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Bringing Female Scientists into the Elementary Classroom: Confronting the Strength of Elementary Students' Stereotypical Images of Scientists

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Abstract

This study explored the effectiveness of bringing female scientists into the elementary classrooms on promoting changes in the stereotypical images of scientists. Qualitative and quantitative data were collected and analyzed to illuminate changes in stereotypical images of scientists. Results indicate that despite the efforts of the scientists to encourage the students to question their image of a scientist, the students held on to stereotypical images. Instead, the students questioned the true identity of the scientists, categorizing them as teachers. The results led to questions of the strength of the image and the extent of efforts needed for students to question that image.

Introduction

Women and minorities remain underrepresented in science despite increased educational/societal, and legislative efforts over the past two decades (National Science Board, 2000; Vetter, 1996). This underrepresentation persists despite many successful efforts aimed at increasing "achievement" and "opportunity" for minority populations in science education. The persisting lack of parity has led to a renewed interest in research on career choice. This research has shown that women and minorities who believe they can succeed in science may not pursue science as a career due to their negative images of scientists (Baker & Leary, 1995).

Science is often considered a nerdy, male, and white occupation (Eisenhart, Pinkel & Marion, 1996). Mead and Metraux (1957) first described the picture of scientists held by high school students. These researchers found that these students perceived a scientist as ". . . a man who wears a white coat and works in a laboratory . . . is elderly or middle aged and wears glasses . . . wears a beard

. . . is surrounded by equipment . . . [and] spends his days doing experiments" (pp. 386-367). Chambers (1983) discovered that this image was not reserved for the high school student but was formed as early as the second grade. Elementary children also thought of scientists as being white males wearing lab coats, eyeglasses, having facial hair, and being in settings that included beakers, vials, and books. Research shows that this image is not broadening. Andre, Whigham, Hendrickson, and Chambers (1999) recently identified many of the same stereotypes in fourth graders.

This stereotypical image of scientists has been found to be both an asset and a liability to the sciences (Chambers/1983). The image has improved the perception of science by populations traditionally underrepresented in the scientific disciplines; however, it has also prevented these populations from seeing themselves as successful science students and potential scientists. The concept of a nerdy, male, white occupation has been found to especially create an impediment for girls' involvement in science education (Kahle & Meece, 1994) and to found to impact their career choice as their desired future images and their image of scientists clash (Packard & Wong, 1999). One solution often proposed is for elementary teachers to bring scientists into the classroom to interact with their students. The idea is that women and minority scientists will help dispel stereotypes that may prevent their students from eventually considering careers in science.

Project

This project was designed to test how having female science graduate students in an elementary school classroom changed the perceptions of the students, and to determine what lessons could be learned for the future education of teachers and of scientists. The guiding qiiestions of the project were as follows:

1. Does the presence of female scientists in the classroom affect elementary students' stereotypical images of scientists?
2. What impressions about these visiting scientists do the students form?
3. What images of scientists do the children hold after female role models are brought into the elementary classroom?

The project brought university scientists into the elementary classroom setting to explore physical science concepts with teachers and students. A primary goal of the project was to broaden the students' image of a scientist by involving women and underrepresented groups in science.

Three female science research assistants from a research university were recruited to take part in the project. They included one white American 39-year-old physicist, one black African 25-year-old physicist, and one white American 28-year-old materials scientist. The 39-year-old physicist took the role of lead instructor to provide continuity for the eight activities over a three-month period. All science research assistants were introduced to the children as scientists, and they will be referred to as such throughout this report. An assistant professor from the Department of Physics and Astronomy, four elementary teachers, and one assistant professor from the Center for Curriculum and Instruction oversaw this group. The scientists led physical science inquiry activities for one group of fourth graders and a second group of mixed fourth and fifth graders once a week for a 45-minute time period during the students' regular school hours. The classroom teachers helped develop and actively participated in all activities. Four visits each were spent doing inquiry-based activities on magnetism and electricity. In addition to these concepts, the scientists described their jobs and work environments to the students. Midway through the project, the students watched a video tour of the laboratory of two of the scientists, during which the scientists discussed their research and careers.

