THE EFFECT OF TRADE BOOKS ON THE ENVIRONMENTAL LITERACY OF
11TH AND 12TH GRADERS IN AQUATIC SCIENCE

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The purpose of this study was to compare the environmental literacy of 11th and 12th graders who participated in an eighteen-week environmental education program using trade books versus 11th- and 12th-graders who participated in an eighteen-week, traditional environmental education program without the use of trade books.

This study was conducted using a quasi-experimental research technique. Four high school aquatic science classes at two suburban high schools were used in the research. One teacher at each high school taught one control class and one experimental class of aquatic science. In the experimental classes, four trade books were read to the classes during the eighteen-week semester. These four books were selected by the participating teachers before the semester began. The books used were A Home by the Sea, Sea Otter Rescue, There’s a Hair in My Dirt, and The Missing Gator of Gumbo Limbo. The instrument used to measure environmental literacy was the Children’s Environmental Attitude and Knowledge Scale. This test was given at the beginning of the semester and at the end of the semester. The scores at the end of the semester were analyzed by 2 X 2 mixed model ANOVA with the teacher as the random effect and the condition (trade books) as the fixed effect.

The statistical analysis of this study showed that the students in the experimental classes did not score higher than the control classes on the Children’s Environmental Attitude and Knowledge Scale or on a subset of “water” questions.

Several limitations were placed on this research. These limitations included the following: (1) a small number of classes and a small number of teachers, (2) change from the original plan of using environmental science classes to aquatic science classes, (3) possible indifference of the students, and (4) restrictive teaching strategies of the teachers.
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CHAPTER 1

INTRODUCTION

In 1992, a panel of distinguished Americans selected *Silent Spring* as the most influential book of the last fifty years. Across those years and through all the policy debates, this book continues to be the voice of reason breaking in on complacency. It brought environmental issues to the attention not just of industry and government, it brought them to the public, and put democracy itself on the side of saving the Earth. More and more, consumer power will work against pesticide pollution, even when government does not. Reducing pesticides in food is now becoming a marketing tool as well as a moral imperative. The government must act, but the people can also decide—and I am convinced that the people will not longer let the government do nothing, or do the wrong thing.

Vice-President Al Gore
Introduction to *Silent Spring*, 1994 edition

This quote highlights the two most important aspects of research on environmental education. The first aspect is the unsteady state of our environment and humankind’s growing concern about its role and responsibility in reversing or controlling, or both, earth’s degradation in the twenty-first century. The second aspect is the importance of trade books, such as *Silent Spring*, in the education of the public.
so that we have a renewed and vital knowledge bank from which to draw when making personal and public decisions in our lives.

The deplorable state of much of our environment is almost incontestable. One has only to view and study toxic dumps, burning rain forests, acid rain, endangered species, melting ice caps, holes in the ozone layer, city smog, oil spills, loss of topsoil, depletion of groundwater, loss of biodiversity, over-harvesting of ocean fisheries and other natural heartaches to understand that great sections of our world are in desperate need of cleanup or other efforts of remediation. In order for world citizens to act intelligently, science educators must strive to make more people scientifically literate in this century. We must all understand what science literacy means and then explore and incorporate actions into our daily lives and schools to insure that our future world is governed by an informed populace.

Science literacy can be defined as the knowledge and understanding of scientific concepts and processes required for personal decision-making, participation in civic and cultural affairs, and economic productivity (Frank, 1992). But in order to truly understand this concept, we need to break it up into sections and discuss each in its own realm. The first section deals with rewards a science-literate person can reap for himself/herself. First, he/she can think for himself/herself and face life head on (Science for All Americans, 1990). Second, he/she can use scientific principles and processes in making personal decisions as he/she learns to value life-long learning (National Science Education Standards, 1996; Science for All Americans, 1990). Third, he/she can feel confident in obtaining a general education that includes aspects of science,
mathematics, and technology (Science for All Americans, 1990). And last, he/she can find worthy use of leisure time by developing a science hobby (Chambers, 1971).

Next, the science-literate person is also able to help others as well as himself/herself. He/she will not fall prey to dogmatists who propose simple solutions to complex problems. Rather, he/she will be able to (1) assess new technologies and their effects on everyone, not just himself/herself (Science for All Americans, 1990); (2) use scientific principles in discussion of scientific issues that affect society; (3) solve problems creatively as well as work cooperatively in teams (National Science Standards, 1996); and (4) understand that science is neither static nor authoritarian and that newspaper reports of new insights and revisions of accepted explanations should be studied carefully (Frank, 1992).

Science literacy produces a better community and national citizen. This citizen wants a society that is open and decent. He/she works to sustain a national economic vitality, yet he/she remains secure in a world torn by hostilities. He/she respects nature with the use of technology so that the earth’s support system is not destroyed and will be able to make intelligent decisions in social and political areas on matters involving science and technology (Science for All Americans, 1990). This mind set is so important because over half the laws passed by Congress involve some aspect of science or technology, and that number continues to increase (Shen, 1975). For democracy to succeed, for voters to make informed decisions about their lives and environments, and for choices to be logical, citizens must be familiar with scientific phenomenon and their impact on society (Fort, 1993).
Finally, science literacy produces an awareness of global magnitude. This awareness is necessary if the United States is going to maintain its leadership role in the world (Frank, 1992). Students need to mature into adults who continue to make contributions to build a new and better world (Chambers, 1971). They need this knowledge and appreciation to face the serious world problems of the twenty-first century. These problems include unchecked population growth, acid rain, shrinking rain forests, endangered species, pollution, disease, extreme inequities in the distribution of the world’s wealth, huge investments of human intellect and scarce resources in preparing for conducting war, and the threat of nuclear war (Science for All Americans, 1990).

How do we know that science literacy is a problem among students and adults? Some of the earlier studies, although ten to twelve years old, hint at present and future problems. According to Jon Miller (1988) in American Scientist, only five percent of the nation’s population is scientifically literate. The American Association for the Advancement of Science (AAAS), as noted in Science for All Americans (1990), is not very encouraging with its conclusion, “Most Americans are not science literate” (p. xv). The AAAS discusses international studies where U.S. students rank near the bottom in math and science. In the latest study of the National Assessment of Education Progress, seventeen-year-olds in 1986 scored lower than those in 1969, despite some small gain (Science for All Americans, 1990). At the 1987 Harvard University commencement exercise, a film-maker interviewed 23 graduates. He asked, “Why is it hotter in summer than in winter?” Only two students answered the question correctly (Hazen & Trefil, 1991). A similar informal survey at George Mason University posed the question, “What
is the difference between an atom and a molecule?” One-half of the seniors could not answer the question completely (Hazen & Trefil, 1991).

Now it is necessary to update these data with more current examples of the lack of science literacy. The main concern of this study is environmental literacy. Documentation of this deficiency can be drawn from four recent studies reported in the *Journal of Environmental Education*. Hausbeck (1997) concluded that environmental science needs to be taught as an individual class because the policy of infusion into other classes was not working in New York State. She cited low test scores but high interest in environmental issues as reasons to change policy. Another researcher, Singletary (1992), found that environmental education improved knowledge of the environment, but no attempt was made to alter student environmental behaviors. In a third study, Gambro and Switzky (1996) interviewed students, parents, and teachers and found low levels of knowledge about the environment in students, although these students did express concern about the environment. In the fourth study, Bradley et al. (1999) found that a ten-day environmental science course improved knowledge and attitudes about the environment. In a meta-analysis, Zelezny (1999) found that the most successful interventions used to improve environmental knowledge and attitudes were those conducted in the classroom versus those done outside the classroom.

Although not listed in the Zelezny analysis, the use of trade books can be considered as a possible intervention. Trade books often go into greater detail, with more colorful descriptions of scientific material, than the regular classroom textbook. Also, trade books are usually more reader-friendly than textbooks. Often the scientific material is entwined in a story and may even be at a lower reading level. Many are low-
cost, thus enabling a teacher to purchase a classroom set for under $100 (Anders, 1987; Carter & Mayer, 1988; Galtung, 1981; Daisey, 1994; Stewart, 1994; Steward, O’Brien, & Moje, 1995).

Statement of the Problem

Environmental literacy in United States high schools has been found to be at a very low level. Although used for years in elementary schools to help teach science, trade books have yet to find the same popularity and usefulness in secondary courses. This study sought to determine the effect on environmental education using trade books in eleventh and twelfth grade aquatic science courses.

Purpose

The purpose of this study was to compare the environmental literacy of eleventh and twelfth graders who participated in an eighteen-week, environmental education program using trade books versus eleventh and twelfth-graders who participated in an eighteen-week, traditional environmental education program without the use of trade books. The independent variable was the use or non-use of trade books in conjunction with an environmental education curriculum. The dependent variable was the environmental science literacy of the students. This dependent variable was measured by scores on the Children’s Environmental Attitude and Knowledge Scale (CHEAKS).

Hypothesis

One research hypothesis was proposed for the study as follows: Eleventh and twelfth-graders who read trade books on environmental science topics in an aquatic
science course will score higher on an environmental attitude and knowledge scale than eleventh and twelfth-graders who do not read books on environmental science topics in an aquatic science course.

Limitations

This study provides information about the effect of using trade books in eleventh and twelfth grade aquatic science classes in two suburban high schools. It may not be possible to generalize the results of this study to students in other locations or at other grade levels.

Definitions of Terms

Trade books are books other than textbooks (Cain & Evans, 1990). They get their name from the fact that they are sold in trade outlets such as bookstores (Carin, 1993). They are the second most abundant source of reading material for science (Edwards & Fisher, 1977). The main types of trade books are biographies, autobiographies, diaries, reports of major scientific events, science fiction, poetry, and expository treatments of science topics (Gega & Peters, 1998; Daisey, 1994).

Science literacy is the knowledge and understanding of scientific concepts and processes required for personal decision-making, participation in civic and cultural affairs, and economic productivity (Frank, 1992). It manifests on five levels: individual, family and peers, community, national, and global (Science for All Americans, 1990). For this study, environmental science literacy was defined by performance on the Children’s Environmental Attitude and Knowledge Scale.
Environmental education is the interdisciplinary search for knowledge about the understanding of natural (physical and biotic) systems and the dynamic intervention between these systems and humankind’s social and cultural systems (Harder, 1984). It produces a citizenry that is (1) knowledgeable concerning the biophysical environment and its associated problems, (2) aware of how to help solve these problems, and (3) motivated to work solutions (Stapp, 1973).

Environmental education interventions are planned strategies that provide information, training, or both, to modify or achieve a predicted pro-environmental outcome (Zelezny, 1999).

Summary of Design/Analysis

The research design of this study was quasi-experimental. Two teachers from two different high schools volunteered to participate in the study. Each teacher taught two aquatic science classes in the fall semester 2002. Each teacher had one class in the experimental group and one class in the control group. Assignment of treatment conditions to these classes was random. Intact classrooms were used; thus, students were not randomly assigned to the classes. At the beginning of the study, the CHEAKS pretest was administered to all the students in the study. During the course of the semester (18 weeks), four trade books were read during the experimental classes. These books all dealt with some aspect of the environment, with heavy emphasis on water—both fresh and saline, because that emphasis tied in more closely with the intent of the aquatic science course. They were selected by the teachers themselves from samples the researcher sent to them. At the conclusion of the semester, CHEAKS was
administered again as a posttest. The pretest was used to establish an equivalence of the treatment groups, and the posttest was used to determine the effect of the instructional intervention—trade book usage versus no trade book usage.
CHAPTER 2

LITERATURE SEARCH

As stated earlier, four studies were found that substantiate the need for improved environmental education in American high schools. Hausbeck et al. (1997) conducted a study with 3,200 eleventh grade students in 30 New York State public schools. At that time, New York had an environmental education policy of voluntary infusion in grades K-12. Very few schools offered courses in environmental studies. This fact seems strange in a state facing nearly every environmental problem known: toxic dumps, saltwater intrusion, aquifer depletion, decreasing solid waste dump space, ozone buildup, rodent infestation, contaminated sediments, and more. The results were that the students scored rather low on knowledge questions, with a mean score of 52% correct. They had slightly higher scores on environmental awareness and concern. The encouraging news was that 56% said they would like additional environmental courses offered in the tenth or eleventh grade. The author concluded with a recommendation that environmental education be required in a separate course in high school because voluntary teacher infusion in other classes did not appear to be successful (Hausbeck et al., 1997).

Singletary (1992) discussed case studies of selected environments courses taught by seven teachers in six Illinois secondary schools. These were separate courses labeled as “environmental science.” Interestingly, two of the seven courses were taught
by social studies teachers, and credit was given for a social studies course instead of a science course. The main conclusion drawn from these cases was that environmental education teachers have to do a great deal to raise environmental knowledge of high school students. All of these teachers emphasized learning facts, and none of them made any attempt to alter student environmental behaviors (Singletary, 1992).

Gambro and Switzky (1996) interviewed students, teachers, and parents from 52 middle schools and high schools. Data from the Longitudinal Study of American Youth (LSAY) was interpreted to determine environmental knowledge and attitude of these students. The findings revealed low levels of environmental knowledge in students. The majority of the students were able to recognize basic facts, but most could not apply this knowledge to comprehend the consequences or potential solutions to the problems. Also, little growth was found in environmental knowledge from tenth to twelfth grade. For the third time though, students expressed concern for environmental problems. This was consistent with a poll by Berk (1990) which stated that (1) 84% of those surveyed reported that they believed pollution in the country as a whole was serious and getting worse, and (2) 71% said we must protect the environment even if it means higher taxes. Gambro and Switzky did quote Astin (1990) as follows: “High school students are concerned about the environment” (p. 32). They concluded that this desire needs to be used as a source of motivation (Gambro & Switzky, 1996).

