology” (National Science Board, 2000) have been very consistent in demonstrating that Americans are “illiterate in science” (“Poll finds,” 1988, p. A3). For example, on the past three surveys, only 45–47% of those surveyed knew that it takes the Earth one year to go around the sun, instead of one day or one month. This response pattern persists into adulthood despite the fact that Earth, sun, moon interrelationships are typically introduced in the early elementary years and are usually addressed again in middle school earth science.

Only about half of the 1999 respondents correctly responded “false” to the statement, “the earliest human beings lived at the same time as the dinosaurs” (National Science Board, 2000). Dinosaurs, in fact, predated early humans by more than 60 million years. Misinformation about the coexistence of dinosaurs and humans is introduced and perpetuated in children’s books, television, movies, and, in some cases, through religious teachings. Apparently this is another misconception that wasn’t corrected through science classes, at least not for the 50% or so of the adult respondents who answered “true” to this statement.

The underlying problem is that erroneous ideas may be retained or interact with new information to produce unintended or unanticipated learning outcomes. In fact, attempts to link new information to incorrect ideas to build
meaning may simply result in failure (Duschl, 1990), that is, a complete lack of understanding. It stands to reason that the introduction of inaccurate information, whatever the source, should be avoided if possible. Our research suggests that by adding trade books containing inaccuracies to the science curriculum, we risk compounding these problems. For this reason, it is imperative that teachers exercise caution in selecting trade books, either as a substitute for or complement to the science text.

Accuracy: A high priority

The problems created by presenting inaccurate content perhaps have greater implications in science than in any other subject. Because science has historically been taught in an authoritarian manner, it is not unusual to find that students assume that information must be correct simply because they heard it in science class. In this context, children are at greater risk of accepting incorrect information whatever the source—whether from the teacher, science texts, or trade books.

Cullinan (1981) underscored this problem as it relates to text books, “Children do not question what they read when they are given one textbook, which is held up as embodying the final and whole truth on the subject” (p. 385). The expectation that science content will always be accurate and realistic is reflected in the words of John Burroughs, a proponent of scientific accuracy in books about nature:

It is always an artist’s privilege to heighten or deepen natural effects. He may paint us a more beautiful woman, or a more beautiful horse, or a more beautiful landscape, than we ever saw; we are not deceived even though he outdoes nature. We know where we stand and where he stands; we know that this is the power of art. But when he paints a portrait, or an actual scene, or event, we expect him to be true to the facts of the case. (cited in Eggerton, 1996, p. 21)

On numerous occasions, I have observed how students, both children and adults, assume that science content is accurate by virtue of the fact that they heard it in “science” class. For example, in my elementary science methods courses, I introduce the use of trade books by reading The Whales by Cynthia Rylant (1996). I give my college students the same pretest and posttest that we developed for elementary children in our study of trade books. Invariably a few students change some of their answers based on the book content, just as the second and fourth graders did. These same students then protest that they changed their answers only because they trusted that I would never read them something that was incorrect. Somewhat embarrassed, they lament, “But you’re the science teacher! We never thought you would read us something that wasn’t correct.”

Using trade books in teaching science: A reasonable option

Historically, elementary teachers have felt underprepared in science and science education and have been uncomfortable teaching science (see for example, Pratt, 1981; Ramey-Gassert & Shroyer, 1992; Royce & Wiley, 1996). The requirement for preservice elementary teachers’ preparation in science is typically limited to “no more than two science courses” (Bethel, as cited in Royce and Wiley, 1996, p. 18). Two, or even three courses, are a bare minimum given the range of topics in the elementary science curriculum. While many elementary teachers view science as important, they do not necessarily see science instruction as important at the elementary level (Butzow & Butzow, 1989).