Methodology

Setting and Participants

The school was chosen in part due to the large population of underrepresented groups. The school had approximately 45% minority enrollment. Seventeen percent of the students were non-native English speakers, with seven languages represented. Ninety-two percent of the school's students received free or reduced-price lunches.

All students in the four targeted fourth and fifth-grade classes took part in the project; however, students representing disadvantaged populations were the focus of the study. The term "disadvantaged" refers to youth from low-income, urban, or ethnic minorities who, for a variety of structural and ideological reasons, have remained outside the culture of power (Pianta & Walsh, 1996). A total of 24 students (14 females and 10 males) were included in the primary data collection and analysis. These students came from a variety of ethnic backgrounds (see Table 1).

Table 1
Ethnic Background of the Students in the Study

Ethnic Background	Number of Students
African American	4
Hispanic	4
Native American	2
Asian Pacific Islander	5
Middle Eastern	2
First-Generation European American	2
White	5

Approximately one-half of the children were categorized as English-as-Second-Language learners and 21 were categorized as having low-socioeconomic status.

Data Collection

Two program evaluators/researchers took part in the project and were present at each of the activities. The research process utilized a questionnaire, interviews, and observations; however, the greatest insight into the project's impact in the classroom was obtained through interviews.

A questionnaire was administered on a pre- and post-project basis. The researchers included questions regarding stereotypical images of science/scientists

and attitudes toward science. The questions were developed based on a review of the literature in these areas. The questionnaire was reviewed with a statistical research consultant, as well as with the classroom teachers. Adjustments were made based on the feedback received.

The classroom teachers administered the questionnaire. Prior to completion, they went over the questions with the students. In addition, the questionnaire was individually administered orally to students with limited-English abilities. One section of the questionnaire had the students respond to questions on a five-point Likert Scale, with responses ranging from Strongly Agree to Strongly Disagree. Sample questions included the following:

1. It is more important for boys to understand physical science than girls.
2. People from all ethnic groups are good in physical science.

Another section of the questionnaire asked students to respond to multiple-choice questions about the type of people that frequently use, are successful in, or hold jobs in various areas of physical science. This section included the question, "Who do you think works in the jobs that involve physical science?"' (Almost all men; More men than women; Equal numbers of men and women; More women than men; Almost all women).

The students' understandings of content and ideas about scientists were monitored through semistructured interviews and participant/observer observations. Eight classroom activities codirected by the female scientists were observed, two researchers completed these observations, and the findings were compared. Following each activity, three to five elementary students were interviewed about their perceived understanding of the content of the lesson and their perception of the scientists and their work. At the completion of the project, 15 of the 24 primary student subjects were randomly selected and interviewed. Sample interview questions included the following:

1. Can you tell me who these visitors are and about their jobs?
2. Did the scientists look like what you thought a scientist would look like? If not, what did you think a scientist would look like?
3. Would you like to do what the scientist does one day? Why/Why not?

The issue of reliability and validity was addressed here by means of data and method triangulation, peer review of qualitative and quantitative data collection instruments, external analysis of quantitative findings by a qualified consultant, and a collaborative look at all the findings.

In addition, based on teacher feedback, the conditions for test administration were adjusted. These adjustments included utilizing adjusted vocabulary for the questionnaire and interview, reviewing the test questions with the students prior to completion, and individually administering the questionnaire to students with limited-English abilities.

Analysis and Results

Quantitative Analysis of Questionnaire

The completed pre- and post-questionnaires were given to an external qualified consultant. The responses were assigned dummy variables and analyzed utilizing the Statistical Package for Social Sciences (SPSS). The findings were then reported and reviewed with the primary researchers. Results of the quantitative analysis indicated no significant difference ($t = 0.040$; $p = 0.967$) between the pre- and post-questionaires in terms of stereotypical images held by students.