A study by Bradley et al. (1999) is the closest to the intent of this research. The author sought to establish a relationship between environmental knowledge and environmental attitude of high school students by the use of an intervention. The intervention was a ten-day environmental science course delivered to high school
students. The reasons for this study were similar to those already expressed as the rationale for this study. Young people need to be able to provide solutions to environmental problems arising from present-day actions. They are the future scientists, policy-makers, consumers, and voters. After administering a pretest and posttest, the author found knowledge of the environment increased 22% and attitudes about protecting the environment improved (Bradley et al., 1999).

The last study to be considered in the introduction of the current study is a meta-analysis of 18 interventions conducted in classrooms and in nontraditional settings. Zelezny (1999) found 34 studies published since 1974 that measured change in environmental knowledge, attitude, or behavior. After reading Brown (1991), who said that efforts to change environmental behavior appeared unsuccessful, Zelezny wanted to know if this was a correct assessment. Her findings were that the interventions in the classroom improved behavior more effectively ($r=.65$) than interventions in nontraditional settings ($r=.27$). Interventions in the classroom included investigations of environmental actions and issues, instruction on environmental action versus environmental awareness only, and a simulation game with feedback. Nontraditional interventions included activities done outside the classroom, such as camps, workshops, and making store displays, brochures, energy-use labels, and videos. She also found that the most effective interventions actively involved students, especially younger students (i.e., eighteen years or younger). She did find some problems with these studies. Few of them measured actual behavior. Instead, they relied on self-reported or inferred behavior. Her conclusion was that no studies of
classroom interventions measuring behavioral outcomes in high school students have been published to date (Zelezny, 1999).

History of Trade Book Use

Examples of trade book use to teach science, reading, and social studies in the elementary classroom are abundant. Reviewing past editions of such teacher magazines as Science and Children, Language Arts, Childhood Education, BioScience, The Clearing House, Science Scope, Reading Research Quarterly, Journal of Research in Science Teaching, and Science Education yielded 23 articles that discussed actual classroom use of trade books to teach science. Although most articles were published in the 1990s, three were from the 1980s, and one was dated 1965. The most current are 2002 and 2001, one each in the March editions of Science and Children. In the March editions, this magazine has published “Outstanding Science Trade Books for Children” lists since 1979. Several times they included an additional article with titles such as “Science Learning with Multi-cultural Emphasis” (1995), “Meeting State Standards Through Literature” (1999), and “Integrated Instruction: A Trio of Strategies” (1998).

Some of these articles summarized different teachers’ success stories with one or more favorite trade books, while other articles discussed detailed research done by college professors teamed with public school teachers exploring specific use of trade books to achieve a stated goal. This literature review will summarize only the formal studies, regardless of subject area or grade level, and then it will relate them to the current study.
Elementary Studies

The first study to be discussed was published in 1992 in the *Journal of Research in Science Teaching* and was conducted by researchers Nancy R. Romance and Michael R. Vitale. They asked the question, “What is the effect of in-depth science-content-based reading instruction over the course of a school year?” (p. 546). They used three intact fourth grade classrooms in one school as the experimental groups and four intact classrooms in a similar school as control classes. Teachers in the three experimental classrooms each incorporated applied reading (and language arts) objectives into science reading activities as part of a daily, expanded, in-depth science block that covered the total instructional time originally allocated to reading and science.

The instruments used to measure results were the Iowa Tests of Basic Skills (ITBS), Metropolitan Achievement Test (MAT), and affect (attitude and self-confidence) measures that consisted of previously developed criterion-referenced banks of items constructed to be parallel, Likert-type items in science and reading (Vitale, 1980). On this last instrument, the Cronbach’s alpha coefficient, showing the internal consistency reliability, exceeded 0.85 for each of five-item subscales.

The results showed that the experimental group of students performed significantly better than the control in both reading and science as measured by the ITBS and MAT. The adjusted mean on the MAT mathematics achievement for the experimental group was almost one grade equivalent higher than that of the control. Experimental group students showed no positive attitude change toward learning and no greater self-confidence in learning science, but the experimental group did display more positive attitudes toward reading activities in school. However, no difference was
found between experimental and control groups on reading self-confidence or attitude toward reading activities out of school (Romance & Vitale, 1992). The relationship of this study to the current study is that one of independent in-class and outside reading activities was the use of trade books and other science print materials.

The second elementary classroom study was done by Lesley Mandel Morrow, Michael Pressley, Jeffrey K. Smith, and Michael Smith, and it was published in the January/February/March 1997 edition of *Reading Research Quarterly*. These researchers wanted to find the effect of a literature-based program integrated into literacy and science instruction with children from diverse backgrounds. They used six, third grade classrooms at one elementary school. This study involved 128 students (68 girls and 60 boys) who were randomly assigned to one of three groups; two of these groups were experimental and one served as the control. The first experimental group received a literature-based intervention in both their literature and science instruction. The second group received a literature-based intervention in their literacy program. The control group received regular, basal-reading, science-textbook instruction.

The testing instruments were informal group tests, individualized tests, and commercially-prepared group tests, and they were administered as pretests and posttests to evaluate growth in comprehension, writing, science vocabulary, and factual knowledge. No reliability or validity was given. Analysis of Covariance (ANCOVA) was used to analyze the data. Posttest scores were adjusted based on the pretest scores. The results in the reading and science portions were statistically significant. Results of the posttest interview, with respect to total number of science and general book titles in three groups, showed the children in the experimental groups could name more book
titles than those in the control group (literature/science group: 151 books; literature-only group: 145 books; control group: 110 books). The children in the literature/science group could name more book titles than children in the other two groups. The book titles named by the literature/science group strongly reflected the four science units studied: plants, space, animals, and the changing earth. During the observations of this group’s literacy activities, it became apparent that children were using science trade books frequently. In 20 of the 98 oral reading episodes, science trade books were used; in 25 of the 82 silent reading episodes, science trade books were selected (Morrow, Pressley, Smith, & Smith, 1997).

The third study using trade books at the elementary level was presented as a dissertation summary at the March 2002, San Diego National Science Teachers’ Convention. Christine Royce gave an overview of her study conducted under the guidance of her major professor, David Wiley. The objectives of her study were (1) to compare effects of using children’s literature on the development of factual and conceptual knowledge of third grade students and (2) to examine the students’ attitudes toward both the method of instruction (textbooks and trade books) and science. She used four intact classes at one elementary school. They were each taught by a different teacher. The study was a six-week unit on invertebrates. One of the control groups was called a “naive” comparison, and this group received no formal education on invertebrates at all in their science instruction. She had this group in her study to show that knowledge of invertebrates did not result from the maturation of the third-graders over the six-week period of the study. She had a textbook group that received instruction only from the textbook on invertebrates. Her next group was a
combined group which received instruction from both the textbook and trade books. The fourth and final group used only the trade books. The instruments used to measure results were as follows: a ten-question objective completion test, two diagrams in which students were asked to label the stages of the life cycle of an invertebrate, three short-answer subjective questions which required students to answer in a sentence or through an illustration, and an attitude survey.

The results showed all three experimental treatment groups performed significantly better on the content knowledge posttest than the control “naive” comparison group. On the ANOVA for repeated measures, there was no significant difference between pretest and posttest among the three experimental treatment groups. There was a significant difference in the attitude toward trade books among the four intact groups when the pretest and posttest scores were compared (Royce & Wiley, 2002).

Another example of using trade books at the elementary level was done in 1992. Researchers Guzzetti, Kowalinski, and McGowan asked the question, “What is the effect of teaching one unit of social studies with children’s literature instead of a textbook?” (p. 115). The classes used were two sixth grade classrooms—one experimental and one control. The study was done over a five-week period for a total of 12.5 hours. The instruments used in the study were an 88 item multiple choice test to measure concept acquisition, the Estes Reading Attitude Assessment (1981), and a survey where the students were asked to rank order the nine subjects composing the sixth grade curriculum in terms of enjoyment and importance. Each measure was administered four
weeks in advance of the “China” unit as a pretest and within one week of the unit’s end as a posttest.

The results showed significant differences in concept acquisition but no differential gain in attitudes toward reading and social studies. Results of the Analysis of Covariance (ANCOVA) for the multiple-choice test revealed significant gains for the experimental group with F(1,39)=14.31, p<.001. Analysis of Covariance for the reading assessment resulted in no significant difference between the test groups, with F(1,39)=0.157, p=.694. On the third instrument, subject ranking, students did not change their subject preference rating from pretest to posttest. Both classes ranked social studies low and reading high on both tests. This study appears to give some empirical support for a literature-based approach to social studies. The study resembles the current study in the use of trade books but is different in that the current study does not remove the textbooks from the curriculum in the experimental group. Rather, the trade books are supplemental.

The last example of trade book use at the elementary level is not a formal study but rather an observational study of two middle grade social studies classrooms. The purpose was to explore how students use nonfiction books during a thematic unit on Native Americans. The researchers found that the students used the trade books like textbooks and encyclopedias, and the books were not used to their full potential (Palmer & Stewart, 1997).
Trade Book Use at the Secondary Classroom Level

The research to locate instances of trade book use in the secondary classroom was much more limited. Only six articles were found, but they had significant information. Four of the six articles dealt with teaching science.

One of the older articles is probably the closest to the intent of the current research. In 1980, Becky Fisher summarized her work, “Using Literature to Teach Science” in the Journal of Research in Science Teaching, Vol. 17, Number 2. She conducted a nine-week experiment with seventh grade students for the purpose of illustrating the advantages of using science trade books in teaching science. She chose teachers similar in teaching methods, style, and positive attitudes toward teaching. Three groups were used in the study—one control and two experimental. The control group received no treatment. The first experimental group was required to read specific trade books. The second experimental group had free use of trade books with no required reading. Two assessments were administered at the end of the nine weeks—one cognitive and one affective. The results showed that high-ability students responded favorably to required readings. The low-ability group seemed to feel better with free but not required reading. Both experimental groups scored higher on the cognitive assessment than the control group. Fisher (1980) concluded with “the use of well-chosen literature in science programs can be an open window into new ways of comprehending scientific concepts” (p. 177).

Perhaps the predecessor to all the studies on using trade books is an article published 35 years ago. Louis E. Barrilieux of Tulane University published an article entitled, “An Experiment on the Effects of Multiple Library Sources as Compared to the
Use of a Basic Textbook in Junior High School Science,” in the *Journal of Experimental Education*, Spring, 1967. A longitudinal study was done with eighth-graders in 1962-63 and ninth-graders in 1963-64 in the Malcolm Price Laboratory School at the State College of Iowa. The 42 students were divided into two randomly-assigned groups, an experimental and a control, with 21 students in each group. The difference in instruction for the two groups was the use of different basic reading reference materials. Otherwise, the methodology was the same. The control group used only the textbook. The experimental group did not; rather, they used a variety of references and sources in the library.

Six instruments or evaluative procedures were used. The Iowa Tests of Education Development (ITED), Test 2 and Test 6, and the Sequential Tests of Educational Progress (STEP) were each given at the beginning and end of eighth grade and at the end of ninth grade. The Test of Understanding Science (TOUS), was administered at the end of ninth grade. The Watson-Glaser Critical Thinking Appraisal (WGCTA) was administered at the end of the eighth grade and at the end of the ninth grade. During grade nine, students were required to write essays on eight problems discussed in class and their application. These were graded subjectively by a panel of three teachers. On this instrument, only one of the intercorrelations fell outside the limit satisfactory reliability. A sixth procedure involved informal observations of library behavior of the students.

Results were summarized in five categories of educational outcomes for which evaluations were conducted: growth in science achievement, critical thinking, science attitudes, writing in science, and library utilization. Where applied, statistical
significance tests were conducted at the p<.05 level. As for growth in science achievement as measured on the ITED (Test 2), achievement was about the same between the two groups. All the statistical tests showed science instruction using library materials without a textbook to be as effective or superior to the use of an issued, basic textbook (Barrilieux, 1965).

A very interesting opinion article appeared in Reading Research Quarterly, July/August/September, 1995. David G. O’Brien, Roger A. Stewart, and Elizabeth B. Moje authored an article entitled, “Why Content Literacy is Difficult to Infuse into Secondary Schools; Complexities of Curriculum, Pedagogy, and School Culture.” This article pinpointed the difficulty of using trade books and other strategies in the secondary classroom. Although supported by university course work, content literacy methods infrequently make it into secondary classrooms. Teachers may admit to the potential value of these strategies, but they fail to see the usefulness of them for mastering their instruction goals. “In fact, they sometimes view the strategies as time-consuming and inappropriate for learning in the discipline” (p. 446).

Another opinion article also emphasized the problem in finding trade book use in the secondary classroom. Roger A. Stewart’s article, “A Causal Connective Look at the Future of Secondary Content Area Literacy,” published in the Winter, 1994 edition of Contemporary Education, takes the reader on a journey through elementary reading instruction and how recent changes within that field may proceed changes in the role reading plays in secondary content classrooms. He found that since elementary teachers are switching to trade books, students grow up with them and want them in the secondary school also. “Secondary teachers continue to construct their classrooms
so that lecture, recitation and a single test predominate” (p. 90). To get secondary teachers to incorporate content area reading into their instruction, Stewart predicts a radical restructuring of secondary level pedagogy and curricula will have to occur. He proposed the lecture and recitation will have to be replaced by more discussion. Instead of one textbook, multiple texts will need to be used. There will have to be a move away from the status quo. Secondary educators are calling for schools, teachers, and curricula that empower students to become independent readers, writers, and lifelong learners responsible for their own learning. Literature-based instruction is one product of this change (Stewart, 1994).