In contrast, reading and reading instruction are of prime importance and elementary teachers generally feel more comfortable with children’s literature than with science texts (Butzow & Butzow, 1989). For these teachers, using trade books in teaching science would seem to be a reasonable option (Royce & Wiley, 1996). Unfortunately, there is evidence that many elementary teachers may not be discriminating in selecting trade books for use in science (Baker & Saul, 1994). Simon (1982) reported that when a particular science topic was studied, all of the books in the school library on that topic were “promptly taken from the shelves and signed out” (p. 5), a practice that is still in evidence today. Sudol and King (1996) pointed out that teachers often do not take time (or, I might add, have time) to think about the accuracy of content in books they choose. Apparently, these teachers just assume that the information is correct and fail to consider that they may be teaching “misinformation.” In light of the large body of research on misconceptions and the recent research on trade books, such actions must be viewed as significant errors in judgment.
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Selecting trade books for teaching science: A comparison of guidelines

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Identifying and selecting quality trade books

There is little question in the scientific or science education communities about the need for accurate science content in literature used in teaching science, though there is some difference of opinion about how strictly accurate the information must be (Johnston, 1991). Mayer (1995) voiced the opinion that teachers must be able to recognize weaknesses in trade books and be prepared to deal with them. Others have suggested that, at the very least, they need to be cognizant of the possibility of inaccuracies in trade books (Royce & Wiley, 1996). Fortunately, there are a number of resources available to assist teachers in their selection of high-quality trade books for their science classes.

Tips on selecting trade books for teaching science have, in fact, been available in the science education literature for quite some time (see for example, Blough, 1973; Janke & Norton, 1983; Simon, 1982). More recently, a number of authors from both the reading and science education communities have published guidelines for evaluating trade books, which elementary teachers may find helpful (Butzow & Butzow, 2000; Mayer, 1995; Pottle, 1996; Sudol & King, 1996). These sets of guidelines vary somewhat in their foci and goals, but all of them propose accuracy as an important criterion. Busy education professionals may use any of these sets of guidelines with confidence to quickly and efficiently select trade books for teaching science. Table 1 provides a comparative summary of these four sets of guidelines.

Elementary teachers may also refer to various reviews for assistance in identifying trade books for their science teaching. These resources, like the guidelines described in Table 1, place strong emphasis on content accuracy. Reviewers also consider how current books are, and look for evidence of cultural, gender, and racial biases. Some of the reviews include information about illustrations, organization, and consistency. Media specialists will be familiar with most of these resources, examples of which are found in Table 2. Science and Children is perhaps the most accessible to elementary teachers as it is commonly found in libraries and is written with them in mind. Membership in the National Science Teachers Association (NSTA) affords teachers a choice of several publications including Science and Children. Appraisal: Science Books for Young People also bears special mention because it is somewhat unique in that each book is reviewed by two individuals, a children's media specialist and a subject area specialist (Holzheimer, 1991).

Many resources are also available to help teachers in expanding their science content knowledge, a step that will contribute to better science teaching in a number of ways. For example, the ERIC Clearinghouse for Science, Mathematics, and Environmental Education (CSMEE) recently published an extensive list of adult-oriented informational trade books that provide reliable content information on a wide
Table 2
Examples of publications that review trade books for use in teaching science

<table>
<thead>
<tr>
<th>Publication name</th>
<th>Publisher</th>
<th>Publication schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appraisal: Science Books for Young People</td>
<td>Northeastern University</td>
<td>3 times a year</td>
</tr>
<tr>
<td>Bulletin of the Center for Children’s Books</td>
<td>University of Chicago Press</td>
<td>monthly</td>
</tr>
<tr>
<td>Science and Children— &quot;Outstanding Science Trade Books for Children&quot;</td>
<td>National Science Teachers Association and Children's Book Council</td>
<td>annually, in March issue</td>
</tr>
<tr>
<td>Science Books: A Quarterly Review</td>
<td>American Association for Advancement of Science</td>
<td>quarterly</td>
</tr>
<tr>
<td>Science Books and Films</td>
<td>American Association for Advancement of Science</td>
<td>5 times a year</td>
</tr>
</tbody>
</table>

variety of science and mathematics topics. Books on the list, entitled “Books to Help Teachers Achieve Science Literacy” were published between the mid-1980s and mid-1990s and address content and skills for science literacy outlined in Project 2061: Science for All Americans (American Association for the Advancement of Science, 1989). The list can be found using the “Search ERIC Database” feature on the ERIC/CSMEE website (http://www.ericse.org) or on ERIC microfiche available in many college or university libraries (Cwikinski, Czapla, & Stern, 1996).

