FIFTH GRADE STUDENTS' PERCEPTIONS ABOUT SCIENTISTS AND HOW THEY STUDY AND USE SCIENCE

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Introduction

Studies assessing students' images of scientists (Krause 1977; Chambers 1983; Schibeci & Sorenson 1983; Fort & Varney 1989; Huber & Burton 1995; Finson, Beaver & Cramond 1995) have shown that students possess interesting stereotypic images of scientists. For example, students generally perceive scientists as being white males and view scientists as individuals who work alone in a laboratory. Chambers (1983) and Schibeci and Sorenson (1983) found that as young children progress through successively higher grade levels, their images of scientists become more and more stereotypic until they reach fifth grade. At this time, their stereotypic image of a scientist appears to be fully developed.

The most common technique used to assess students' images of scientists has been the Draw-A-Scientist Checklist (DAST-C), developed by Chambers (1983). In using DAST, investigators ask students to reveal their image of a scientist through a drawing. To provide a reliable and efficient format for analyzing students' drawings, Finson, Beaver, and Cramond (1995) developed the Draw-A-Scientist Checklist (DAST-C). Each item on the DAST-C represents a stereotypic characteristic derived from reviews of literature relating to students' images of scientists. During the analysis of a student's drawing, the more items "checked" on the DAST-C, the more stereotypes appear on the student's drawing. Although the DAST and the DAST-C are useful; tools in gaining insight into students' concepts of scientists, Finson, Beaver, and Cramond (1995) identify two cautions in the use of these instruments:

Maoldomhnaigh and Hunt (1989) reported that students may posses more than one definition of the word scientist, and this may results in students drawing different images at different times without having their perceptions changed by a particular treatment. Additionally, Maoldomhnaigh and Mhaolain(1990) found that changing the wording in directions given to students can alter the types of drawings produced. Such results underscore the importance of having a standardized procedure, including standardized instructions, to follow when administering the DAST. In addition, although the DAST-C appears to yield results similar to those obtained through structured interviews (indicating it accurately assesses the students perceptions of scientists), it may fail to elicit all the richness of data possible through interviews. (p.204)

The Portrayal of Scientists in the K- 12 Curricula

Since the early 1970's, concerted efforts have taken place to present inclusive images of scientists and to show how they engage in the scientific enterprise. For example, in K-12 science programs, women and ethic minority groups are depicted as having active roles in science. In features like "Ask a Scientist" in *Addison-Wesley Science,* scientists are portrayed as "regular people" who dress in everyday clothes and are able to communicate about their scientific activities to children (Barman, et.al. 1992). Science related careers are highlighted in *Destinations in Science* (Brummett, et.al. 1995), *Discover the Wonder* (Heil, et.al. 1993), and *MacMillan/McGraw-Hill Science* (Atwater, et.al. 1993) to show students that "doing science" occurs in a variety of occupations. In addition, some science programs have incorporated features that show students how science occurs in their everyday lives. For example the "Back Home" feature from *Destinations in Science* (Brummett, et.al. 1995) invites students to use their home or neighborhood to study science and the "Technology and Society" feature in the *MacMillan/McGraw Hill Science* (Atwater, et.al. 1993) shows students how science knowledge and the applications of science relate to the everyday life of themselves and their family members.

The way students studied science has also been an area of concern for science educators and curriculum developers. The main issue has been to find ways for students to be "doing" science rather than just reading about it (Kahle 1992). Therefore, most recent K-12 science materials have included a variety of activities that encouraged students to engage in the same processes that scientists use. In these activities, students describe objects and events, ask questions, construct explanations of natural phenomena, test those explanations, and communicated their ideas to others.

Procedures

Because of the concerted efforts since the 1970's to provide students with a realistic image of scientists and how they go about "doing science," we are interested in addressing three specific questions related to the way students view science. Specifically, we will focus on the following questions: (a) What are the current images that students have of scientists? (b) How do students perceive they study science in school? and (c) Do students perceive they are using science outside of school? To address these questions, we devised a protocol that incorporated the current methods of DAST, some techniques to take into account the cautions suggested by Finson, Beaver, and Cramond (1995) which relate to using a standardized procedure and structured interview questions, and procedures that we felt would further enhance our ability to understand the students' perceptions of scientists and science.

An initial concern that we had about DAST was related to asking students to make a "forced choice." If you ask students to draw a scientist, does this force them to make a choice between a male or female? Or, if you asked students to draw two scientists, would this provide them with the freedom to depict both sexes? To answer this question, we randomly selected two groups of ten fifth grade students. Each group had an equal number of boys and girls. Group A was asked to draw two scientists doing science while Group B was asked to draw one scientist doing science. In Group A, 7 students drew two male scientists, 2 students drew a male and female scientist, and 1 student drew 2 female scientists. In Group B, 7 students drew a male scientist and 3 students drew a female scientist. Because the drawing of two scientists took each students twice as long to complete as the drawing of one scientist and because there appeared to be no major differences in the results of groups A and B, we decided to develop our protocol with students drawing only one scientist.

