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The Effect of Historical, Nonfiction Trade Books on Elementary Students' Perceptions of Scientists

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Abstract

Elementary students perceive scientists in stereotypical ways. This study examined the influence of historical, nonfiction trade books on children's images of scientists. Of the 13 self-contained third grade classrooms (n=156), six randomly assigned teachers were instructed to read one trade book each week for six weeks to supplement their modular/kit-based instruction (n=72). The other seven classrooms received only modular/kit-based instruction (n=84). In the evaluation of their drawings, the treatment group demonstrated a broader perception of who does science, where science is done, and what activities scientists do, and they were able to maintain their broadened perception for four weeks after the intervention.

Introduction

Research has firmly established that students possess stereotypical images of scientists. They predominately portray scientists as males confined to a laboratory of dangerous chemicals (Chambers, 1983; Mead & Metraux, 1957; Schibeci & Sorenson, 1983). This stereotype has been consistently portrayed by students for 50 years (Barman, 1997; Chambers, 1983; Finson, 2002a; Fort & Varney, 1989; Mead & Metraux, 1957; Schibeci & Sorenson, 1983).

These insular perceptions of science and scientists are not only common in high school and middle school students but also in young children (Barman, 1997; Chambers, 1983), and it has been suggested that these images affect students' attitudes toward science. Chambers (1983) revealed that older elementary students included more indicators of stereotypical images in their illustrations than did five- to seven-year-olds, suggesting that by fourth and fifth grades, students already have formed their limited views of who a scientist is. This research is significant because it is possible that students are not likely to pursue scientific careers if those stereotypical perceptions do not fit with beliefs about themselves or their aspirations for the future. The positive news is that several research studies have reported that stereotypical images can be improved by meeting scientists in the classroom (Bodzin & Gerhinger, 2001; Flick, 1990). The purpose of this study was to examine whether elementary students' limited views of scientists could be influenced by a different intervention than visiting scientists; the treatment was nonfiction, historical, trade books. This research was designed to answer the following question: Does the inclusion of historical, nonfiction, trade books, presenting scientists as people working with or developing an idea, as part of kit-based instruction influence third grade students' representations of the contemporary scientist and his or her work?

Statement of the Problem

Elementary students perceive scientists in a stereotypical way. Although it has been established that meeting scientists affects children's perceptions of them, the probability of many classrooms putting this into practice is minimal for a variety of reasons. First, there simply are not enough scientists to go around for every elementary classroom. Secondly, and more importantly, if someone is an accomplished, highly respected scientist, that does not necessarily make him or her a wonderful role model for elementary aged children. Some visits might actually reinforce the stereotypical image, and having a visitor in the classroom requires a great deal of work on the part of the teacher. Even if the teacher believes it is a worthwhile idea, he or she may disregard it because of the inconvenience of communicating with outside agencies. Lastly, availability of scientists is limited by their own work schedule, and there are simply not enough scientists to fill every elementary classroom in the United States. Because of the previously stated reasons, a more practical, less time-consuming intervention must be researched. Teachers need a technique for revealing a broad range of scientists to children. This technique should utilize the content required by state and national standards and be sensitive to the time constraints faced by teachers. A technique that meets this criteria is the use of historical, nonfiction trade books. Butzow and Butzow (1989) reported that children's literature is often a major strength and interest to elementary teachers. Trade books could be made available to teachers through a classroom library or as part of a science kit, and using them assumes no background knowledge on the part of the teacher. This is important since a number of today's elementary teachers do not have a background in science (Borko, 1992; Enochs & Riggs, 1990; Smith & Neale, 1989).

Background

Several sources have projected that a shortage of scientific personnel will occur in the future, and unless there is an increase in minority and women participation in scientific fields, the United States will be unable to meet its future technical and scientific needs (National Science Board, 1986; National Science Foundation, 2000).

Science and engineering indicators report that while in some years, there was a slight increase in the number of minority science and engineering majors, overall numbers continued to decline over the past several years (Higher Education Research Institute, 2002). The percentage of Caucasian males has consistently been greater than the number of females entering science-related careers from 1975 to 2000. The same remains true for African American, Asian American, Mexican American, Chicano and Puerto Rican American, and American Indian students. In the last 25 years, biological and agricultural sciences have consistently attracted more females than the physical sciences (2002).