Table 2
Means and Standard Deviations for Pretest and Posttest on Student' Stereotypical Images of Scientists

	Mean	Deviation
Pair 1 (stereotypes): Pretest	25.9500	5.9513
Pair 1 (stereotypes): Posttest	25.9000	3.7120

Qualitative Analysis of Questionnaires and Interviews

Results of the qualitative analysis provided insight into the results described above. The initial categorization system for this analysis was developed based on the research questions. The basic codes wexe labeled "confronting existing stereotypes," "summative impressions of the female scientists," and "summative impressions of scientists." The observation field notes and transcribed verbatim interviews were coded based on this system. The system was tested for completeness (Guba, 1978). The completed categories were then analyzed and reported in narrative form, as presented below.

Searching for Identity

The findings of the analysis reveal that the students rejected the idea that the visiting women were scientists; therefore, findings could not support that they confronted their existing stereotypes of scientists.

During the first couple of days of the project, the female scientists introduced and re-introduced themselves to the children as scientists. The scientists also spent a short time explaining what they do in their jobs. Despite these activities, the classroom observations soon raised questions as to whether the students actually understood that these women were scientists. These inquiries were initially prompted when researchers noted that the students were interacting with the scientists the same way they would with a teacher; for example, there were no questions about the scientists' jobs or whether they used these concepts in their jobs. During the formative interviews that followed three separate activities, the students were asked to explain who the visitors were, where they were coming from, and the jobs that the visitors did when they weren't at the students' school.

When asked to explain who the visitors were, one student reasoned that "they must study electricity"; however, the majority of the students simply shrugged and stated some version of "I don't know." In one case, the child was asked directly whether the women could be scientists, to which he simply stated,"Maybe." The uncertainty of the visitors' identities was supported when, in the course of the overall interviews, the students would refer to the female scientists as "the girl in the maroon shirt" or "the teacher who is writing." The children also revealed that, ''No," they did not know where these people were coming from, although one student did think he remembered that the visitors were from ". . . the college

or university?" In all but one case, the students did not know who the people were and most didn't have any idea about where they were coming from.

The students were also asked to describe what job they thought the visitors held when they were not with them at the school. Except for two that simply responded that they did not know, all the other students had guesses similar to the following examples: "teach about electricity,' "teach; help people learn," or ". . . they're just like the teachers."

The analysis of the formative interviews revealed that, instead of confronting their stereotypical images of scientists, the students rejected the idea that the visiting women were scientists. Their responses revealed that they did not know who these women were, why they were coming to their school, or what jobs they held when they weren't at their school.

Summative Impressions of Visiting Female Scientists

The female scientists gave the students a video tour of their laboratory midway through the project, like video included pictures and explanations of lab equipment, and discussions of what scientists do. The observation notes and summative interviews were explored for the effects this effort, as well as the overall project, had on the impressions the students had of these scientists at the conclusion of the project.

During the summative interviews, the children were once again asked to identify the women that had been visiting their classrooms once a week for several months. Two of the fifteen children interviewed did understand that the visitors were scientists. "They're, um, scientists. They do things with magnets and electricity. (They showed me a movie.)" and "She invents things, like, um, light bulbs and stuff?" Four of the children still made statements such as "I don't know." Eight children identified the visitors as teachers: "They were from the university . . .," "science teachers from the university," "(They are) from the university . . . they teach kids," "(They are) teachers," and "they teach where they came from. . . ." The 13 children that did not understand that the women were scientists were asked directly if the women were scientists. Two gave a definite "No." Another restated that they were "Teachers." Another explained that when the women were not within their classroom they were "get(ting) stuff ready for the next Wednesday." The others gave responses similar to "Maybe."

Despite the female scientists' repeated introductions of themselves as scientists, the video tour of a lab, and a discussion of what they do at work, the majority of the students did not identify the women as scientists. Instead, they identified the visitors as teachers.

Summative Effects on Stereotypical Image of Scientists

The observation notes and transcribed final interviews were coded for the summative images of a scientist held by the students. The data revealed that the students held firmly to the stereotypical image of the unfriendly, unapproachable, man in a white lab coat. These images prevented them from identifying the visitors as scientists.