Using trade books in teaching science: Some suggestions

Today science and reading educators, classroom teachers, and children’s authors are sharing creative ways to use trade books in teaching science. Elementary teachers may access this information by attending presentations at science and reading professional organization meetings, by reading popular publications and professional journals, and by exploring the Internet. While it is beyond the scope of this article to provide an in-depth discussion of the many potential uses of trade books, mention of a few examples will provide a sense of the range of possibilities.

While some educators feel that hands-on science leaves no room for science reading, there are, in fact, a number of strategies for teaching science that combine the strengths of reading and activity-based science instruction. Casteel and Isom (1994), for example, described a number of ways fiction and nonfiction trade books may be incorporated into thematic units that require students to exercise literacy skills such as predicting and organizing while engaging in science activities that require science process skills such as hypothesizing, gathering and organizing data, and drawing conclusions. They suggested that focusing on the literacy aspects of science instruction reduces many of the factors contributing to children’s dislike of science and, thus, helps children learn science while they become more proficient in reading and communication skills.

The learning cycle is another strategy that integrates literature and science (for details, see Barman, 1992; Marek & Cavallo, 1997). The first and last of the three stages in the learning cycle engage children in hands-on experiences, creating an initial concrete context for introduction of new science concepts and an opportunity at the end of the lesson to demonstrate understanding, obtain clarification, and reinforce these same concepts. Sandwiched between these two stages is the term introduction, consisting of activities that have traditionally constituted the entire science lesson, such as reading the text, watching videos, and defining terms. Trade books and other types of children’s literature are very appropriate for the term introduction stage as are textbooks, films, and other resources.

Miller et al. (1996) described another strategy that uses children’s literature and hands-on experiences, in this case to directly address misconceptions. Introducing lessons with What I Know-What I Want to Know-What I Learned (KWL) charts, the teacher identifies a misconception held by the children, followed by a demonstration that contradicts this invalid idea. A variety of related children’s literature, examples of real-life connections, or applications of the science concept are then combined with a
number of hands-on activities to facilitate children's shifts toward more valid scientific ideas.

Others have described various strategies that use trade books to engage children in inquiry activities. For teachers who desire a more structured approach similar to that afforded by textbooks, Crook and Lehman (1990) recommended using a five-phase direct instruction model that uses nonfiction trade books to engage children in clearly defined, purposeful research activities. Taking a different tack, Short and Armstrong (1993) described an inquiry cycle approach that brings together fiction and nonfiction literature with observation centers and displays. In their view, literature should support "the ‘doing’ of science, not take the place of observation and experimentation" (Short & Armstrong, p. 185). One of the important components of this second strategy is paired reading of trade books.

Another technique that has the potential to enhance the use of trade books (as well as science texts) in teaching science is Questioning the Author, or QtA (for a detailed discussion, see Beck, McKeown, Hamilton, & Kucan, 1997). Initially used with social studies texts, this strategy is appropriate for expository texts or for narrative texts including fictional stories, novels, and fables. Rather than using the typical questioning pattern that assesses comprehension after reading and formulation of ideas, QtA assists students in comprehending while they are reading. With QtA, the teacher uses "queries" to stimulate discussion, to uncover misconceptions, and to encourage collaborative construction of meaning as the children read. A strength of QtA for the science classroom, as I see it, is that it has the potential to reduce the authoritarian manner in which science has traditionally been presented by encouraging, actually requiring, children to question what the author is trying to say and why.

Strategies for using trade books in science lessons generally presume that the content is accurate, however, as we have seen, this is not always the case. McMillan (1993), himself an author of children's nonfiction science trade books, points out that even nonfiction books containing misinformation sometimes make their way to bookstore shelves despite thorough review. He stresses that authors must guard against not only misstatements in their books, but also errors of omission.