Reasons to Use Trade Books to Teach Elementary Science

Trade books have been used in elementary science for a variety of reasons. Probably the most compelling is that they provide an opportunity for students to read about topics in greater depth than found in textbooks (Wolfinger, 2000; Palmer & Stewart, 1997; Hansen & Schmidt, 1989; Carin, 1993; Tolman & Hardy, 1999; Cain & Evans, 1990; Johlen, 2000; Simon, 1982). Thus, the potential for meaningful discussion and learning in content area classrooms is significantly increased (Wolfinger, 2000). Because they provide specific information instead of broad spectrum topics as in textbooks, trade books complement textbooks as textbooks complement them (Tolman & Hardy, 1999). Students should learn and retain more science concepts with the use of trade books because they lower the abstraction when students experience, interpret, and personalize the concepts (Kralina, 1993; Barrilieux, 1967; Gega & Peters, 1998). Trade books increase comprehension skills (Edwards & Fisher, 1991) as well as help students correct misconceptions (Cerullo, 1997).

In addition, trade books are more interesting and exciting to read than textbooks. They are easier to read from cover to cover and for longer periods of time. Because they add humor to reading, they are more enjoyable (Carter & Mayer, 1988; Cain & Evans, 1990; Gega, 1997; Kralina, 1993; Royce & Wiley, 1996; Hansen, 1983; Osbourne, 1998; Gega & Peters, 1998; Chambers, 1971).

Trade books also provide an excellent opportunity for cross-curricular teaching. They expose students to science content through a whole language or integrated approach to learning. They blend reading, writing, and talking into an activity-based
“Trade books are probably the best means we have for providing for individual differences in reading” (Gega, 1997, p. 21). This quote by Peter Gega in the March 1997 edition of *Science and Children* summarized another vital reason for using trade books. These books answer the needs of individual children by allowing the teacher to provide materials on a variety of reading levels (Wolfinger, 2000; Gega & Peters, 1998; Carin, 1993; Frank, 1992; Edwards & Fisher, 1991; Chambers, 1971; Simon, 1982). They provide experience in reading nonfiction. Most children have ready only nonfiction in their textbooks. Reading trade books builds proficiency in this area and motivates the reluctant reader (Kralina, 1993; Simon, 1982; Palmer & Stewart, 1997; Cain & Evans, 1990; Carin, 1997; Jacobson & Bergman, 1991; Chambers, 1971). Besides providing for diverse reading levels, trade books also provide for the diverse interests of students (Wolfinger, 2000; Palmer & Stewart, 1997; Cain & Evans, 1990; Tolman & Hardy, 1999; Edwards & Fisher, 1991; Chambers, 1971; Gega & Peters, 1998). Trade books may also be more effective in teaching about science itself than other methods. They delineate the scientific process far better than most textbooks. They show how science works, how science has been interpreted by great thinkers, and how we may use and misuse scientific knowledge (Carter & Mayer, 1988; Gega & Peters, 1998; Royce & Wiley, 1996; Coffey, 1993; Janke & Norton, 1983; Frank, 1992). Students are able to recognize scientists as writers and storytellers (Cerullo, 1997) and can experience the excitement of new discoveries along with the scientists (Carin,
They describe these scientists as flesh-and-blood people rather than a list of names and dates. They evaluate the objectivity, qualifications, and accuracy of authors.

Students need to learn to evaluate conflicting information from different written sources. How old is the source? What are the credentials of the authors? (Kralina, 1993; Simon, 1982; Hansen & Schmidt, 1989; Cerullo, 1997; Carin, 1997; Janke & Norton, 1983; Montebello, 1972; Chambers, 1971).

Trade books offer possibilities for interdisciplinary extensions such as creative writing, dramatizations, and role playing. Students’ imaginations are stimulated and scientifically-minded children are encouraged to write about their interests (Hansen & Schmidt, 1989; Cerullo, 1997; Gega & Peters, 1998; Janke & Norton, 1983; Royce & Wiley, 1996; Lauber, 1992). These books can help prepare older students to teach younger children. They acquaint them with vocabulary, maturity level, and possible questions or problems to be expected (Kralina, 1993; Janke & Norton, 1983; Barlow, 1991; Edwards & Fisher, 1977).

Elementary teachers often feel their science knowledge may be lacking. Trade books are more comfortable for them (Cerullo, 1997). The abbreviated vocabulary and lower reading levels allow them to concentrate on the basic scientific concepts to be explained.

The last reason to use trade books is that they are fun. They may encourage students to become recreational readers of science. A student may not be interested in becoming a scientist, but he/she could have a scientific hobby (Carter & Mayer, 1988; Fisher, 1980; Carin, 1993; Lauber, 1992; Chambers, 1971). Seymour Simon (1982) summarized this reason well when he said, “Perhaps the best science trade books are
those children read for pleasure but from which they learn without realizing they are being taught” (p. 6).

Reasons to Use Trade Books to Teach Secondary Science

Many of the reasons stated for teaching science with trade books at the elementary level also apply to the secondary level, but the sources cited in this section draw their evidence from studies done with high school students, college students, or both, rather than younger students. The first reason is the premise of this paper: teaching science with trade books affects science literacy. But there are other reasons to use trade books. One is that they provide constructivist-based instruction, where learners appear to develop ownership of science concepts in a process of change from the naive or incomplete conceptions of natural phenomena to mature conceptions that reflect current understandings in the scientific community (Anderson, 1987).

Students’ attitudes toward science improve using trade books because instruction is relevant, includes all groups of students, and nurtures emotional as well as academic growth (Daisey, 1994). Trade books help place science in a liberal arts context as it relates to the social sciences and humanities (Carter & Mayer, 1988).

Trade books also promote higher levels of literacy, that is, students become better readers. Johan Galtung (1981) makes an interesting analogy: “Literacy is there to a large extent to create an illusion of equality. It is not really being used, so like a leg never used, it will tend to wither away” (p. 275). Content area teachers need to continue teaching reading in the secondary classrooms. Reading is a lifelong, developmental process. Skills may be needed in secondary classes that were not
needed in elementary classes. The content area teacher is the expert in that content
domain. Therefore, he or she is the best and most logical person to guide students
through these books. Finally, instructional efficiency improves, and students learn more
content by becoming proficient readers (Daisey, 1994; Stewart, 1994; Stewart, O’Brien
& Moje, 1995).

As in elementary classrooms, trade books in the secondary classroom provide for
a variety of reading levels (Daisey, 1994). According to Graff (1987), “What is needed is
a broader view of reading and writing that emphasizes that many human abilities in a
context of a changing world that requires their development and use (p. 397).

Trade books teach young people to think scientifically and become problem
solvers. C. Jencks summarized the situation in his comments about high school
graduates who have not read as widely as their predecessors or who at least do not
know much about the kinds of things young people traditionally learn from reading.
These students tend to do worse on tests that ask about literature, history, politics, and
scientific subjects. He said they do not seem to think as carefully about the problems
that testers set for them, even when the solution does not require external information.
Carter and Mayer (1988) express similar conclusions in their statements, “They do not
read, think, or speak like biologists. They are not even biologists in mind and spirit” (p. 491).

By reading about scientific discoveries and scientists, students have vicarious
experiences in the science process. They are introduced to people and ideas they may
have not known otherwise. Flesh is put on well-known names, and scientists are
humanized and shown to be not unlike the readers (Daisey, 1994; Carter & Mayer, 1988; Lauber, 1992).

Trade books introduce students to how we may use and misuse scientific knowledge. A nonfiction book may be based on fact, but this does not always mean it tells the truth. “Something can be perfectly accurate but untrue” (Freedman, 1992, p. 3).

Freedman (1992) supported the use of quality trade books as follows: “They must make the written world so believable and vivid that the reader will enter it willingly and leave it reluctantly” (p. 3). Trade books are more enjoyable, interesting, imaginative, and emotional than textbooks. They animate the subjects and infuse them with life. They provide an approach to literacy that is flexible and dynamic (Daisey, 1994; Carter & Mayer, 1988; Freedman, 1992; Graff, 1987).

The final reason for using trade books with secondary students brings us back to the purpose of the study. Science literacy demands thinking citizens. According to Carter and Mayer (1988), trade books lift students to their highest potential as scholars, while they help them to discover the nature of biological thought.

Criteria for Selection of Trade Books

The literature search for criteria for selecting trade books yielded several requirements or considerations. Most of these also seem to apply to secondary classrooms, but the sources were addressing elementary sites. Most researchers emphasized the need for accurate facts as the number one requirement. The trade book must have authentic and valid information and not be wild speculation. One
should use up-to-date books and pay close attention to the copyright dates. Does the author have the scientific qualifications to write books on that particular subject? Are significant facts omitted? Is information presented without relying on anthropomorphism, the attribute of human traits to animals? This aspect may be acceptable in fiction but not in nonfiction (Carin, 1993; Carter & Mayer, 1988; Cerullo, 1997; Simon, 1982; Ellerman, 1992; Dowd, 1992; Janke & Norton, 1983; Montebello, 1972).

Closely related considerations are reflected in the following questions: Whether fiction or nonfiction, is the book truly representative of the scientific discipline? Are facts distinguished from theories? Are there clear distinctions between fact, theory, and opinion? Are different points of view presented on controversial subjects? Since there are usually two sides to any issue or event, are opposing viewpoints introduced? Addressing these questions will help students see that experts do not always agree. This also links to social problems with science and makes them more realistic (Carter & Mayer, 1988; Janke & Norton, 1983, Ellerman, 1992; Montebello, 1972; Lauber, 1992).

A third requirement is that stereotypes be eliminated. Current contemporary books probably are not guilty of the blatant biases common in the past. Rather, they are more likely to suggest stereotyping through inclusion or exclusion of certain groups in certain fields. Also, the book should accentuate the positive and show diversity with many cultures (Carin, 1993; Janke & Norton, 1983; Ellerman, 1992; Dowd, 1992; Cerullo, 1997).

A fourth consideration involves the illustrations. Do they clarify the text? Are the captions and legends good? Do they make size relationships apparent? Do they place
familiar objects next to the unfamiliar to help students understand the concepts? Are they accurate and current? (Carin, 1993; Janke & Norton, 1983; Ellerman, 1992; Montebello, 1972).

Another requirement is that the book be organized to help understanding. Does the information progress from simple to complex and from familiar to unfamiliar? Are organizational aids included to assist students when they are using the books? These aids include the table of contents, glossary, index, appendices, subheadings, etc. (Carin, 1993; Janke & Norton, 1983; Ellerman, 1992; Cerullo, 1997).

One of the hardest criteria to judge is the book’s ability to encourage analytical thinking. Are students challenged to solve problems? Are they encouraged to observe, gather data, experiment, compare and formulate hypotheses? Does the book foster the use of the scientific methods and spirit of inquiry? Does it use open-ended questions? (Carin, 1993; Janke & Norton, 1983; Montebello, 1972).

Writing styles are another consideration. Does the type stimulate the interest of the intended reader? Are the style, vocabulary, and general complexity age appropriate? Is the reader involved by the use of vivid and interesting language that conveys a positive tone about the subject? Does it engage the reader? The author should have a storyteller’s talent for grabbing and holding the reader’s attention (Carin, 1993; Janke & Norton, 1983; Lauber, 1992; Ellerman, 1992; Cerullo, 1997).

Last of all, is there a variety of choices of trade books in the classroom? Students should be surrounded with stories of animals and trade books on various science topics (Tolman & Hardy, 1999; Gega & Peters, 1998; Edwards & Fisher, 1977).
Strategies for Using Trade Books at the Elementary Level

Trade books can be used individually, in small groups, or as a whole class activity (Cain & Evans, 1990). When used individually, they have intrinsic values that cannot be found in other instructional resources. First of all, they are highly portable and can be easily read at home, on vacation, on the bus, at reading time in other classes, or at any other appropriate time. They are individually paced so the student can read as far as he/she wishes and as fast as desired, and they are reusable. If proper care is given, they can last several years, and many students may benefit from their use (Chambers, 1971).

When used in small groups or as a classroom activity, trade books should be integrated with first-hand experiences of observing, classifying, measuring, recording, and generalizing (Montebello, 1972). This integration provides fun experiences for the class (Chambers, 1971). This approach is also a departure from the classroom procedure of lecture, recitation, and test, where there is no need for extended reading forms, (e.g., a trade book) because the teacher provides the bulk of the information. With trade books, there needs to be significantly more discussion and reduction of teacher control. Students are more responsible for their own learning (Stewart, 1994; Montebello, 1972).

Regardless of grouping used, certain criteria should be followed to maximize learning. The teacher needs to be sure the students have specific reading skills for that particular trade book. Can they read the charts, graphs, tables, and formulas? Can they use the table of contents and index? Can they follow directions up to the point that the book can be read alone? Difficult vocabulary terms should be identified. The student
should be shown how to pronounce them and be given concrete experiences with the new terms (Edwards & Fisher, 1977; Jacobson & Bergman, 1991).

Strategies for Using Trade Books at the Secondary Level

Although the criteria for using trade books at the elementary level basically apply at the secondary level, more in-depth sources were found that dealt only with secondary classrooms. Peggy Daisey in *School Science and Mathematics*, April 1994, provides seven suggestions for their use. The first use is in group problem-solving. The participants read a story, stop to predict outcomes, raise questions, and share feelings. They share ownership in the learning experience and begin to value the opinion of their peers (Daisey, 1994; Harste, Pierce & Caimey, 1985).