A significant deterrent to minorities and females entering science as a field of study or vocation appears to rest with the stereotypical images of scientists that they hold (Finson, 2002a, 2002b). Students' occupational preferences and career aspirations are strongly linked to their images of particular occupations (Gottfredson, 1981). Smith and Erb (1986) hypothesized that if students encountered a variety of appropriate career role models in science, then the attitudes of both male and female students toward women in science and scientists would be positively affected. Gettys and Cann (1981) noted that students categorize occupations based on gender, and this affects the range of possible careers from which they choose. Although this stereotyping persists as students grow, upon the approach of adolescence, they do become more accepting in their views of whether jobs could be done by either sex, with girls showing more flexible attitudes than boys (Entwisle & Greenberger, 1972). It is important to recognize, however, that girls self-select themselves out of careers in the areas of science and technology between the grades of fifth and seventh grades (Erb, 1981). This finding supports the argument for early career education interventions. If students are not made aware of the variety of scientific careers, misinterpretations about becoming a scientist may evolve, as well as misunderstandings of what scientists do. For over 30 years, researchers have been aware that these ideas about scientists are already formed by the end of elementary education (Entwisle & Greenberger, 1972).

Previous Research Influencing Students' Perceptions of Scientists

Bodzin and Gerhinger (2001) and Flick (1990) reported that children's perceptions of who scientists are and the work they do can be influenced by visiting scientist programs. In both studies, the visits resulted in a decrease in many stereotypical features of scientists, indicating that children's images of scientists can indeed be influenced, and these authors recommend that teachers include scientists in their classroom science program.

Efforts to broaden these images of scientists have been helpful, but these relationships are not a realistic proposition for every classroom. This researcher cautions the indiscriminate use of visiting scientists for the following reasons. Not everyone can relate to children in an age appropriate way without specialized training, and some scientists may not be able to present their field in a positive light without reinforcing common stereotypes. Even if visitors are carefully screened and properly trained, there are not enough scientists to fill the need in every elementary classroom nationwide. Even when the resource pool is expanded to include such professionals as radio/TV meteorologists, county extension agents, and wildlife management officers, the availability of scientists is still limited by their own work schedule and restrictions of geography, such as in rural locations, or the particular kinds of science performed in a particular area. An oceanographer, for example, would be readily available in Boston but not in Boise, while a volcanologist would be available in the Pacific Northwest but not the Southeast.

Furthermore, teachers are limited by time, not only to meet day-to-day responsibilities of classroom instruction, but also local, state, and national requirements, from state standards of learning from the mandates of No Child Left Behind. Lastly, classroom visitations need to be carefully planned and require maintance. A well-designed literature program about scientists and the work they do can fill the void when qualified professionals are not available to represent their field.

National Science Education Standards

Not only are students influenced by personal images of scientists but also by the content of the science courses they have experienced in schools. Traditionally, the overwhelming emphasis in science education has been on mastering the body of knowledge. Consequently, students have obtained a narrow and somewhat erroneous impression of what science is; however, this situation has become the focus of science reform in recent years with the creation of The National Science

Education Standards (NSES) (National Research Council, 1996). One strand, titled History and The Nature of Science, encourages an understanding of "Science as a Human Endeavor." The premise is that understanding the nature of science should begin at the earliest level, as it is a fundamental component of scientific literacy.

Developing an understanding of the nature of science permeates K-12 science education. To achieve this understanding, the NSES outline what students should learn at different levels throughout their K-12 experience, as shown in Figure 1.

Figure 1. National Science Education Standards Nature of Science Strand

Levels K-4	Levels 5-8	Levels 9-12
Science as a Human Endeavor	Science as a Human Endeavor	Science as a Human Endeavor
	Nature of Science	Nature of Scientific Knowledge
	History of Science	Historical Perspectives

History & Nature of Science Standards

The NSES advocate that the human side of science should be taught as early as the elementary grades, "in order to provide a foundation for the development of sophisticated ideas related to the history and nature of science that will be developed in later years" (NRC, 1996, p. 141).

Four aspects of "Science as a Human Endeavor" are contained in the NSES:

1. Science and technology have been practiced by people for a long time.
2. Men and women have made a variety of contributions throughout the history of science and technology.
3. Science will never be finished. Although men and women using scientific inquiry have learned much about the objects, events, and phenomena in nature, much more remains to be understood.
4. Many people choose science as a career and devote their entire lives to studying it. Many people derive great pleasure from doing science (NRC, 1996, p. 141).