We also wanted to provide students with an opportunity to draw scientists from different racial backgrounds. Therefore, we provided each student with a set of colored pencils or crayons before they were asked to draw a scientist.

Each student was given the following directions and asked questions individually. Even though each student was asked a set of standard questions, each interview session was informal enough to allow the investigator to gain additional information about the students' drawings and to clarify any of their responses. The responses were audio-taped and later transcribed for further analysis. The set of directions and questions used in each interview session are:

1. Will you please draw a picture of a scientist doing science? When you are finished, will you please explain your drawing?
2. On another piece of paper, will you please draw a picture of yourself doing science in school? When you are finished, will you please explain your drawing?
3. Can you think of some ways you use what you learn in science outside of school?

Sample

One hundred seventeen fifth grade students (57 males and 60 females) from the midwestern and southwestern parts of the United States were chosen for this study. Eighty-seven of these students came from one private school and two public schools in a large midwestern city. The remaining 30 students came from a private school in a large southwestern city. The students enrolled in the private school in the midwest were primarily from middle to upper income families while the students from the private school in the southwest were mostly from middle income families. The two public school from the midwest contained students primarily from low to middle income families. In terms of ethnic background, 73 students were Caucasian, 40 students were Afro-American, and 4 students were of Asian descent.

Analysis

The student's drawings of scientists were analyzed using the DAST-C. Each drawing was rated for specific stereotypic images and additional information obtained from the student interviews was compiled and reviewed (table 1).

Table 1

Students' Stereotypic Images of a Scientist (N = 117)

Common stereotype Students responding (in %)

1. Scientist Wearing a Lab Coat 26
2. Scientist Wearing Eyeglasses 26
3. Scientist With Facial Hair 5
4. Symbols of Research Displayed 85

(e.g., instruments, lab equipment, etc.)

5. Symbols of Knowledge 15

(e.g. books, clip boards, pens in pockets, etc.)

6. Technology Represented 11

(e.g. telephone, TV, computers, etc.)

7. Relevant Captions 7

(e.g. formulae, classification, "eureka", etc.)

8. Male Gender Only 80

9. Caucasian(s) Only 93

10. Scientist in Middle Aged/Elderly 10

11. Scientist has Mythic Stereotypes 15

(Frankenstein creatures, etc.)

12. Indications of Secrecy 2

(Warnings of "private," etc.)

13. Scientist is Working in Lab 90

14. Indications of Danger 11

15. Open comments related to dress items, neckties, hair style, smile/frown, etc.

- Depicted scientists wearing regular clothing (e.g., bluejeans, T-shirt) 20
- Drew the scientist with a smile 23

The drawings of students doing science were grouped into two main categories: (1) those who pictured themselves as passive learners such as reading about science or taking notes at a desk and (2) those who saw themselves as active learners (table 2). Additional information obtained from interviews was also compiled and analyzed.

Table 2

Students' Perceptions of "Doing Science" in School (N = 117)

Activity represented Students responding (in %)

1. Seated at Desk Reading or Taking Notes 56

2. Participating in Activity 27

3. Other (looking for insects, leaves, plants, or rocks outdoors) 17

Data related to students' perceptions about using science outside of school were gathered from the interview transcripts. These data were categorized into four main groups: (a) students who think they can use science but are unsure how, (b) students who only see themselves using science by repeating activities from school, (c) students who could generalize the use of science knowledge and processes to everyday situations, and (d) students who did not see any use of science outside of school (table 3).

Table 3

Student Perceptions of Using Science (N = 117)

Category	Students responding (in %)
1. Never Use Science Outside of School	26
2. Activities are Extension of School Assignments	60
3. Did Use Science But Not Sure How	5
4. Could Generalize Use of Skills and Knowledge of Science to Everyday Situations (e.g., solving problems, making observations and inferences, animal and plant identification, prediction weather, and care for plants and pets)	9

Results

Perceptions of Scientists

As shown in table 1, the students in this study had similar images of scientists to those revealed in previous studies (Chambers 1983; Fort & Varney 1989; Finson, Beaver, & Cramond 1995; Huber & Burton 1995). Generally, the students perceived scientists as being white males who do their work in some type of laboratory.

A few other items worth noting about the students' drawings of scientists are related to the scientists' clothing and their facial expressions. Scientists wearing regular clothing such as bluejeans and T-shirts are depicted by 20% of the students while 26% pictured the scientist in a lab coat. In regard to showing any facial expressions on the scientists, most of the students depicted scientists with no expression. However, 23% of the students did draw scientists with smiles on their faces. When asked to explain this aspect of the drawing, the students generally indicated that the scientists enjoyed doing their work.