Trade books can be used to guide class discussions. After stating the purpose or rationale for a story or section of a book, the teacher can pose a question. The students synthesize their answers to the question, either individually or in small groups. The teacher listens to the ideas, may propose other sources of information, and may even ask students to clarify their thoughts by restating their ideas (Daisey, 1994). This approach was illustrated by teacher Megan Garrison in her article, “Literacy Science” in the November, 2000, issue of *Science Teacher*. She discussed her earth science class reading *Silent Spring* as a class activity. She commented that her students got so involved that when class was over, they were asking questions about DDT. She states, “. . . as a teacher, my most important goal is to listen to my students and tactfully use their interests to guide their learning” (p. 29).
Another suggestion is to have each student choose a book from a variety of trade books available. The teacher would then give the student a choice of possible ways to illustrate the book. The student can paint a mural, act out a historical “you are there” scene based on the story, design a book jacket or poster with a summary of reasons why he/she recommended it, or compose a song or limerick (Daisey, 1994).

Biographies of scientists can engage students’ emotions and imaginations. By letting students choose biographies and autobiographies of different scientists, they may see traits they share with these people, and they may realize they, too, can be competent in science. The students can explore the many paths by which people develop interests or careers in science. Teachers may use character journals to encourage students to assume the role of a scientist (Daisey, 1994; Hancock, 1993).

Also, the students can read just for fun. For this reason, the school library needs plenty of good books. Students may want to make time capsules, artifacts, or comic strip drawings about their books. They should be encouraged to make portfolios of work samples that they can reflect upon during the year (Daisey, 1994).

When trade books are used as a resource tool, the teacher may select a topic and ask, “Who? When? How? Where?” Birthdays of scientists can be celebrated or the teacher can just read out loud because even high school students love to have someone read to them. This approach also reaches the “at-risk” student who may become interested in a scientist even if science concepts are otherwise difficult for him/her to grasp. This student can present the story through collages, displays, models, dolls, and videotapes (Daisey, 1994).
Recommendations for Changes in Methodology so Trade Books Can be Utilized

Researchers Palmer and Stewart (1997) provide valuable recommendations for changes in science instruction at the secondary level so that trade books can be utilized to their fullest potential. Assignments need to change if trade books are to be used as a research tool. Too often, the research questions asked can be found in encyclopedias. Students will tend to choose that route due to its ease and convenience. More in-depth questions need to be posed in order to force students to expand their searches. Assignments need to be individualized, open-ended investigations of varying depth and breadth. This puts the student in the “driver’s seat,” where he/she is allowed to define what is important to him/her, what should be displayed to a larger audience, and what should be drawn from the literature being explored (Palmer & Stewart, 1997).

Trade books need not to be used as encyclopedias or textbooks. When students look up a topic, they need to use indexes, tables of contents, pictures, and bold-face words as their primary sources. They seldom do extensive reading. If the assignments demanded more thought, the students would be forced to read for understanding. The second reason trade books tend to be used as encyclopedias is because there is not enough research material available for use, thus forcing students to use trade books this way (Palmer & Stewart, 1997).

Training needs to be provided for teachers and students in effective use of nonfiction trade books. Many secondary teachers have never taken a children’s literature class, and few courses exist in methods in using trade books with secondary students. Training would let these teachers know what is available in this field in terms of appropriate nonfiction trade books. Teachers would not have to stumble around
looking for appropriate books and experimenting with unsuitable titles. Even teachers who know children’s fiction may not be familiar with nonfiction. They may be able to use nonfiction to extract information, but their overall knowledge of nonfiction is limited. Although experts in content, secondary teachers are not trained in methodology and tend to follow the expected format of lecture, seat work, and test, the approach associated with single textbook approach (Palmer & Stewart, 1997).

Students also need assistance in using trade books. They may be able to locate the trade book but many may not be able to extract the appropriate information from it. Teachers need to model how to locate and use nonfiction sources effectively so the students can use the research process and learn meaningfully from it. Last, librarians should be consulted and utilized extensively. Most of them do not get any suggestions from the classroom teacher when ordering selections. Thematic units could be developed over time if the teacher and librarian work together on securing a library research collection (Palmer & Stewart, 1997).

Recommendations for Improving Students’ Attitudes Toward Reading Science

Many students become frustrated when reading scientific technical materials such as textbooks and nonfiction trade books. Science instructors want students to understand their world and have positive attitudes about their ability to comprehend information about environmental issues and other topics. A study done by researcher Annie Harder (1989) provides some suggestions on increasing students’ positive attitudes. In her research, 117 adults in human anatomy and physiology classes were questioned about their attitudes about reading assignments in their textbook. Several
suggestions were discussed at the end of this study. Students need to be encouraged to take more responsibility for their reading comprehension. Teachers can help by modeling a variety of comprehension strategies such as summarizing, outlining, mapping with flow charts, paraphrasing, identifying key words, diagraming and charting. They can also guide class discussions about the purpose for the reading and provide times for small group discussion or peer teaching. They can help students develop self-testing techniques, such as writing questions that identify key concepts and quizzing other students. The implication of this study is that teaching science involves addressing students’ frustration with reading technical material. Teachers can produce a positive change in attitudes by acknowledging this problem and recommending possible solutions. “When students monitor their reading comprehension strategies, they can demonstrate that they have responsibilities for their learning processes” (Harder, 1989).

Recommendations for Changing Teachers’ Attitudes Toward Environmental Science Education

Views about science have changed since the seventeenth century. Teachers must reflect on these changes, challenge their assumptions, and improve their understanding of the influences that shaped these attitudes. What were some of those early views? In the medieval and early modern period, religion played an important role in developing an attitude of anthropocentrism, where humankind was the master of nature and controlled it for personal benefit. A respect for nature was still evident, and humankind was designed as the caretaker of the tenant (Littledyke, 2000).
In the seventeenth century, Descartes continued anthropocentrism when he postulated that animals were like machines, with impulses and reflexes but no capacity for sensation, language, rational thought, or suffering. This paved the way for exploration of the animal kingdom in hunting, domestication, vivisection, and meat consumption, as well as large scale activities such as mining and deforestation. Also seen here is the philosophy of Cartesian dualism, which separated humans from nature so humans could master, control, and exploit nature (Littledyke, 2000).

Since the Industrial Revolution and exponential population growth, human societies have damaged their environments with such intensity that global effects have appeared. In this industrial development, the environment was mixed with human labor to create property, while ecosystems were treated as dumping grounds for the wastes of this technology. Some concern for the environment did emerge in the nineteenth century. The writings and art of Constable, Blake, Wadsworth, Coleridge, and others reflect the damages of industrialization. As early as 1846, Thoreau wrote in *On Walden Pond* on this destruction of nature as he called for the new preserves in the natural environment. Environmentalists today are still influenced by his powerful and political statements (Littledyke, 2000).

America failed to listen to Thoreau’s pleas and instead embarked on a less conservative approach to protecting the environment. Rather than restrain public access to selected wilderness as Thoreau would have preferred, the United States government chose to establish national parks where the public could enjoy these areas with certain limitations. In the middle of the twentieth century, Aldo Leopold (1949)
wrote *A Sand County Almanac* and called for a new set of values for land where money is not the top priority (Littledyke, 2000).

However, by the 1960s and 1970s, the evidence of technology polluting our world was mounting. The book quoted in this study’s introduction, *Silent Spring*, by Rachel Carson (1964), was the nation’s wake-up call. Carson cited case after case of habitat destruction, threatened species, and long-term effects of dangerous chemicals such as the pesticide, DDT. This book started a series of writings on the environment such as Meadow’s *The Limits of Growth* (1972) and *Blueprint for Survival* by Goldsmith (1972). The idea of the ecological sustainability of human activity has been a vital topic of concern in the scientific world since then (Littledyke, 2000).

“Deep ecology” was a response to these concerns. This radical philosophy recognizes intrinsic value in all living things and proposes that anthropomorphism is the main cause of environmental problems. The proposed solution to the earth’s degradation in this area is the adoption of a system of economic where the producer, consumer, and environments all have top priority instead of the monetary value that our present system holds paramount (Littledyke, 2000).

All of these developments have led to the emergence of environmental groups such as Friends of the Earth and Greenpeace, which have been successfully active in stimulating campaigns on specific issues to raise public awareness and initiate political responses. These efforts have resulted in banning CFCs, removal of lead from gasoline, restricting seal hunting, and forbidding whaling. The general level of environmental awareness and protection has increased dramatically over the last thirty years (Littledyke, 2000).
Because of this awareness, teachers must strive to increase their students’ science literacy, especially in the arena of environmental education. Students need to see how to analyze situations which are not easily solved with right or wrong conclusions. So many of the environmental problems have several facets feeding into them. Many people, like scientists, prefer uncomplicated solutions. Those rarely exist in the environment. As educators, we must develop in our students a questioning attitude and a broad mind to absorb and evaluate each problem and potential solution in the environment. Trade books are hopefully one tool to use to accomplish this goal.

Recommendations for Changing Environmental Education High School Curriculum

Hausbeck, Milbrath, and Enright (1997) offered six suggestions for updating the curriculum in high school environmental science courses. The first suggestion is that the course should be multi-disciplinary, drawing from the natural sciences as well as the humanities and social sciences. Next, it should involve learning concepts so students will not make errors in the analysis of the information presented. The students should be encouraged to think holistically and to integrate materials from several sources. Third, the course should be problem-oriented. These problems should involve areas the students encounter in their daily lives. Discussions should be conducted about the solutions to these real problems. Fourth, the course should involve value clarification and moral reasoning. Teachers should not impose their values on the students, but rather they should get students to think about their values so the students can make confident and sound individual decisions. Next, the course should address both local issues and global aspects of environmental controversies. Last, the course should
involve hands-on contact with nature, through means such as hiking, field trips, and stream clean-ups (Hausbeck, Milbrath & Enright, 1997).

Need for Further Research

Although the literature search for the use of trade books to teach elementary science yielded many personal experiences with trade books from teachers, there were only a few empirical studies. When the literature review was restricted to secondary science classrooms, the studies were reduced considerably. If the goal of affecting *environmental science literacy* is added to trade book use in secondary classes, no formal studies were found that addressed all three criteria. It is the intention of this study to add information to this void in the literature.
CHAPTER 3

METHOD

Participants

The Texas Education Agency provided a list of 483 secondary schools in Texas that taught environmental science courses during the school year 1999-2000. From these 483 schools, 14 school districts were contacted, and two schools in one district agreed to participate in the study (see Appendix A). At each school, the sample of participating students were those enrolled in an aquatic science course for the fall semester of 2002. A total of 59 eleventh and twelfth grade students participated in the study. Each of the two high schools had two aquatic science classes taught by the same teachers. These two teachers averaged eleven years of teaching experience, with at least two years in aquatic science. It should be noted that aquatic science is an elective and does not count as science credit.

In these four classes, 18 students were girls, and 41 were boys. Forty-three of the students were Caucasian, nine were Hispanic, six were African-American, and one was Oriental. The pretest of Children’s Environmental Attitude and Knowledge Scale was used to confirm the equality of groups. Statistical procedures were used to adjust posttest scores based on pretest scores.
Procedure

During the summer of 2002, both teachers in the study reviewed various environmental trade books supplied by the researcher. Four books were selected by these teachers to be used. The first book was *A Home by the Sea* by Kenneth Mallory (1998). In this book, the author illustrates how animals have been caught in a losing battle with man on our nation’s coastlines. He also shows how humans and animals can share precious living space and live peacefully side by side. The second book was by Gary Larson (1998), creator of “The Far Side.” This book, *There’s a Hair in My Dirt*, is a worm’s story about finding a hair in his plate of dirt. He becomes upset about this “rotten” meal and his life in general. This prompts his father to read him a story about a fair young maiden. In his comic style, Larson tells readers about the difference between Nature’s ideal and the cold, hard reality of life for all creatures as well as humankind. *Sea Otter Rescue* by Roland Smith (1990) covers the aftermath of the 1989 oil spill off the coast of Alaska. Smith shows how nearly 75% of the sea otters that were brought into the Sea Otter Rescue Center were saved. The fourth book in the study was *The Missing Gator of Gumbo Limbo*. Here, Jean Craighead George (2000) weaves a mystery around an alligator that disappears after concern is raised about it scaring visitors in the Florida Everglades.

Before entering either of the two high schools, a consent form was obtained from the participating principals (see Appendix B). The study began with each teacher receiving two sets of the four classroom sets of trade books before the school semester started. On the second day of school during the fall semester, the pretest was administered to the experimental and control classes at the two high schools. Since the
researcher could not be at both schools on the same day, a research assistant was employed to administer the tests at one of the high schools. A scripted set of directions was used to insure consistency between the two test administrators (see Appendix C). Also at that time, the permission consent forms were secured from each student (see Appendix D). Since all the students were over fourteen years of age, it was not necessary to obtain parental consent. A letter of participation (see Appendix E) was given to each student to take home. The participating teachers decided they wanted this letter returned to them for placement in their files.

Immediately after the administration of the pretest, each teacher began reading one of the trade books aloud in the experimental class. Focus questions were asked before starting each book in order to stir the curiosity of the students. These questions were written down and circulated to the next teacher so her focus activity would be very similar (see Appendix F). As the book was read aloud, discussion questions were posed, answered, and recorded (see Appendix F). In order to keep the two presentations similar in the two experimental classes, an outline of methodology (see Appendix G) was provided for each teacher to follow.