Although these four aspects may appear obvious to the adult reader, each needs to be systematically taught to young children (Roach & Wandersee, 1993).

Contemporary Science Education

Elementary science instruction has made tremendous advances in the last half of the century (Shymansky, 1989). One of the gains has come from the development of modular/kit-based instruction. Modules provide teachers with content guidance and pedagogically sound practice. Modular instruction has an ever-increasing role in elementary education today, and some are endorsed by the National Science Foundation for use in classrooms, such as Full Option Science System (FOSS) and Science & Technology for Children (STC). Some of these modules include stories of scientists designed to form broader perceptions of scientists and what they do.

This study researched the effects of using historical, nonfiction trade books in conjunction with modular/kit-based elementary science instruction on students' perceptions of scientists and their work as measured by their drawings of scientists.

Procedures

Methodology

This study utilized a two-group pretest/posttest/delayed posttest approach with 13 intact classes assigned to two instructional approaches: (1) inquiry science and (2) inquiry science with embedded historical, nonfiction trade books. The modules used during the course of study were either "Electricity & Magnetism" or "Structures of Life." It is important to point out that the historical, nonfiction trade books were not associated with the content of the modules but only with the scientific inquiry and people doing science. The experimental group followed the teacher's guide and the modified learning cycle for the inquiry modules but infused six historical, nonfiction trade books within the unit of study. All of the trade books were selected for this study because they had six basic characteristics:

1. contained a simplified story about scientists and their work that went beyond facts, dates, or time-lines of scientists' lives
2. demonstrated a nonstereotypical portrayal of scientists
3. contained accurate information
4. used age-appropriate language
5. displayed a common theme of the struggles these scientists faced and their perseverance
6. contained colorful illustrations and easy text that might be enjoyed over and over again

They were read in no particular order. The control group followed the FOSS outline as provided, including the modules' science stories, and used the same total instructional time as the experimental group (120-180 minutes per week). The FOSS Science Stories included in the modules differed from the treatment group's historical, nonfiction trade books in three ways:

1. The FOSS Science Stories were brief biographies ranging from two to four pages. The historical, nonfiction trade books were entire books on the human endeavors of that particular scientist, ranging from 12 to 30 pages.
2. The FOSS Science Stories included pictures that were limited to head shots of scientists. The historical, nonfiction trade books included illustrations involving the scientist in science activities.
3. The FOSS Science Stories often used pictures that were in black and white. The historical, nonfiction trade books included colorful, vivid illustrations.

At the beginning of the study, students in all 13 classes (N=156) were asked to complete a modified Draw-A-Scientist Test (mDAST, Farland, 2003). On six occasions, evenly spaced over an eight-week period, the treatment teachers were asked to read a historical, nonfiction trade book to students in their class. Teachers were instructed in the procedure for reading trade books as described in a researcher-developed teacher training manual. The control classes maintained their regular science instruction with FOSS modules. At the end of the eight-week period, the mDAST was administered as the posttest by the classroom teachers. The mDAST was readministered four weeks later as the delayed posttest to the treatment students only and were scored by the two trained coders. Each student was assigned a raw score from these drawings to give the student's total score for each category on each test.

The following trade books were selected for this study: *Mae Jemison: A Space Biography* (Yannuzzi, 1998); *It Takes Two: The Story of the Watson & Crick Team* (Farland, 2002c); *Archimedes' Dilemma* (Farland, 2002b); *Starry Messenger* (Sis, 1996); *A Weed Is a Flower* (Aliki, 1998); *Jungle Jane* (Farland, 2002a). The researcher developed and published three of these books because of the limited availability of appropriate trade books that specifically included the previously discussed six characteristics.

Subjects

The study was conducted in a public school system located in northeastern Massachusetts that serves 6,000 students. The sample consisted of 156 third grade students, heterogeneously grouped in 13 classes. Seven were randomly assigned to the control (N=84), while the other six were assigned to the treatment group (N=72). All students had used FOSS Modules in grades one and two. On average, teachers reported teaching science two to three days a week for about 45 to 180 minutes.