Fortunately, trade books that contain errors or that leave open the possibility of misinterpretation can be used effectively in teaching science. Errors, whether identified by the teacher or the children, can be used to help children learn to question the accuracy of what they read by comparing their own observations and the information in their texts to the science presented in trade books (Martin, 1997). Children can also read several sources on a given topic (Nordstrom, 1992; Ross, 1994; Short & Armstrong, 1993; Simon, 1982). As Blough (1973) pointed out, it's almost a given that children will find contradictions or disagreements if they read multiple sources. Based on multiple readings, they can make comparisons, verify facts, and note inconsistencies and errors.

Students may also be taught to evaluate qualifying statements such as "evidence seems to indicate" or "some scientists say" (Blough, 1973, p. 22) and to analyze the content in trade books to determine whether the author has included all of the necessary supporting information, whether the facts fit together logically, and whether the information is up to date (Casteel & Isom, 1994). In pursuing such questions, children can engage in research that facilitates the development of skills necessary for becoming better, more critical readers and better consumers of scientific information. In addition, the preparation of reports and communication of findings so basic to science can become opportunities to develop both writing and verbal skills.

Teachers should also feel free to use parts of books, omitting sections that are inaccurate, out of date, or otherwise problematic. For example, using Heller's The Reason for a Flower (1983) can contribute much to a lesson on flowers, if the teacher stops short of that last page indicating that mushrooms are plants.

One final thought on using trade books in elementary science can be attributed to my undergraduate elementary science methods students, who complete research projects on using trade books in science. Several of them reported that children with whom they worked in their field placements who were already familiar with a concept seemed to be more critical of what was read to them than were the students for whom the concept was relatively new. It appeared that a "little bit of knowledge" encouraged children's questioning and discouraged their acceptance of
what the “science” teacher had read as “fact.” My students concluded that quality of content is not the only issue to be considered when selecting and using trade books, but that when trade books are used is perhaps as important. Although teachers often read a trade book at the beginning of a lesson to provide a context, arouse curiosity, or raise questions (Martin, 1997), my students expressed the opinion that, in many instances, trade books might be better suited for later in the lesson or unit, rather than earlier.

**Use good science trade books in your classroom**

Earlier in this article, I raised several questions about the appropriate role of trade books in teaching science. A review of the reading and science education literature clearly demonstrates both pragmatic and theoretical support for their use in the elementary science classroom and suggests a wide range of strategies for their integration into the science curriculum. However, recent research has demonstrated that children learn not only “good science” from trade books, but also encounter errors in their reading. Therein lies the basic problem. Science content in trade books cannot always be trusted to be accurate, particularly given that most authors of children’s books, even nonfiction science trade books, lack science credentials (McMillan, 1993). Errors of omission, incomplete statements, value statements, outdated information, and lack of detail create problems just as overtly erroneous information does.

As a result, teachers should exercise caution in selecting trade books for their science classes, not simply default to trade books just because they and their students might be more comfortable with this form of literature than with science texts. Trade books should supplement, not supplant quality science texts; they should be picked with care, not swept en masse from the library shelf. Teachers must have a clear idea of their objectives and the specifics of how a particular trade book will be used in instruction. Today, educators in both science and reading are making identification of quality trade books—and there are many—easier by providing critiques, recommendations, and guidelines for evaluating trade books for teaching science. Teachers who don’t feel confident about their science backgrounds will find these resources particularly helpful.

It is only fair to note that fault does not necessarily lie with trade books or their authors. Many of the books being used in elementary and middle school science classes today, especially fiction trade books, were not written with the intent that they would become part of the science curriculum. As Mayer (1995) noted, “a book might be an excellent example of children’s literature, but at the same time, a poor resource for learning science” (p. 18). Despite the problems, the potential of trade books to enhance the science curriculum and to invigorate science instruction is significant and limited only by our imaginations.

In her poem, “Half Moonshine,” Judith Viorst (1995) aptly captured the challenge facing elementary teachers in choosing trade books for science. In a clever series of comparisons, Viorst contrasts myths or misconceptions with accurate scientific facts about the moon, labeling each statement as either “moonshine” or “true” (p. 22). The ability of teachers to identify both the shortcomings and strengths of trade books and to recognize whether students are being presented scientific fallacies or facts—moonshine or truth—is critical to the effective use of this valuable resource in the elementary science classroom.

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**References**


**Children’s books cited**