Since this reading would require a certain amount of class time in the experimental classes, it was assumed that the same amount of time would be available in the control classes. The teachers were informed that no new material could be introduced in this time period. The same objectives and content (topics and subtopics) were covered in all four classes. Also, the same teaching strategies and activities (except for the trade books) were used in all four classes. To document the activity performed in this time slot, the teachers were asked to record exactly what was done,
including the number of minutes spent in that activity, whether it was trade book reading time or alternate activity time (see Appendix H). In one of the control classes, the time schedule was shortened by fifteen minutes because that time was allowed for announcements each day. In the other control class, the teacher allowed an additional ten to fifteen minutes for silent homework time or additional lab time that was used to feed the animals in the room and clean the cages.

At the end of the first month, each teacher began reading the second trade book to her experimental class. The same methodology was followed as with the first trade book. At the end of the second month, the two teachers exchanged their two sets of trade books. The third book was read aloud during the third month, and the fourth trade book was covered during the fourth month. Then, at the end of the fall semester, the posttest was administered at both campuses on the same day by the researcher and her research assistant.

As mentioned in Chapter 1, the type of study described here is quasi-experimental. A pretest–posttest control design was utilized. At each participating high school, the experimental and control treatments were randomly assigned to the two, intact, aquatic science course sections. The independent variables were the use of trade books or non-use of trade books to teach environmental science and the teachers (one at each of the two high schools). The dependent variable was the environmental attitude and knowledge as measured by the Children’s Environmental Attitude and Knowledge Scale.
Instrument

The instrument used in this study was the Children’s Environmental Attitude and Knowledge Scale (CHEAKS) (see Appendix I). This test was developed in the early 1990s by psychology professors Frank C. Leeming, William O’Dwyer, and Bruce A. Bracken at the University of Memphis. They wanted an instrument which could be used in various studies so the results could be compared across studies. Previously, the professors had only been able to find tests that had been developed for one project, with little attention given to the tests’ validity and reliability (Gray, Borden & Weigel, 1985).

These researchers found no single scale that was widely used to measure children’s attitudes, knowledge, or both, of a broad range of environmental issues. Therefore, they constructed CHEAKS, using an adult scale developed by Maloney, Ward, and Brancht (1975) to measure ecological attitudes and knowledge as a guide. This adult test was developed over several years and was carefully constructed. It possesses acceptable levels of reliability and validity as described below and is composed of four types of attitudinal questions—verbal commitment, actual commitment, behavior, and affect. It contains knowledge questions as well (Leeming, O’Dwyer, & Bracken, 1995).

Leeming, O’Dwyer, and Bracken (1995) obtained reliability and validity data on the CHEAKS. They examined two forms of reliability (i.e., stability and consistency) and several forms of validity (i.e., content, convergent, discriminate, contrasted groups, developmental age progression, and factor analysis).
With respect to stability, the test-retest correlations were generally relatively moderate (exceeding .56), and the majority were in the .60 to .70 range. There was little difference between the correlations of control and experimental subjects. The results did show that CHEAKS was more stable when used with older children than younger children, with reliability coefficients of .716 for grades 4-7 and .603 for grades 1-3. It also was more stable for the attitude than the knowledge scale (.567 and .457 respectively for the younger children and .701 and .615 respectively for the older children (Leeming, O’Dwyer, & Bracken, 1995).

Although the test-retest correlations were high for the attitude and knowledge scales, the correlations of attitude scores with knowledge scores were quite low (.125 for the first administration and .127 on the second administration). This shows that the attitude and knowledge subscales measure independent constructs (Leeming, O’Dwyer, & Bracken, 1995).

Cronback alpha coefficients for the CHEAKS Total Score were consistently high (i.e., .88 to .90). Reliability coefficients were also quite high for the attitude subscales, ranging from .89 to .91, with older children showing a more consistent response pattern than younger children. The alpha coefficients for the knowledge subscale showed strong internal consistency (alpha=.73 for the first administration and .78 for the second administration) (Leeming, O’Dwyer, & Bracken, 1995).

ANOVAAs were conducted on each scale to determine development age-progression validation. On the total scale, mean scores of the older children were significantly higher than those of younger children. On the first administration, \( F(1,1195)=69.88, p<.001 \), while on the second administration, \( F(1,1239)=48.16, p<.001 \).
On the attitude scale, the mean scores of the younger children were significantly higher than those of older children on both the first and second administrations, with \( F(91,1217)=13.13, p<.001 \) and \( F(1,1142)=26.75, p<.001 \) respectively. On the knowledge subscale, the older children showed significantly greater knowledge of the environment than did the younger children on both the first and second administrations, with \( F(1,1195)=209.06, p<.001 \) and \( F(1,1239)=200.74, p<.001 \) (Leeming, O’Dwyer, & Bracken, 1995).

A repeated measure analysis of variance was conducted on the data from the 1,040 children who did not complete the scale on both administrations. For the total scale, mean scores on the second administration were significantly higher than on the first administration, with \( F(1,1038)=8.75, p<.003 \). There was also a significant age by order administration interaction, with \( F(1,1038)=8.16, p=.004 \) and with younger children showing a greater increase in total score than older children (Lemming, O’Dwyer, & Bracken, 1995).

To find contrasted-groups validity, the researchers compared the students’ CHEAKS scores with predictions from their teachers. Twenty-one teachers nominated two groups of students, one with high levels of interest in and knowledge of the environment and the other with low levels of interest in and knowledge of the environment. The ANOVAs performed on the total scales as well as on the attitude and knowledge subscales showed that main effects for teacher nomination and age were both highly significant. New-Keuls comparison of group means found that “high environmentalists” scored significantly higher than both groups on the total scale score as well as the attitude and knowledge subscales. Also, the “low environmentalists”
scored significantly lower than a non-rated group of children on the total scale and knowledge scale but not on the attitude scale. These data show that the CHEAKS successfully distinguished between children judged as being “high environmentalists” and those judged as being “low environmentalists” (Lemming, O’Dwyer, & Bracken, 1995).

Factor analysis was the fourth line of evidence. This factor analysis on all scores from the first administration did not converge in twenty-four iterations. A scree analysis, suggested two factors. The subsequent analysis, forcing two factors and using a varimax rotation, showed that the first factor had an eigenvalue of 8.3. This factor contained attitude questions exclusively and accounted for 12.6% of the variance. The second factor, with an eigenvalue of 3.9, contained knowledge questions exclusively and accounted for 6.0% of the variance (Lemming, O’Dwyer, & Bracken, 1995).

Separate analyses were conducted on the attitude and knowledge questions. In both cases, scree analysis suggested the presence of a single dominant factor, supporting the goal of creating a global scale. With the attitude items, this global factor had an eigenvalue of 8.09 and accounted for 22.5% of the variance. With the knowledge items, the global factor had an eigenvalue of 3.73 and accounted for 12.4% of the variance (Leeming, O’Dwyer, & Bracken, 1995).

The authors concluded that the development and use of CHEAKS could prove valuable in assessing children’s environmental attitude and knowledge. As a teaching and research tool, the results could be used as a common standard to judge the effectiveness of various interventions. This test was said to be very helpful in determining whether short-term and very specific interventions are beneficial and
permanent affective. Thus, the current study applied the CHEAKS to an intervention using trade books to enhance high school students’ environmental science knowledge and attitude.

The CHEAKS test consists of 66 questions. The first 36 questions measure attitudes toward environmental issues and behavior based on these attitudes. Twelve of these items reflect verbal commitment, and 12 reflect actual commitment. The remaining 12 assess affect. These 36 came equally from six domains: animals, energy, pollution, water, recycling, and general issues. The knowledge section of the test consists of 30 questions from these domains, with five items in each domain. Finally, a total score is derived from a combination of the scores obtained on the attitude and knowledge scales.

The 36 questions in the attitude scale are presented in a five-point Likert response format. These responses are “true,” “mostly true,” “not sure,” “mostly false,” and “false.” The most pro-environmental response to each item is credited with five points, whereas the least pro-environmental response receives one point credit. This scoring results in a possible score on the attitude scale ranging between 36 and 180. Nine of the attitude items, three in each section, are negatively connoted and are reverse scored to reduce the likelihood of student response set. On the knowledge scale, correct answers receive six points, with results ranging from 0 to 180. Possible scores for the CHEAKS Total Scale range from 36 to 360, with higher scores indicating combined positive attitudes and increased knowledge (Leeming, O’Dwyer, & Bracken, 1995).
Treatment of Data

The pretest was used to confirm the equality of the experimental and control groups. A one-way multi-variate analysis of variance or MANOVA with four groups was used to establish this equality. The four groups were Experimental/Teacher 1, Control/Teacher 1, Experimental/Teacher 2, and Control/Teacher 2. The MANOVA was chosen because there were two dependent variables from the CHEAKS administration: the attitude and knowledge subscales. Also, the MANOVA was chosen to establish equivalence among the four groups or classes before the administration of the trade book intervention.

The statistical analysis chosen for the posttests was a 2 x 2 mixed-model analysis of variance or ANOVA. The condition (trade book or not) was the fixed effect, and the teacher (teacher 1 and teacher 2) was the random effect. The dependent variable was the score on the posttest attitude subscale of the CHEAKS. A second mixed-model ANOVA was conducted on the knowledge subscale. The dependent variable was the score on the posttest knowledge subscale of the CHEAKS. ANOVA was chosen here because it is a procedure for determining whether the difference in the mean scores of two or more groups on a dependent variable is statistically significant.
CHAPTER 4

RESULTS

Test Reliability

The attitude scale was found to be internally consistent ($KR_{20} = .83$) at posttest.

The knowledge scale $KR_{20}$ was $.13$ at posttest.

Pretests

Descriptive Statistics for the Pretests

The means and standard deviation for attitude and knowledge subscales on the Children’s Environmental Attitude and Knowledge Scale are presented in Table 1. The two control groups are labeled C1 and C2. The two experimental groups are E1 and E2. C1 and E1 were taught by Teacher 1, and C2 and E2 were taught by Teacher 2. The results are shown below in Table 1.

<table>
<thead>
<tr>
<th>CHEAKS Subscale</th>
<th>Group ID</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Attitude</td>
<td>C1</td>
<td>103.06</td>
<td>21.57</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>E1</td>
<td>106.80</td>
<td>21.96</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>C2</td>
<td>121.38</td>
<td>12.70</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>E2</td>
<td>105.00</td>
<td>32.67</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>All Groups</td>
<td>109.85</td>
<td>23.25</td>
<td>72</td>
</tr>
</tbody>
</table>
As shown in Table 1, the means of the groups on the pretests on the attitude subscale ranged from a low score of 103.06 to a high score of 121.38. The four attitude subscale scores averaged 109.85 with an average standard deviation of 23.25. The highest score was the Control/Teacher 2 (121.38), and the lowest score was Control/Teacher 1 (103.06). On the knowledge subscale, the means ranged from a low score of 53.70 to a high score of 61.20. The four knowledge subscale scores averaged 57.75 with an average standard deviation of 14.78. The highest score was the Experimental/Teacher 2 (61.20), and the lowest score was Experimental/Teacher 1 (53.70).

One-Way Multi variate Analysis of Variance (MANOVA) for the Pretests

A one-way MANOVA was conducted on the pretests to determine if the classes were equal on the CHEAKS attitude and knowledge subscales at the beginning of the study. For this analysis, each class was considered a level of the independent variable. There were two dependent variables: scores on the attitude and knowledge subscales.

The null hypothesis stated that there would be no significant difference between the pretest means for all four groups or classes. Box’s test of equality of covariance
matrices indicated covariance assumption was met ($F_{9, 38759} = 1.77, \ p<.07$). The statistical test used for testing the null hypothesis in the MANOVA was Wilks’ lambda. With the use of Wilks’ criterion, the combined dependent variables were not significantly different by class. It was concluded that the four groups did not differ significantly in CHEAKS knowledge and attitude ($F_{6, 134} = 1.78, \ \lambda = .86, \ p<.11$) at the beginning of the study.

### Posttests

Descriptive Statistics for the Attitude Subscale for the CHEAKS

A 2X2 (teacher by experimental condition) mixed model analysis of variance was conducted on the posttest results for the CHEAKS attitude subscale. The teacher was the random effect, and the experimental condition was the fixed effect. Descriptive statistics for total attitude on the CHEAKS posttest are presented in Table 2.

**Table 2 - Means and Standard Deviations for the CHEAKS Posttest Attitude Subscale**

<table>
<thead>
<tr>
<th>Treatment Condition</th>
<th>Teacher</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>C1</td>
<td>103.75</td>
<td>24.46</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>C2</td>
<td>120.05</td>
<td>18.89</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>All Groups</td>
<td>112.81</td>
<td>22.75</td>
<td>36</td>
</tr>
<tr>
<td>Experimental</td>
<td>E1</td>
<td>101.25</td>
<td>19.67</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>E2</td>
<td>102.36</td>
<td>34.59</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>All Groups</td>
<td>101.78</td>
<td>27.16</td>
<td>23</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
<td>102.68</td>
<td>22.17</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>113.77</td>
<td>26.43</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>All Groups</td>
<td>108.51</td>
<td>24.93</td>
<td>59</td>
</tr>
</tbody>
</table>
As shown in Table 2, the scores on the attitude subscales for the control classes ranged from 103.75 (Teacher 1) to 120.05 (Teacher 2). These two scores’ average was 112.81 with an average standard deviation of 22.75. On the attitude subscales for the experimental classes, the scores ranged from 101.25 (Teacher 1) to 102.36 (Teacher 2). These two scores’ average was 101.78 with an average standard deviation of 27.16. If teacher 1's control class and experimental class are averaged together, that average score is 102.68, with an average standard deviation of 22.17. If teacher 2's control class and experimental class are averaged together, the average score is 113.77, with an average standard deviation of 26.43.