Seventy-seven percent of the participating teachers (N=13) majored in elementary education at the undergraduate level. Seventy percent had a graduate degree, including the 46% who majored in elementary education at the graduate level. Years of teaching experience ranged from 0 to 35, with an average of 11.5 years. Teacher training in the use of FOSS Modules ranged from 0 to 15 hours. Thus, the variation in the amount of training each teacher received in proper use of FOSS modules is a limitation. This researcher did not conduct classroom observations of the participating teachers and therefore could not establish whether the modules were used as they were intended or whether the teachers modified the modules due to their knowledge, experience, or sense of self-efficacy, or lack thereof. The control group maintained "regular science instruction," yet there was little the researcher could do to ensure that science instruction was similar in all classes. While no teacher performance data was collected, the researcher discussed the participating teachers with their direct supervisor of instruction and was assured that they were all well-qualified and effective professionals. The researcher, therefore, was confident that the primary variable was the use of historical, nonfiction trade books.

Instrument & Scoring Procedures
Description of the modified DAST (mDAST)

The modified DAST (mDAST, Farland, 2003) is based on the Draw-A-Scientist Test (DAST) developed by Chambers (1983). This test was designed to capture students' images of scientists regardless of writing ability because all children cannot respond appropriately to written instruments. The instructions for the original DAST were limited to "draw a scientist." For this study, a modified DAST was developed by the researcher, and the directions were as follows:

> Imagine that tomorrow you are going on a trip (anywhere) to visit a scientist in a place where the scientist is working right now. Draw the scientist busy with the work this scientist does. Add a caption, which tells what this scientist might be saying to you about the work you are watching the scientist do.

A space is then provided for children to illustrate their perception. This modified DAST also consists of a second page of four questions asking for specific information about the drawing in the event the illustration is unclear: (1) I am a boy/girl, (2) Was the scientist you drew a man or woman?, (3) Was the scientist you drew working outdoors or indoors?, (4) What was the scientist doing in your picture?

The DAST Rubric

The DAST Rubric was developed by the researcher to specifically score the mDAST for this study. The original DAST has been often scored with the DAST-C (Finson, Beaver, & Cramond, 1995). The DAST-C is a checklist for scoring students' illustrations and was not suitable for this study for several reasons.

- The DAST-C is a tool that is limited to labeling stereotypic features of drawings.
- The DAST-C is not concerned with the activity of the scientist or other important features of the drawing, such as location.
- The DAST-C can measure changes in students' perceptions of scientists by identifying a decrease or increase in the stereotypic features from pretest to posttest. The DAST Rubric, however, can more effectively measure changes in students' perceptions of scientists because it identifies an increase or decrease in specified categories (e.g., appearance, location, and activity).

These tests were then divided and scored independently by two trained coders using the DAST Rubric (see the following page). Each student drawing (or test) was given a raw score by each coder in the categories of appearance, location, and activity. The two scores were added together for a final raw score in each of the three categories. All student names were held in confidence.

While the DAST Rubric was designed to ensure consistency, it is still open to some interpretive differences inherent to the individual scoring the illustrations. Hence, each drawing was coded twice, by two different coders for whom an interrater reliability of 90% was established during a two-hour training session.

Treatment

Both the treatment and control groups received the same instructional time (120-180 minutes per week) with the FOSS modules. The only variation in time between the two groups was the additional time teachers needed to read the historical, nonfiction trade books to their classes. Teachers were specifically instructed not to read the trade books during any part of their weekly allotted science time. Rather, they were instructed to find time within their regular school day in which to read the trade books aloud to the students (e.g., during snack or after recess).