When questioned about why the visiting women could not be scientists, students responded that the visitors did not show certain characteristics. One characteristic mentioned by many of the students was wearing a white lab coat: "(Scientists) have on these big white coats"; "She would be dressed in science suits .. .", "Like white, scientists would be in a long white coat with, um, glasses to protect their eyes . . . and gloves"; "She didn't have on a white suit. They would have a white suit"; ''No, because in movies I see scientists with long white coats on"; and "They didn't have like their jacket." Other characteristics mentioned were glasses, gray hair, and looking old.

In addition to physical appearance, the children also noted that the women scientists did not behave as they expected scientists to behave. For example, they felt that the women were too nice, "they are, um, try to make things easier for us to understand, show more expression," and "they let us do fun things." In contrast, they thought "real" scientists "talk about more complicated things" and they do not show expression. They also stated that "real" scientists "do experiments" and "have cups with all kinds of experiments in them."

Despite the efforts of the project to identify the women visitors as scientists, students retained their stereotypical images of the appearance and behavior of scientists and, instead, determined that the visiting women could not be scientists.

Conclusion

One of the goals of the project was to demonstrate that scientists are diverse and are not always "nerdy males" wearing white lab coats. Despite the teachers' and scientists' efforts to identify the visitors as scientists and encourage the students to see them as such, the children did not question their stereotypes and, instead, they questioned whether the visiting women were actually scientists. The students' stereotypical images of scientists did not change. The students did note that the visiting women scientists did look and act like their teachers. Their conclusion. which is stronger than our words, was that the visiting women scientists were teachers.

Implications

As mentioned earlier, one solution often proposed to increase the representation of women and minorities in science is for elementary teachers to invite scientists into the classroom to interact with students. The presence of women and minority scientists is expected to help dispel stereotypes that may prevent their students from considering careers in science; however, this research has caused us to re-examine our own ideas of what it may take to dispel the students' images of scientists.This project raised the following questions:

Age and Gender. Would the students have an easier time accepting older women as scientists? Would young men face the same categorization as the young female scientists with whom the students interacted on this project? Would it make a difference if we had female and male scientists working with the students? Would the students identify the women in a mixed-gender group as scientists or as assistants to the male scientists?

Environment. The interviews showed that students had a preconception of both scientists' appearance and their environment. Would it make a difference if we introduced the women as scientists by showing them videotapes of the women in their labs for a few weeks before they have contact with the students?

Focus on Learning vs. an "Event." The interviews showed that the students had a preconception that scientists would be difficult to understand and would

not be interested in whether the students were learning. This type of extended contact between scientists and students can be compared to "one-shot" visits, in which teachers invite scientists to come and do a "show" or a special hands-on activity. Does the special nature of a one-time event emphasize that the visitors are scientists?

Deprogramming. Must we cater to stereotypes in order to challenge students to confront them? Consider what might happen if the women scientists first appeared wearing the expected white lab coats and glasses. Over a period of time, the women would gradually lose the trappings that define the stereotype of the scientist. Would the students change their perception of the scientists in their classroom or their stereotypes of scientists as the female scientists begin to look more like the women in their everyday life, that is, their teachers?

Teachers. Many of the same stereotypical images of a scientist that these students had are also held by preservice elementary teachers (Kahle, 1987). How deeply engrained are these images? Is it easier/harder to address these images in college students? Are our current efforts to address this stereotypical image enough?

Teacher Education. Bringing diverse role models in the classroom is a common teaching strategy recommended in many science methods courses; however we seldom prepare these teachers to explore the impact of such strategies. Would the teachers that graduate from our institutions have understood that the students did not confront their existing stereotypical images of scientists? How do we prepare teachers to effectively explore and adjust suggested teaching strategies?

The answers to these questions are critical to efforts aimed at broadening students' images of scientists. If the images that our students hold are so firmly fixed that bringing in real scientists from diverse backgrounds into their classrooms does not convince the students to reevaluate their images of scientists, how will the students ever begin to picture themselves as scientists?

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