Inferential Statistics for Attitude Subscale of the CHEAKS

A two-way analysis of variance was chosen to analyze the posttest scores on the CHEAKS attitude subscales. The Levene test was conducted to test the homogeneity of variance assumption. The Levene test showed the assumption of homogeneity of variance was not met (F = 3.88 df = 3,55 p = .014), indicating a possible inflated Type I error rate.

The null hypothesis for the analysis of variance statistic was that the independent samples were drawn from different populations with the same mean. The alternate hypothesis was that the populations were not equal. As detailed in Table 3, from the analysis of variance showed that the means at the posttests were equal on the CHEAKS attitude subscale. Thus, the null hypothesis was sustained, and the alternate hypothesis was rejected.
Table 3 - Tests of Between-Subjects Effects on Attitude Subscale

<table>
<thead>
<tr>
<th>Effect</th>
<th>df</th>
<th>F</th>
<th>p&lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition (Experimental vs. Control)</td>
<td>1,1</td>
<td>1.77</td>
<td>.41</td>
</tr>
<tr>
<td>Teacher</td>
<td>1,55</td>
<td>1.82</td>
<td>.20</td>
</tr>
<tr>
<td>Condition X Teacher Interaction</td>
<td>1,55</td>
<td>1.38</td>
<td>.25</td>
</tr>
</tbody>
</table>

Descriptive Statistics for the Knowledge Subscale of the CHEAKS

A 2x2 (teacher by experimental condition) mixed model analysis of variance was conducted on the posttests’ results for the CHEAKS knowledge subscale. The teacher was the random effect, and the experimental condition was the fixed effect. Descriptive statistics for the knowledge subscale are presented in Table 4.

Table 4 - Means and Standard Deviations for the CHEAKS Posttest Knowledge Subscale

<table>
<thead>
<tr>
<th>Condition</th>
<th>Teacher</th>
<th>Mean</th>
<th>Std Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>C1</td>
<td>53.63</td>
<td>12.09</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>C2</td>
<td>58.80</td>
<td>14.12</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>All Groups</td>
<td>56.50</td>
<td>13.33</td>
<td>36</td>
</tr>
<tr>
<td>Experimental</td>
<td>E1</td>
<td>46.00</td>
<td>11.82</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>E2</td>
<td>57.27</td>
<td>17.88</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>All Groups</td>
<td>51.39</td>
<td>15.75</td>
<td>23</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
<td>50.36</td>
<td>12.37</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>58.26</td>
<td>15.27</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>All Groups</td>
<td>54.51</td>
<td>14.41</td>
<td>59</td>
</tr>
</tbody>
</table>

As shown on Table 4, the scores on the knowledge subscales for the control classes ranged from 53.63 (Teacher 1) to 58.80 (Teacher 2). These two scores’ average was 56.50 with a standard deviation of 13.33. On the knowledge subscales for the
experimental classes, the scores ranged from 46.00 (Teacher 1) to 57.27 (Teacher 2). These two scores’ average was 51.39 with an average standard deviation of 15.75. If teacher 1's control class and experimental class are averaged together, that average score is 50.36, with an average standard deviation of 12.37. If teacher 2's control class and experimental class are averaged together, that average score is 58.26, with an average standard deviation of 15.27.

Inferential Statistics on the Knowledge Subscale of the CHEAKS

A two-way analysis of variance was conducted on the posttest scores on the knowledge subscale. The Levene test was conducted to test the homogeneity of variance assumption. This test showed that this assumption was not violated (F = .94, 3/55, p = .427). The results of the two-way analysis of variance, as shown in Table 5, indicated that the means on the posttests were equal on the knowledge subscale by condition and teacher by condition. The means for the knowledge subscale were found to differ significantly by teacher.

<table>
<thead>
<tr>
<th>Effect</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
<td>1,1</td>
<td>2.25</td>
<td>.38</td>
</tr>
<tr>
<td>Teacher</td>
<td>1,55</td>
<td>4.84</td>
<td>.05*</td>
</tr>
<tr>
<td>Condition X Teacher Interaction</td>
<td>1,55</td>
<td>0.67</td>
<td>.42</td>
</tr>
</tbody>
</table>

The null hypothesis for the analysis of variance statistic was that the independent samples were drawn from different populations with the same mean. The alternate hypothesis was that the populations were not equal. As detailed in Table 5, the data
from the analysis of variance showed that the mean at the posttests were not equal on
the CHEAKS knowledge subscale. The classes of Teacher 2 scored statistically
significantly higher than the classes of Teacher 1 on the posttests of the CHEAKS
knowledge subscale. Thus, the null hypothesis was rejected and the alternate
hypothesis was sustained.

Descriptive Statistics on Ten Questions on Water on Knowledge Subscale of the CHEAKS

A 2X2 (teacher by experimental condition) mixed model analysis of variance was
conducted on ten questions over water on the posttests’ results for the CHEAKS
knowledge subscale.

Table 6 - Means and Standard Deviations for the Ten Water Questions
on the CHEAKS Knowledge Subscale

<table>
<thead>
<tr>
<th>Treatment Conditions</th>
<th>Teacher</th>
<th>Mean</th>
<th>Std Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>C1</td>
<td>28.38</td>
<td>3.65</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>C2</td>
<td>31.95</td>
<td>4.14</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>All Groups</td>
<td>30.36</td>
<td>4.27</td>
<td>36</td>
</tr>
<tr>
<td>Experimental</td>
<td>E1</td>
<td>30.17</td>
<td>4.11</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>E2</td>
<td>32.27</td>
<td>2.90</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>All Groups</td>
<td>31.18</td>
<td>3.66</td>
<td>23</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
<td>29.14</td>
<td>3.88</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>32.06</td>
<td>3.70</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>All Groups</td>
<td>30.67</td>
<td>4.03</td>
<td>59</td>
</tr>
</tbody>
</table>

As shown on Table 6, the scores on the ten water questions on the knowledge
subscale for the control classes ranged from 28.38 (Teacher 1) to 31.95 (Teacher 2).
The average of these two scores was 30.36, with a standard deviation of 4.27. On the
ten water questions on the knowledge subscale for the experimental classes, the scores ranged from 30.17 (Teacher 1) to 32.27 (Teacher 2). The average of these two scores was 31.18, with an average standard deviation of 3.66. If Teacher 1’s control class and experimental class are averaged together, that average score is 29.14, with an average standard deviation of 3.88. If Teacher 2’s control class and experimental class are averaged together, that average score is 32.06, with an average standard deviation of 3.70.

Inferential Statistics on Ten Water Questions on the Knowledge Subscale of the CHEAKS

A two-way analysis of the variance was conducted on the posttest scores of the ten water questions on the knowledge subscale. The Levene test was conducted to test the homogeneity of variance assumption. The test showed that the assumption was not violated (F = .65, 3/55, p = .584). The results of the two-way analysis of variance, as shown in Table 7, indicated that the means on the ten water questions were not significantly different by condition, by teacher, and by teacher-condition interaction.

Table 7 - Tests of Between-Subjects Effects on Ten Water Questions for Knowledge Subscale

<table>
<thead>
<tr>
<th>Effect</th>
<th>df</th>
<th>F</th>
<th>p &lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition (Experimental vs. Control)</td>
<td>1,1</td>
<td>2.07</td>
<td>.39</td>
</tr>
<tr>
<td>Teacher</td>
<td>1,55</td>
<td>14.96</td>
<td>.16</td>
</tr>
<tr>
<td>Condition X Teacher Interaction</td>
<td>1,55</td>
<td>.52</td>
<td>.47</td>
</tr>
</tbody>
</table>
Table 7, the data from the analysis of variance showed that the mean at the posttests were not significantly different on the ten water questions on the CHEAKS knowledge subscale. Thus, the null hypothesis was retained.
SUMMARY, DISCUSSION, AND RECOMMENDATIONS

Summary

The purpose of this study was to test the following research hypothesis: eleventh and twelfth-graders who read trade books on environmental science topics in an aquatic science course will score higher on an environmental attitude and knowledge scale than eleventh and twelfth-graders who do not read trade books on environmental science topics in an aquatic science course.

The statistical analysis of this study showed that the students in the experimental classes did not score higher than the control classes on the Children’s Environmental Attitude and Knowledge Scale. Therefore, the research hypothesis was rejected. Instead, the null hypothesis was retained. This null hypothesis indicated that the mean scores of the four classes (two experimental and two control) were equal.

Discussion

Several limitations were placed on this research. Probably the most significant was the limited number of classes, teachers, or both, available for the study. Although 17 school districts were notified, few responded favorably to participating in the study. More teachers and more classes would have given a broader view of the student population and more strength to the statistical analysis. In reviewing the MANOVA on
the CHEAKS pretests, it was found that all the means on all four classes were equal. This was a favorable result because it illustrated that the four classes were equivalent at the beginning of the study. At the end of the study, the mixed model ANOVA on the posttests, with teacher effect as the random effect, showed all the classes were equivalent except for one of the experimental classes whose scores were significantly higher because of the teacher.

This small number of classes is not unusual in the research on trade book usage studies at the elementary level. Romance and Vitale (1992) used three intact fourth grade classrooms. Pressley, Smith, and Smith (1997) used six third grade classes at one elementary school. The invertebrate study done by Royce (2002) had four intact classes at the same elementary school. She used different teachers, and each teacher used a different teaching method. Branching out into social studies, Guzzetti, Kowalinski, and McGowan (1992) used two sixth grade classrooms—one experimental and one control.

The results of the above elementary studies on trade book use are inconclusive. Romance and Vitale (1992) found the experimental group students performed significantly better than the control in both reading and science, as measured by the Iowa Tests of Basic Skills (ITBS) and the Metropolitan Achievement Test (MAT) respectively, with the adjusted mean for MAT science achievement of the experimental group being almost one grade equivalent higher than that of the control. Experimental-group students also displayed more positive attitudes toward learning science activities both in and out of science and greater self-confidence in learning science. However, no difference was found between experimental- and control-groups students on reading,
self-confidence or on attitude toward reading activities out of school (Romance & Vitale, 1992).

Morrow, Pressley, Smith, and Smith (1997) also found statistically significant results when literature (i.e. trade books) was integrated into science instruction. These results do not agree with the current study which found no significance with trade book use.

Royce (2002) did not report significant improvement in knowledge or attitude, and, therefore, these findings are similar to the current study. Royce reported that there was no significant difference among any of the three treatment groups—textbook only group; trade book and textbook group; trade book only group.

Guzzetti, Kowalinski, and McGowan (1992) reported mixed results. Findings showed significant differences in concept acquisition but no differential gains in attitudes toward reading and social studies.

At the secondary level, researcher Fisher (1980) used three groups—one control and two experimental. It is assumed that these were intact classrooms, but this fact is unstated in the research. Barrilleux (1967) divided 44 students into two groups—one experimental and one control. Both of these studies reported statistically significant results with the use of trade books. Thus, these results do not agree with those of the current study.

A closely-related restriction for the current study was the necessity to move from environmental science to aquatic science. Although the initial list of environmental science courses was over 400, contact with several districts revealed that few schools actually taught environmental science, even though it was listed in the approved
curriculum. To complicate the problem further, none of the schools contacted in the first attempt taught more than one class of environmental science in any given semester. This led the researcher to pursue the recruitment of aquatic science teachers, especially after the science coordinator in north Texas forwarded two names of teachers who would participate in the study. These two teachers were the first and only recruits, despite efforts to find additional participants. At one time, three other teachers were interested in the study. Unfortunately, two principals would not give consent, and the third teacher was not assigned any aquatic science class for the fall.

Switching from environmental science to aquatic science invited a third limitation into the study. This limitation was the necessity for any outside research project to correlate with the curriculum already in place in the chosen district. The trade books had to tie into that curriculum. If more freedom had been granted, the trade books could have covered a fuller range of environmental education content. The four books chosen did not discuss recycling or energy sources, two of the six main topics on the CHEAKS. The coverage in the four trade books was limited to ocean water, while the CHEAKS asked questions about rivers, rain, and groundwater. Choosing more diverse books (such as Silent Spring, The Heat Is On, Rain of Troubles, and Never Cry Wolf) would have permitted a broader range of information to be covered and could have made a difference in the results of this study. This limitation illustrates the need to have environmental science classes taught in high school instead of relying on voluntary teacher infusion of these concepts in other classes. Hausbeck, et al. (1997), reported this latter approach was not successful in the New York State public schools that she
investigated. She concluded that environmental education should be required in a separate course in high school.

A fourth and “hidden” limitation in the study was the apathy or indifference of the students. This may have been the result of the nature of the aquatic science course as taught in most schools in Texas. This course cannot be taken for science credit; rather, it is only an elective. Many students may have taken the class “for fun.” As a result, they did not seriously participate when they took the pretests and posttests. The researcher observed students reading through the test rather quickly and with very little outward concern. Successfully attaching a more serious connotation to the trade book, the tests, and the study could possibly have yielded different results. Polling the students before the study began might have found an underlying concern for the environment that the teachers could have used as a springboard for the trade book use. Gambro and Switzky (1996) and Hausbeck, et al. (1997) found high school students scoring high on environmental awareness and concern, even when knowledge scores were low.