The control and treatment students were instructed with the FOSS modules as their regular science instruction. The kit-based science instruction includes a series of guided discovery activities that lead children to gain their own understanding of a phenomenon in a particular way (Shymansky, Kyle, & Alport, 1982). Students are exposed to activities in which they often play the role of the scientist. The creators of the FOSS modules have attempted to teach "Science as a Human Endeavor" through their newly added FOSS Science Stories. The paperback component in each module includes biographies of the lives of scientists. In the "Electricity and Magnetism" module, there is a two-page fictional interview with Benjamin Franklin and a two-page brief biography of Thomas Edison. The mock interview with Benjamin Franklin is about one of his most famous experiments that helped him discover that lightening is actually a form of electricity. The book shows black and white photographs of each scientist from the neck up and no illustrations of any of them involved in science activities. The "Structures of Life" module has a four-page story of Barbara McClintock, which highlights the life and struggles of this female scientist. There are four pictures, one on each page. One picture shows her holding an ear of corn; the second picture shows harvesting of a cornfield; the third picture shows an ear of corn; and the last photograph shows her accepting the Nobel Prize. Although her work as a geneticist is discussed, there are drawings or photographs to show how she conducted her science experiments. The FOSS Science Stories component asks three questions: (1) What are some of the things that made Barbara McClintock a good scientist?, (2) Why do you think it took so long for Barbara's ideas to be accepted?, and (3) If you could ask her a question about her work, what would you ask her?

It is important to point out that these books were not associated with the content of the modules but only with the scientific inquiry and people doing science. These books were purposely selected as an introduction of "Science as a Human Endeavor"—not to be confused with any science content—with a focus on the diversity in the appearance of scientists to highlight the variety of places where science is done and illustrate the variety of activities scientist do. For this reason, the researcher intentionally selected books with no relevance in science content; however, it was relevant that each book contained the four previously mentioned aspects of "Science as a Human Endeavor."

This research demonstrated that these types of trade books expanded students' views of who does science. Ethnic and gender diversity were represented in the books selected. For example, *Jungle Jane* is about a white female scientist. *Archimedes' Dilemma* and *Starry Messenger* are about white male scientists. *It Takes Two: The Story of the Watson & Crick Team* portrays the teamwork of two white male scientists working together to solve a problem. *A Weed Is a Flower* is about an African American male scientist, and *Mae Jemison* is about an African American female scientist.

The control and treatment students were exposed to these stories as part of their regular science instruction with the FOSS modules.

Results of the Analysis of Data

Equivalency of Control and Treatment Groups

On the first day of the study, all students (control=82, treatment=74) were given the mDAST. These pretests were scored using the DAST Rubric and were analyzed using a two-tailed t-test to determine whether the control and treatment groups were equivalent and could be said to belong to the same population. It was determined that the treatment group and control group were equivalent with respect to two of the three categories: (1) appearance and (2) activity (see Table 1).

Table 1. Analysis of Pre & Posttests Mean Scores of Control and Treatment Groups

	Control			Treatment				
	N	M	SD	N	M	SD	t	
APP	82	3.293	1.591	74	3.486	1.682	0.739	(ns)
LOC	82	2.878	1.318	74	3.405	1.344	2.472*	(s)
ACT	82	2.968	1.136	74	3.176	1.297	0.9925	(ns)

Note: APP designates appearance, LOC designates location, ACT designates activity.

Note: *p<.05

The control and treatment groups were not equivalent in the category with respect to location represented in the pretest. The difference between the treatment and control group with respect to location may have been part of the teacher variable. The Survey of Teacher Knowledge and Training revealed limitations in the control group teachers' conceptions of the places in which scientists work in comparison to the teachers' conceptions in the treatment group. After determining that the control and treatment groups were significantly different in one of the three categories, location, the researcher dropped location from any further consideration, as it could not be compared reliably (3.289 significant difference between the control and experimental group at the beginning of the study) and proceeded cautiously with further data analysis.

Data Analysis

Research Question

Does the inclusion of historical, nonfiction trade books, presenting scientists as people working with or developing an idea as part of kit-based instruction, influence third grade students' representations of the contemporary scientist and his or her work?

Hypothesis One

Students in the treatment group who are read historical, nonfiction, trade books in conjunction with their modular-based science instruction will demonstrate a significant improvement in their mean score when comparing pretest to posttest.

Results of Hypothesis One

As reported in Table 2, the mean score of the treatment students improved significantly from pretest to posttest in each of the three categories when using a one tailed t-test to analyze the means.

Modified Draw-a-Scientist Rubric
Directions: Award points for each category by circling boxes.