Perceptions of School Science

When students were asked to draw a picture of themselves doing science in school, 56% drew themselves at desks either reading a science book or taking notes. When asked about their drawings, several of the students said that they usually sit at a desk and read their science book. However, these students also indicated that they would prefer to do some type of activity during science. Doing some type of science activity was depicted by 27% of the students while 17% drew themselves outdoors looking for insects, leaves, rocks, or plants.

Perceptions About Using Science Outside of School

The majority of the students (60%) viewed the use of science outside of school as an extension of their school experiences. Students cited specific school activities that they did at home such as mixing vinegar with baking soda. Several students stated that they were able to help one of their younger siblings with their science homework because they had been given similar assignments. It was felt by 26% of the students that they never use science outside of school and 5% thought they probably use their science knowledge and skills outside of school, but they were unsure as to how they use the knowledge or skills.

A total of 9% of the students were able to connect the skills and knowledge they gained from science to everyday activities. For example, these students cited how they use problem solving, making observations and inferences, identifying small animals and plants, predicting weather, and caring for plants and pets in their everyday lives.

Discussion

Although steps have been taken by curriculum developers and science educators in the last few decades to highlight women and minorities in science, most of the students in our sample perceive scientists as white males who practice science in some type of laboratory. This points to a continued need to search for ways to show K- 12 students that scientists are represented by both genders and are from a variety of ethnic backgrounds. In addition, scientists should be portrayed as everyday people. Therefore, teachers need to be encouraged to use the special features in science textbooks that highlight science careers, depict scientists as everyday people who are capable of sharing their work with non-scientists. Resources, like *Dragonfly* (Project Dragonfly 1996), could also help teachers present students with an inclusive image of science and scientists. *Dragonfly is* a publication in which students interview scientists and publish the procedures and results of studies they have conducted. In addition, this magazine highlights the work and daily lives of scientists.

The most recent K-12 science curriculum programs include activities to engage students in "doing science." However, a large number of students in our sample perceive their school science experience as either a reading exercise or a time to listen to someone lecture about science. The *National Science Education Standards* (National Research Council 1996) has explicit recommendations about teaching science as a process of inquiry. Teachers need professional development which provides dialogue and concrete examples designed to help them put these recommendations into classroom practice.

Videotapes featuring scientific expeditions and investigations would present scientists in a dynamic mode. Inviting women and minorities to talk with the class about how they learn about and use science would offer opportunities for students to broaden their ideas about scientists on a more personal level. Building on these experiences, pointing out the scientific contributions by females and minorities would continue to broaden student perspectives. The historical sequence in the development of our understandings about the way things work would help students gain an appreciation for the personalities of scientists as "real people. "

Our findings in this study indicate that most students do not see a connection between what they learn in science and how it can be applied to their everyday lives. Students need to be presented with concrete examples that demonstrate the connection between school science and what they do outside of school. For example, teachers could engage students in activities that show them how specific skills like observing, measuring, and classifying are used in everyday activities (Mercier & Ostlund 1996). Students could be encouraged to make collections of things such as rocks, leaves, insects, etc. in order to discover patterns and to develop classification skills.

Engaging students in product testing is an effective strategy for learning how to use the skills of science. As students conduct a "fair test" for various products they will learn how to control variables in an investigation. This may help make science more relevant for students. Additionally, involving teams of students in long term investigations will help them get a feel for the work that scientists do. These projects simulate what scientists do, e.g., working together to formulate a question, making observations, gathering data, drawing conclusions, sharing and challenging conclusions drawn from data, and finally trying to reach a consensus. Additionally, making connections with math and communications creates a realistic view of doing science.

Science classes could also incorporate live communication with scientists. For example, Internet connections can involve classes around the world in conducting research and sharing data on phenomena such as the pH of rain. The Jason Project is another way students can engage in doing science with active scientists.

Final Note

The next step is to plan and implement a pilot program using some of the ideas presented above. Since assessment often drives the curriculum, if students' ideas about scientists and how they use science everyday is evaluated, teachers will be more likely to employ strategies to increase realistic perceptions. The information that we obtained in this study has been limited to a few schools in the midwest and southwest. We encourage others to use the protocol discussed in this paper to gain insights about how students in different parts of the United States perceive science and its relevancy to them. We also believe that the protocol discussed in this paper should be used on a continual basis by teachers to collect information about how their students' views regarding science change over time. These data would provide valuable feedback to teachers regarding whether students are developing a realistic perception about science and its usefulness to them. This information could serve as an evaluation tool for teachers to assess the effectiveness of their science instruction.

For a complete description of the protocol used in this study, please refer to: Barman, C. How do students really view science and scientists? (1996) *Science & Children. 34 (1): 30-33.*

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