Changing teaching strategies also could have had a positive impact on the study. Zelezny (1999) found that interventions that actively involved the students were more effective than those activities in which the students only read and answered questions. If hands-on activities had been employed that were directly aligned with the trade books being read at that time, the students might have learned and retained more of the environmental concepts illustrated by the trade books (Montebello, 1972). The teachers in this study read the trade books out loud to their experimental classes. They asked a few discussion questions, but time limitations prevented much interaction. The
trade books were not aligned with any particular laboratory activity or research assignments. Either of these could have increased learning and appreciation for the environmental problems. In hindsight, perhaps there needed to be more interactive discussion and reduction of teacher control, where students were more responsible for their own learning (Stewart, 1994; Montebello, 1972; Daisey, 1994).

Implications for Further Research

Although there is a great deal of anecdotal data concerning trade book use in elementary and secondary classrooms, there are not many experimental studies such as this one, especially in conjunction with secondary courses. According to Romance and Vitale (1992), work is needed to determine qualitative differences in understanding science concepts through trade book experiences compared to traditional textbook presentations. Based on the results of this study, one cannot conclude that trade book experiences lead to concepts being more meaningfully connected with related ideas or that trade book experiences result in students better relating new ideas to prior knowledge.

Future research must go further than what occurred in this investigation. For example, there were no hands-on opportunities tied to the trade books. Montebello (1972), Stewart (1994), and Daisey (1994) all made this recommendation. In the current science reform movement, this combination is considered desirable.

It is also important to know whether a treatment has long-term effects. Future investigations should possibly consider a longitudinal study in which students are followed for one or two years. Barrilleux (1967) was one of few researchers to find
statistical significance in the use of multiple library sources (e.g., trade books) in his two-year study. Also, possibly allowing students freedom of choice in their trade book selection would have produced significant results. This was Fisher’s strategy in her 1980 study.

It is also possible that both teachers did not cover the same material. For example, if one teacher concentrated on ocean topics, her students might not have been exposed to certain concepts on fresh water. Also, it would have been interesting to know if either or both teachers taught aquatic science more as a biological science or more as a physical science. Did they link the course to other factors that influence the integrity of the aquatic system? Or did they simply teach a descriptive course about aquatic animals, etc.? Also, it is possible they might have chosen a different textbook, different trade books, or some other combination of textbook and trade books, if they had been aware of the multiple environmental topics covered on the CHEAKS.

If changes were to be made in future replication of this study, two alternative approaches are recommended. If aquatic science classes were used again, another instrument should be used to measure environmental attitude and knowledge of water concepts only. If CHEAKS is still the instrument of choice, then the researcher suggests that another setting (e.g., environmental science in high school or eighth grade integrated science) be used. This would enable the choice of trade books to be broader and larger, and therefore the spectrum of topics covered by reading them would include all six of the topics included on the CHEAKS.
APPENDICES
November 16, 2001

Ms. Vickie Christianson  
Curriculum Director  
Denton Independent School District  
P.O. Box 2387  
Denton, TX 76202

Dear Ms. Christianson:

Last week I tried to contact several science coordinators in the Metroplex. You may recognize my name from your voice mail. After successfully only reaching two of the five administrators, I realized another approach may be better. Therefore, I am sending you this request by mail.

I am a doctoral student in curriculum and instruction at North Texas. For my dissertation, I need a sample group of high school environmental science classes. My proposal is the introduction of popular trade books into environmental science classes in order to promote science literacy. On the following page I have outlined the study very briefly so you could see if you and your teachers would be interested in participating in the study.

You need not respond to this letter as I will contact your office by phone in a couple of weeks to see if you have had time to review my request. I can be reached at school during my conference hour, 8:45 to 9:45, at 254-968-6967 or you could reach me at my school email address: alewis@stephenville.k12.tx.us.

Thank you for your time in considering my request. I know how busy all educators are today and I appreciate your attention.

Thank you.

Ann Lewis
December 28, 2001

Curriculum Director
Birdville Independent School District
6125 Belknap
Haltom City, TX 76117

Dear Director:

I am sending this letter to several school districts in the Metroplex. I have tried to contact the appropriate persons by phone and have not been successful. Please take a few minutes to consider my request. I appreciate your time.

I am a doctoral student in curriculum and instruction at North Texas. For my dissertation, I need a sample group of high school environmental science classes. My proposal is the introduction of popular trade books into environmental science classes in order to promote science literacy. On the following page I have outlined the study very briefly so you could see if you and your teachers would be interested in participating in the study.

You need not respond to this letter as I will contact your office by phone in a couple of weeks to see if you have had time to review my request. I can be reached at school during my conference hour, 8:45 to 9:45, at 254-968-6967 or you could reach me at my school email address: alewis@stephenville.k12.tx.us.

Thank you for your time in considering my request. I know how busy all educators are today and I appreciate your attention.

Thank you.

Ann Lewis
Dissertation Proposal

Problem: Will the use of popular trade books in high school environmental science classes promote science literacy?

Sample: At least one environmental class to receive the intervention (the trade books); at least one environmental class to serve as a control (does not use books); preferably taught by the same teacher so he/she is not a variable

Time required: one semester

Actual class time required:
10. About 30 minutes to administer a pretest at the beginning of the semester
11. About 30 minutes to administer a posttest at the end of the semester
12. The students would actually read the trade books outside of class

Books used in the study:

J. Silent Spring
K. The Heat is On
L. Never Cry Wolf

Provision of books:

I would provide 24 copies for one classroom. This is approximately a $200 to $350 expense I would cover personally. If more books are desired, additional funds would need to be secured. The cooperating teacher would then keep this initial set of books for his/her future teaching.

Additional benefits:

1. I have assembled 40 study questions for each of these books and two true-false tests covering these questions for each book. I would be glad to let the cooperating teacher use these if so desired.
2. Hopefully these books will increase science literacy by increasing science knowledge, expanding science appreciation, and improving science attitudes.
March 6, 2002

Karen Hibbs  
Curriculum Director  
Birdville Independent School District  
6125 Belknap  
Haltom City, TX 76117

Dear Ms. Hibbs:

I have talked to your secretary a few times but have been unable to talk to you directly. Therefore, I am sending you this letter with my request. I will try to be brief.

I am a doctoral student at North Texas University. For my dissertation study, I need one more teacher with two aquatic science classes. This teacher would receive a classroom set of trade books if he/she decides to work with me on the study. Do you have a teacher who might be interested? I would be glad to send more detailed information to that person if you can provide a name and address. Please respond by email even if declining so I will stop trying to make contact.

Thank you for your time and attention.

Ann Lewis  
email: alewis@stephenville.k12.tx.us
APPENDIX B

PERMISSION LETTER TO PRINCIPALS
Dear Principal,

I am Ann Lewis, a doctoral student at the University of North Texas. Your teacher, Joe Harrington, has agreed to participate in a study with me for my dissertation. The study will involve his two aquatic science classes for the school year 2002-03. One class will receive an intervention and the second class will serve as a control.

The intervention I am proposing is the introduction of four environmental trade books into his classroom. These books have been carefully chosen by the four teachers in the study. The purpose of the study is to show the effects of introducing the students to trade books on the environment. The participating teachers will read the books in class during an 18-week semester. This will be an addition to the regular curriculum. At the end of the 18 weeks, a standardized test will be given to both control and experimental classes. This test addresses general knowledge and attitudes about the environment. The results will be used to decide if the use of the trade books is statistically significant. No student names will be attached to any score and I will have no access to those names. The control group students will not be held responsible in any way for materials from the trade books.

To compensate these teachers for the time and effort of participating in this study, each teacher will retain one set of the trade books to be kept in his/her classroom permanently.

Instead of giving a pretest, I would like to have composite GPAs on the two classes in the study. This will allow me to prove that both classes were comparable and will set the benchmark for the study. If I am unable to obtain this information, a pretest will be necessary. The decision is basically yours to make.

Since the students are over 14 years of age, they can sign their own consent forms. These are very detailed forms and list all the risks (though minimal). Also, I have prepared a detailed letter of information for all the parents to read and sign for their acknowledgment.

Please sign and date below if I have your permission to use these classes in this study and obtain group GPAs on the participants.

______________________________  ____________________________
Principal’s Printed Name        School

______________________________  ____________________________
Principal’s Signature           Date

Thank you for your time and attention.  Ann Lewis
Instructions for Administering the CHEAKS Test

1. Hand out an answer sheet to each student. Say:
   DO NOT WRITE YOUR NAME ANYWHERE ON THE ANSWER SHEET.
   YOU MAY ANSWER IN PEN OR PENCIL.
   PLEASE WRITE CLEARLY AND LEGIBLY.
   YOU MAY NOT KNOW THE ANSWERS TO ALL THE QUESTIONS. PICK THE
   ANSWER YOU THINK IS BEST AND WRITE IT DOWN. PLEASE DO NOT LEAVE
   ANY ANSWER SPACE BLANK.

2. Hand out the test booklets. Say:
   PLEASE DO WRITE ON ANY PAGE OF THE TEST BOOKLET. ON THE FIRST 36
   QUESTIONS OF THE TEST YOU WILL CHOOSE THE ONE ANSWER THAT BEST
   APPLIES TO YOU. ON THE NEXT 30 QUESTIONS YOU WILL CHOOSE THE
   ANSWER YOU THINK IS CORRECT. AGAIN, PLEASE DO NOT LEAVE ANY
   ANSWER BLANK. YOU ARE NOT EXPECTED TO KNOW ALL THESE ANSWERS.
   YOU WILL HAVE ONE CLASS PERIOD TO FINISH THE TEST. WHEN YOU ARE
   FINISHED, RAISE YOUR HAND AND I WILL COME GET YOUR TEST AND
   ANSWER SHEET.
APPENDIX D

STUDENT CONSENT FORMS
Title of Study

The Effects of Using Trade Books in High School Aquatic Science Classes

Principal Investigator: Ann Lewis, doctoral student in Curriculum and Instruction at the University of North Texas

Faculty Advisor: Dr. Patricia Moseley, Head of Curriculum and Instruction Department University of North Texas

Phone Number: 940-565-2922

Before agreeing to participate in this research study, it is important that you read and understand the following explanation of the proposed procedures. It describes the procedures, benefits, risks, and discomforts of the study. It also describes the alternative treatments that are available to you and your right to withdraw from the study at any time. It is important for you to understand that no guarantees or assurances can be made as to the results of the study.

Purpose of the study and how long it will last:

The purpose of this study is to compare the environmental science literacy of students who have participated in a semester intervention with trade books with students who were not exposed to the trade books. The control groups will not read the trade books during the semester of the study. These trade books are an addition to the regular curriculum. Other than reading the trade books, the curriculum for the trade groups will be identical as that for the experimental group.
Description of the study including the procedures to be used:

Each of the teachers will be given one set of trade books to use in her intervention class. That class will read the book for four weeks. Then she will exchange her set of books with another teacher in the study. She will read that book in her class for the following month. At the end of the two months, she will exchange with a third teacher and obtain a third book. Four weeks later she will get her fourth and final set of books to be read. She will be allowed to keep this set of books in her classroom.

The control groups will not read the trade books during the semester of the study. They are easily obtained from school and public libraries and could be read in the spring semester.

These four books will be chosen by the classroom teacher from the following list: A Home By the Sea, Big Wave, Children of the River, Streams to the River, Paddle to the River, Three Days on a River, Poisoned Land, Silent Spring, Love Canal, The Cay, The Voyage of the Frog, The Black Pearl, The Island, and possible others.

At the beginning of the semester, a 66-question, standardized test will be administered to all eight classes as a pretest. This standardized test is called CHEAKS or Children’s Environmental Attitude and Knowledge Scale. This test was devised by psychologists Frank C. Lemming, William O’Dwyer, and Bruce A. Bracken and published in the Journal of Environmental Education, 1995, Vol. 26, No. 3.

At the end of the semester the same test will be given as a posttest. The questions are very general and measure environmental knowledge and attitudes. The questions are not derived from the trade books specifically. The test will be the same for the control groups and the experimental groups.

The control groups will not be held responsible in any way for materials not presented to them. No test questions or assignments will reflect materials from the trade books only.

The results will be tabulated by the researcher only and used only for statistical analysis. No names will be attached to any score nor will the scores be available to the classroom teacher. Therefore, these test scores cannot be used to formulate any grade in the regular course.
Description of procedures/elements that may result in discomfort or inconvenience:

 Students in the experimental group will have slightly more classwork than those in the control group because the trade books will be read during class. If students in the experimental group opt out of the study, their work load will be reduced only by not taking the standardized tests. They will still have to do all the class assignments, including reading the trade books. They will just not take the pretest and posttest.

Description of the procedures/elements that are associated with foreseeable risks:

 In order to compensate for the unavailability of the trade books for the control groups, the teachers in the study will encourage those groups to read the trade books in the spring semester, directly following the conclusion of this study.

Benefits to the subjects or others:

 The students in the intervention group will have the opportunity to read four environmental books. The students in the control group will have the opportunity to read these books in the study in the next semester. These books can be found in school or public libraries or purchased in local book stores for $10 or less.

 The teacher will retain one set of books for her classroom permanently. This is her compensation for participating in the study.

Confidentiality of research records:

 The test results will be seen and used only by the researcher for statistical analysis. The classroom teacher will not have access to these test scores and they cannot be used to assess any classroom grade. The researcher will have no names attached to any scores.
Review for protection of participants:

This research study has been reviewed and approved by the UNT Committee for the Protection of Human Subjects (940) 565-3940.

RESEARCH SUBJECTS’ RIGHTS: I have read or have had read to me all of the above.

___________________________ has explained the study to me and answered all of my questions. I have been told of the risks or discomforts and possible benefits of the study. I have been told of other choices of treatment available to me.

I understand that I do not have to take part in this study, and my refusal to participate or to withdraw will involve no penalty or loss of rights or benefits or legal recourse to which I am entitled. The study personnel may choose to stop my participation at any time.