Student Code # ___________________

Attribute	Sensationalized	Traditional	Broader Than Traditional	Can't Be Categorized
Appearance (also refers to question #2)	Male or female who resembles a monster, or who has clearly "geeky" appearance (e.g., crazy hair, odd appearance, cape).	Standard looking white male or standard looking scientist, unable to determine gender. This scientist clearly lacks any references that are bizarre (e.g., humpback).	Female, person of different ethnicity, or two or more scientists.	• No scientist • Historical figure • Reflects teacher or student • Difficult to discern
Student's Score	**1**	**2**	**3**	**0**
Location (also refers to question #3)	Resembles a basement, cave, or setting of secrecy and/or horror. Often elaborate, with equipment not normally found in a laboratory (e.g., bubbling beakers).	Traditional lab setting; table with equipment in a normal looking room (e.g., beakers without bubbles).	Anywhere other than a traditional lab setting.	• Difficult to discern • Looks like a classroom
Student's Score	**1**	**2**	**3**	**0**
Activity (from question #4 and support from caption)	The scientist's work is either magical or destructive, or about spying, stealing, killing, or scaring. Often science done unrealistically under dangerous conditions (e.g., toxic, potions, explosions).	"The scientist is studying or is trying to . . ." But does not show how the scientist is studying or how he or she is studying/researching. Student sees the scientist involved in work that is miraculous in nature (naïve on the part of the student), not destructive (scientists could find a cure everyday if they wanted to).	"The scientist is studying . . ." and the caption or drawing shows how the scientist is doing this. Indicates that the student is portraying the type of work that a scientist might actually do either in the laboratory or in the field.	
Student's Score	**1**	**2**	**3**	**0**

Table 2. Analysis of Pre- to Posttest Mean Scores of Treatment Group Students

	Pretest			Posttest				
	N	M	SD	N	M	SD	t	
APP	74	3.486	1.682	74	4.635	1.410	4.502*	(s)
LOC	74	3.405	1.344	74	4.216	1.641	3.289*	(s)
ACT	74	3.176	1.297	74	4.189	1.653	4.151*	(s)

Note. APP designates appearance; LOC designates location; ACT designates activity.

Note.*p<.001

Hypothesis One was supported, indicating that students in the treatment group who were read historical, nonfiction trade books in conjunction with their modular-based science instruction did demonstrate "more inclusive" representations of scientists at work in all three categories assessed by the DAST Rubric: (1) appearance, (2) location, and (3) activity. The term *more inclusive* for the purposes of this study meant that students were able to represent their perceptions in drawings that included a wider variety of people practicing science (e.g., women, minorities) in addition to the stereotypical white male that past research has established (Barman, 1997; Chambers, 1983; Mead & Metraux, 1957). Additionally, "more inclusive" drawings placed scientists in locations other than a laboratory or basement setting (including outdoors, forests, oceans, space). The connection between the term *more inclusive* and the DAST Rubric is the students scoring in either the "Traditional" category or "Broader than Traditional" category were identified as "more inclusive." These locations were not confined to the sensationalized laboratory or basement settings recorded in past research (Barman, 1997; Chambers, 1983; Mead & Metraux, 1957).

"More inclusive" representations with respect to activity meant that students who drew scientists mixing chemicals on the pretest, later expanded their ideas about the activities of scientists to observing phenomena and predicting results (e.g., testing an idea or trying to solve a problem). Illustrations that included any activity other than the traditional working with chemicals or sensationalized practices of science were termed "more inclusive."

Hypothesis Two

Students in the control group who experience only kit-based science instruction will demonstrate no significant changes in their representations of scientists at work from pretest to posttest.

Results of Hypothesis Two

As reported in Table 3, students in the control group had no significant improvement in the mean scores from pretest to posttest in each of the three categories (appearance, location, and activity) when using a one-tailed t-test to analyze the means of both groups.

Table 3. Analysis of Pre- and Posttest Mean Scores of Control Group Students

	Pretest			Posttest				
	N	M	SD	N	M	SD	t	
APP	82	3.305	1.585	82	3.049	1.625	1.022 (ns)	
LOC	82	2.878	1.318	82	2.866	1.395	.057	(ns)
ACT	82	2.707	1.083	82	2.732	1.187	0.137	(ns)

Note: APP designates appearance; LOC designates location; ACT designates ACTIVITY.

Note: *p<.05

Hypothesis Three

Students in the treatment group will demonstrate more inclusive representations of scientists at work than those students in the control group when comparing posttest to posttest.

Results of Hypothesis Three

As reported in Table 4, students in the treatment group drew significantly different pictures in comparison to the students participating in the control group on the posttest in the two categories: (1) appearance and (2) activity. Students in the treatment group drew pictures of scientists that received higher scores on the DAST Rubric; consequently, Hypothesis Three was supported in the two categories: (1) appearance and (2) activity. The location category could not be analyzed as equivalency was not established (see Table 1).

Table 4. Analysis of Posttest Mean Scores of Control and Treatment Group Students

	Control			Treatment				
	N	M	SD	N	M	SD	t	
APP	82	3.451	1.765	74	4.581	1.471	4.317*	(s)
ACT	82	2.932	1.187	74	4.109	1.676	5.962*	(s)

Note: APP designates appearance; ACT designates activity.

Note: *p<.0001

Hypothesis Four

Students in the treatment group will maintain their inclusiveness of representations of scientists at work when comparing posttest to delayed posttest means four weeks after the investigation has ended.

Results of Hypothesis Four

As reported in Table 5, students in the treatment group did maintain their inclusiveness of their representations of scientists at work four weeks after the intervention ended. In the appearance category, no significant differences were found from posttest to the delayed posttest, indicating that students were able to maintain these improved perceptions. In the location category, there was a significant improvement from the posttest to the delayed posttest, indicating that students who had made an initial gain as a result of the treatment continued to make gains even after the intervention had ended. In the activity category, there was also a significant improvement from the posttest to the delayed posttest, revealing that students continued to make gains in their perceptions of the types of activities performed by scientists once the intervention had ended.

Table 5. Analysis of Posttest and Delayed Posttest Mean Scores of Treatment Group Students

	Posttest			Delayed Posttest				
	N	M	SD	N	M	SD	t	
APP	74	4.635	1.410	74	4.662	1.397	0.117*	(ns)
LOC	74	4.216	1.641	74	4.892	1.371	2.719*	(s)
ACT	74	4.189	1.653	74	4.649	1.574	1.732*	(s)

Note: APP designates appearance; LOC designates location; ACT designates activity.

Note: *$p<.05$

Finally, this study found that students in the treatment group maintained the inclusiveness of their representations of scientists at work four weeks after the intervention. Bodzin and Gehringer (2001) investigated the effect of classroom visits by a scientist on students' perceptions of scientists. The results from delayed posttests in the study were similar to the improvements made by the third graders involved in this research. Both posttests occurred four weeks after the intervention had ended. Students in this study appear to have maintained their improved perceptions of scientists in the appearance category. Treatment group students involved in this study also demonstrated a significant improvement in the location and activity categories, as identified in the DAST Rubric, four weeks after the intervention had ended.

Discussion

The review of the previously existing research had shown that stereotypical perceptions of scientists are commonly exhibited by grade-school-aged children (Barman, 1997; Chambers, 1983; Mead & Metraux, 1957). This study supported previous research; 72% of the third grade students (n=156) drew male scientists on the pretest; 26% of the third grade students drew female scientists on the pretest; 2% of the third grade students drew both male and female scientists working together.

While nationally endorsed science content modules may be beneficial to students in many ways (e.g., developing their own process skills, fostering their curiosity for science, and teaching science content), they do not consider the nature of science, more specifically "Science as a Human Endeavor" and therefore may not contribute to expanding students' perceptions of scientists. Years of media exposure to stereotypical images of scientists were not challenged for the students in this study by just behaving like a scientist as in most modular-based approaches. This research indicates that students' involvement in hands-on, discovery activities, which may improve their process skills, may not be enough for them to change their perceptions of the appearance and activities of professional scientists. Elementary students appear to need more explicit instruction.

The study supports the idea that students' perceptions of the appearance and activities of scientists can change when they are made aware of the variety of people who participate in the field of science, the variety of places where people practice science, and the variety of activities included in science.

Students in this study who were only exposed to kit-based science instruction did not change their perceptions of the appearance and activities of scientists as represented in the drawings, despite the fact that both groups, control and treatment, reported the same number of minutes of science instruction at approximately 120-180 minutes per week as recorded in the Survey of Teacher Knowledge and Training.

It should be noted that all classes did not study the same FOSS modules, and this design feature may or may not bias the results.