In case there are problems or questions, I have been told I can call Ann Lewis at 254-968-5050.

I understand my rights as a research subject, and I voluntarily consent to participate in this study. I understand what the study is about and how and why it is being done. I have been told I will receive a signed copy of this consent form.

Subject’s Signature       Date

Witness’ Signature        Date

For the Investigator or Designee:

I certify that I have reviewed the contents of this form with the person signing above, who, in my opinion, understood the explanation. I have explained the known benefits and risks of the research.

Principal Investigator’s Signature       Date
APPENDIX E

LETTER OF PARTICIPATION TO THE PARENTS
Dear Parent:

Your son/daughter has agreed to participate in a research study in his/her aquatic science class. The title of the study is *The Effects of Using Trade Books in High School Aquatic Science Classes*. The principal investigator is Ann Lewis, doctoral student in the Curriculum and Instruction Department at the University of North Texas. The purpose of this study is to compare the environmental science literacy of students who have participated in a semester intervention with trade books with students who were not exposed to the trade books. The control groups will not read the trade books during the semester of the study. These trade books are an addition to the regular curriculum. Other than reading the trade books, the curriculum for the control groups will be identical as that for the experimental group.

Each of the teachers will be given one set of trade books to use in her intervention class. That class will read the book for four weeks. Then she will exchange her set of books with another teacher in the study. She will read that book in her class for the following month. At the end of the two months, she will exchange with a third teacher a obtain a third book. Four weeks later she will get her fourth and final set of books to read. She will be allowed to permanently keep this last set of books.

At the beginning and end of the semester, all eight classes (four control and four experimental), will take a 66-question, standardized test to evaluate environmental knowledge and attitudes. The test is not derived from the trade books. The results will be tabulated by the researcher only and used only for statistical analysis. No names will be attached to any score nor will the scores be available to the classroom teachers. The control group students will not be held responsible in any way for materials not presented to them. They will not be given test questions or assignments that reflect material in the trade books only.

I foresee no discomfort or inconvenience for any of the subjects. The students in the intervention group will have the opportunity to read environmental books. The teacher will retain one set of books for her classroom permanently. The students in the control group will be given a list of the trade books used in the experimental group at the end of the study. Then the control group members can ready any or all of the books at their own discretion as most of them are in the school libraries. Any others can be purchased easily at a local book store for @$10.

As a parent, I have been informed that my son/daughter is participating in the above study. I have read all of the above. In case there are problems or questions, I have been told I can call Ann Lewis at 254-968-5050.
APPENDIX F

QUESTION FORMAT FOR TRADE BOOK DISCUSSION
Teacher Question Worksheet

I. Focus Questions:
A. 

B. 

C. 

D. 

II. Class Discussion Questions:
A. 

B. 

C. 

D. 

E. 
APPENDIX G

OUTLINE OF METHODOLOGY
Outline of Methodology

I. Teacher preparation
   A. Teacher receives 24 copies of Book #1 before school starts.
   B. Teacher reads Book #1 (should take 1 hour and less, depends on book).
   C. Teacher writes down focus questions to stir the curiosity of students.
   D. Teacher maps out time-line for reading the book before "Switch" date (This could be 2 full class periods within the month or 4 partial class periods).

II. Introduction of book to class
   A. Teacher asks questions to the class to see what they already know about the topics in the book.
   B. Incorrect or lacking knowledge makes students see the need to read an "extra" book.
   C. Hand books out to the students so they can see how attractive and interesting they are (Reason #2 for reading the books) Give them a couple of minutes to browse.
   D. Be sure students understand not to write on the books. These books will go to other teachers except for the last set. DO NOT let them take the books out of the classroom. Keep track of the books by number and notify researcher if any are lost so that they can be replaced before the set is rotated to the next teacher.

III. In-class reading sessions
   A. Read ½ or ¼ of the book out loud. Teacher may do the reading or he/she may choose students who are comfortable reading out loud and can do so well. It is not wise to pick poor readers here as that will distract from the ideas presented in the trade books.
   B. Stop periodically to ask questions about new words or new ideas.
   C. Be sure to document on Teacher Record Sheet the activity or activities that are done in the control class instead of reading the textbook. This is very important to protect the integrity of the study. Remember, these activities can only reinforce textbook information; they cannot present new information at all.

IV. Record-keeping
   A. In an effort to minimize teacher-time-on task, the researcher has prepared a chart to be used to summarize time spent on reading the trade book in the experimental classes and time spent on reinforcing textbook information in the control class.
   B. Briefly describe the activity done in the control class so that activity could be repeated in another setting after reading those directions.
   C. Fill out the Teacher Question Worksheet before sending the set of books to the next teacher. This will minimize work for all the teachers and emphasize important ideas that occur in all the classes reading the trade books.
APPENDIX H

TIME RECORD
### Teacher Record Sheet

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<th>Date</th>
<th>Time</th>
<th>Trade Book Class</th>
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APPENDIX I

CHILDREN’S ENVIRONMENTAL ATTITUDE AND KNOWLEDGE SCALE (CHEAKS)
Children’s Environmental Attitude and Knowledge Scale

(CHEAKS)

Frank C. Leeming, William O’Dwyer, and Bruce A. Bracken
1995
Children’s Environmental Attitude and Knowledge Scale (CHEAKS)

Verbal Commitment

1. I would be willing to stop buying some products to save animals’ lives.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

2. I would not be willing to save energy by using less air conditioning.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

3. To save water, I would be willing to use less water when I bathe.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

4. I would not give $15 of my own money to help the environment.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

5. I would be willing to ride the bus to more places in order to reduce air pollution.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

6. I would not be willing to separate family’s trash for recycling.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false
7. I would give $15 of my own money to help protect wild animals.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

8. To save energy, I would be willing to use dimmer lights.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

9. To save water, I would be willing to turn off the water while I wash my hands.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

10. I would go from house to house to pass our environmental information.
    (1) very true
    (2) mostly true
    (3) not sure
    (4) mostly false
    (5) very false

11. I would be willing to write letters asking people to help reduce pollution.
    (1) very true
    (2) mostly true
    (3) not sure
    (4) mostly false
    (5) very false

12. I would be willing to go from house to house asking people to recycle.
    (1) very true
    (2) mostly true
    (3) not sure
    (4) mostly false
    (5) very false
Actual Commitment

13. I have **not** written someone about a pollution problem.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

14. I have talked with my parents about how to help with environmental problems.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

15. I turn off the water in the sink while I brush my teeth to conserve water.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

16. To save energy, I turn off lights at home when they are not in use.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

17. I have asked my parents **not** to buy products made from animal fur.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

18. I have asked my parents to recycle some of the things we use.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false
19. I have asked others what I can do to help reduce pollution.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

20. I have often read stories that are mostly about the environment.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

21. I do not let a water faucet run when it is not necessary.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

22. I leave the refrigerator open while I decide what to get out.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

23. I have put up a birdhouse near my house.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

24. I do not separate things at home for recycling.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false
25. I am frightened to think people don’t care about the environment.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

26. I get angry about the damage pollution does to the environment.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

27. It makes me happy when people recycle used bottles, cans, and paper.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

28. I get angry when I think about companies testing products on animals.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

29. It makes me happy to see people trying to save energy.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

30. I am not worried about running out of water.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false
31. I do **not** worry about environmental problems.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

32. I am **not** frightened about the effects of pollution on my family.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

33. I get upset when I think of the things people throw away that could be recycled.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

34. It makes me sad to see houses being built where animals used to live.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

35. It frightens me to think how much energy is wasted.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false

36. It upsets me when I see people use too much water.
   (1) very true
   (2) mostly true
   (3) not sure
   (4) mostly false
   (5) very false
Knowledge

37. Most elephants are killed every year to provide people with
   (1) trophies.
   (2) ivory.
   (3) oil.
   (4) skin.

38. Burning coal for energy is a problem because it:
   (1) releases carbon dioxide and other pollutants into the air.
   (2) decreases needed acid rain.
   (3) reduces the amount of ozone in the stratosphere.
   (4) is too expensive.
   (5) pollutes the water in aquifers.

39. Ecology assumes that man is what part of nature?
   (1) special
   (2) related to all other parts
   (3) not important
   (4) the best part
   (5) the first part

40. Phosphates are harmful in sea water because they:
   (1) cause cancer in fish.
   (2) stop reproduction in fish.
   (3) make fish nervous.
   (4) make the water cloudy.
   (5) suffocate fish by increasing algae.

41. Compared to other paper, recycled paper:
   (1) takes more water to make.
   (2) takes less energy to make.
   (3) is less expensive to buy.
   (4) is harder to write on.
   (5) produces more pollution.

42. The most pollution of our water sources is caused by:
   (1) dams on rivers.
   (2) chemical runoff from farms.
   (3) methane gas.
   (4) leaks in the sewers.
   (5) human and animal wastes.
43. Ecology is the study of the relationship between:
   (1) different species of animals.
   (2) plants and the atmosphere.
   (3) organisms and their environments.
   (4) man and other animals.
   (5) man and the environment.

44. The most common poisons found in water are:
   (1) arsenic, silver nitrates.
   (2) hydrocarbons.
   (3) carbon monoxide.
   (4) sulfur, calcium.
   (5) nitrates, phosphates.

45. Where does most of the garbage go after it is dumped from the garbage trucks?
   (1) to an aquifer where it is buried
   (2) it is dumped into the ocean
   (3) it is recycled to make plastic
   (4) to a landfill where it is buried
   (5) to farmers to use for fertilizers

46. Which is most responsible for creating acid rain?
   (1) sulfur dioxide
   (2) carbon dioxide
   (3) ozone
   (4) nitrogen
   (5) ultraviolet radiation

47. Catching tuna in the ocean:
   (1) is eliminating a main food source for whales.
   (2) protects baby sea turtles.
   (3) also kills many dolphins.
   (4) is now against the law.
   (5) is necessary to keep the population size down.

48. Which is an example of a perpetual energy source?
   (1) nuclear
   (2) oil
   (3) wood
   (4) uranium
   (5) solar
49. Which of the following is the most dangerous to the earth’s environment?
(1) damming rivers
(2) overpopulation
(3) tornadoes
(4) household pets
(5) nuclear power plants

50. Most of the lead in our air is caused by:
(1) cars
(2) industrial plants
(3) airplanes
(4) burning refuse
(5) cigarettes

51. Precycling means that:
(1) people buy things that can be used again.
(2) more people should ride bicycles.
(3) small children should wear the clothes of their older brothers or sisters.
(4) items should be tested before we buy them.
(5) environmental changes are always taking place.

52. Animals alive today are most likely to become extinct because:
(1) natural selection kills weaker animals.
(2) where they live is getting too warm.
(3) they are unable to reproduce because of pollution.
(4) the habitat where they live is destroyed.
(5) their food supply is destroyed by acid rain.

53. Coal and petroleum are examples of:
(1) fossil fuels.
(2) renewable sources of energy.
(3) energy sources that are plentiful.
(4) alternative sources of energy.
(5) recycled resources.

54. Environmental problems are a threat to:
(1) mostly people in small countries.
(2) only people who live in cities.
(3) only wild animals and endangered species.
(4) mostly tropical plants and animals.
(5) all living things in the world.
55. Which of the following does not do much to reduce the pollution by automobiles?
   (1) properly tuned engine  
   (2) high octane gas  
   (3) low lead gas  
   (4) smog control devices  
   (5) propane engines

56. The main problem with landfills is that they:
   (1) take up too much space.  
   (2) are ugly to look at and smell bad.  
   (3) attract rats and other pests.  
   (4) prevent farming of nearby land.  
   (5) do not produce enough methane.

57. Building a dam on a river can be harmful because it:
   (1) makes the river muddy.  
   (2) can no longer be used to make electricity.  
   (3) increases level of pollution on the water.  
   (4) causes the river to flood.  
   (5) damages the river’s natural ecosystem.

58. Where is water under the ground found?
   (1) in landfills  
   (2) in ponds  
   (3) in low pressure areas  
   (4) in aquifers  
   (5) in rivers

59. Killing animals like wolves that eat others:
   (1) is necessary and should be done.  
   (2) may increase the number of other animals.  
   (3) does not affect other animals in the area.  
   (4) may decrease the number of other animals.  
   (5) will help protect the environment.

60. A good example of a nonrenewable resource is:
   (1) petroleum.  
   (2) trees.  
   (3) ocean water.  
   (4) sunlight.  
   (5) animals raised for food.
61. Most air pollution in our big cities comes from:
   (1) cars.
   (2) jet planes.
   (3) factories.
   (4) big trucks.
   (5) landfills.

62. An item which cannot be recycled and used again is:
   (1) disposable diapers.
   (2) newspapers.
   (3) aluminum cans.
   (4) motor oil.
   (5) plastic bottles.

63. What is the main problem with the use of aquifers for a water supply?
   (1) they recharge too quickly
   (2) they are becoming used up
   (3) they contain too much fresh water
   (4) they contain too much salt water
   (5) it is hard to get the water out

64. A species that no longer exists is:
   (1) protected.
   (2) endangered.
   (3) abundant.
   (4) extinct
   (5) wild game.

65. Which uses the most energy in an average house in the United States?
   (1) lights
   (2) TV
   (3) hot water heater
   (4) telephone
   (5) refrigerator

66. Which of the following groups is most interested in environmental issues?
   (1) Boy Scouts of America
   (2) The Sierra Club
   (3) Kiwanis
   (4) 4-H Club
   (5) American Cancer Society
REFERENCE LIST