Implications for Classroom Practice

This research offers several implications for practice. This study has indicated the value of using historical, nonfiction trade books as a means of broadening students' representations of the appearance and activities of scientists. More inclusive drawings by students in the treatment group resulted regardless of the order in which the historical, nonfiction trade books were read; therefore, the implication is that this treatment is not prescribed or scripted. Rather, teachers have the professional freedom and flexibility to select historical, nonfiction trade books when interdisciplinary opportunities arise. Historical, nonfiction trade books may support and enrich a variety of curriculum. For example, one book used in this study titled *Jungle Jane* may be read in conjunction with studying animals, Africa, women in science, or habitats. Therefore, Jane Goodall's human endeavor as a scientist is explicitly being taught through a link with existing content. The study further suggests that trade books with specific characteristics are beneficial. Effective books . . .

- contain a simplified version of a story.
- demonstrate a nonstereotypical appearance of scientists.
- contain accurate information (Rice & Snipes, 1997).
- are age-appropriate.
- focus on the process of science (e.g., the struggles and perseverance) in contrast to the ideas of science as miraculous events.
- have colorful illustrations and may be enjoyed over and over again.

Teachers in this study were creative in finding time to introduce 'Science as a Human Endeavor' through historical, nonfiction trade books. For example, they read the books during snack time and after lunch, easily incorporating them into otherwise busy classroom practices. The books were not intended to replace the allotted science time but rather to enrich the current curriculum and allow students the visual representation of scientists.

The research question focused on whether there was a difference in the representations of scientists by third grade students when read historical, nonfiction trade books. The data indicates that for students involved in this study, there was a significant increase in their inclusiveness that was maintained four weeks following the study. For many decades, researchers have been well aware of the stereotypical images students have of scientists; however, until now, research has been limited to demonstrating effective means of improving elementary students' perceptions of scientists through classroom visits by scientists (Bodzin & Gehringer, 2001; Flick, 1990). This study investigated the effect of historical, nonfiction trade books as a tool for exposing "Science as a Human Endeavor" to third grade students. This research linked an important aspect of science education, specifically an understanding of the concept of "Science as a Human Endeavor," with classroom modular/kit-based science instruction by investigating the effectiveness of these books in relation to students' representations of scientists. The results of this study also indicate that modular/kit-based instruction alone may not be enough to address students' stereotypical ideas of who does science, where science is done, and what activities scientists do.

Limitations

Several limitations were identified:

- It was impossible to know how students' exposure to scientists beyond their classroom experience would affect their drawings. Students' prior experiences with stereotypical or nonstereotypical scientists may have affected some students' illustrations. The limitations include not knowing how many students may have been subjected to a particular stereotypical or nonstereotypical scientist *during* the study, thus possibly negating the experience of the trade books read to the treatment group or reinforcing the control group's drawings.
- Students' ability to illustrate what they actually perceive is a limitation. Finson, Beaver, and Cramond (1995) suggested that the DAST accurately assesses test takers' perceptions of scientists; however, there is still a debate among researchers in this field, as children may choose to draw an image of a scientist that is popular or comical versus real and scientific for a number of reasons.
- Students who participated in this research needed to be present on three separate occasions in the treatment group during the pre-, post-, and delayed posttest. Student absences may have resulted in drawings being removed from the study.
- It was impossible to know whether the teachers completed all FOSS lessons as outlined by FOSS or modified the lessons in some way. This was a limitation because an accurate account of how much science was done with these kits could not be established.
- The role of the classroom teacher was a limitation; it was impossible to know the language the teachers used in their classrooms. Despite the researcher trying to control this variable with a scripted language for the teachers, it was impossible to know whether the teacher's language varied from the script and may have influenced students' illustrations.
- Lastly, it is not known whether students perceive the assignment (mDAST) as one opportunity to get all their ideas about scientists across to their audience (namely their teacher). In an attempt to please their teacher, they may include as many stereotypical features as possible in an effort to get their point across the first time. By asking the experimental group to repeat this drawing two more times, it is impossible to establish whether students used the second or third drawing to be more "Broader than Traditional" on their own without the influence of the trade books.

Researchers should probe more deeply into students' perceptions of scientists in future research. Students should be asked to draw a scientist several times and consistencies between these drawings may help researchers understand their perceptions more clearly. Similarly, other interventions, like DVDs should be designed to determine whether they produce similar results as the trade books in this study. Researchers should continue to examine whether holding a non-stereotypic perception of a scientist influences a child's success in school science education and its implications.

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