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ABSTRACT

This paper presents a national study in which K-8 preservice and inservice teachers participated to gain information about their students' views of science. This project primarily focuses on engaging the teachers in classroom research. The first section includes specific components and the results of the project. The second section describes the K-8 teachers' perceptions of participating in the study and examines their views of conducting research. The third section discusses the value of classroom inquiry research for K-8 teachers and the implications for teacher education. (Contains 18 references.) (YDS)

A Project Designed to Engage K-8 Preservice and Inservice Teachers in Classroom Inquiry

by

Charles R. Barman

A PROJECT DESIGNED TO ENGAGE K-8 PRESERVICE AND INSERVICE TEACHERS IN CLASSROOM INQUIRY

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Teachers engaging in educational research is a topic addressed in the National Science Education Standards (1996) and is a prominent issue discussed in the educational literature (Butzow & Gabel, 1986; Elliot, 1991; Eiriksson, 1995; Goswami & Stillman, 1987; Hubbard & Power, 1993; Kyle & Shymansky, 1988). Educators argue that teachers who engage in classroom inquiry will use the information they gain from these endeavors to make careful reflections about their teaching and will experience an increase in confidence and professionalism (Smith, Layng, &
Jones, 1996).

In 1984, the National Science Teachers Association (NSTA) established a program for K-12 teachers called "Every Teacher a Researcher" (Gabel, 1986). NSTA surveyed K-12 science teachers to find out their research interests and to start a research network of teachers. Once a sufficient network was developed, an invitation was extended to members of the network to join with colleagues of similar research interests and become partners in a research project.

In the same spirit as the Every Teacher a Researcher program, a project was organized to invite K-8 preservice and inservice teachers to participate in a national study. By participating in this project, teachers would not only gain information about how their students view science, but would also contribute data that would develop a national profile of students' views related to scientists and studying science. Although the initial purpose of this project was to engage teachers in classroom research, it was also an excellent vehicle to find out their views about the value of engaging in educational inquiry.

The remainder of this paper is divided into three main sections. The first section focuses on specific components and the results of the national study. The second part deals with the K-8 teachers' perceptions about participating in the study and examines their views of conducting

future research. The third and final section discusses the educational implications of the results of the national study and the K-8 teachers' views regarding their participation in this study.

A National Study Involving K-8 Teachers

An Invitation to Teachers

In the fall of 1996, an article was published in Science & Chidren (S & C) which invited K-8 teachers to participate in a national study (Barman, 1996). In this article, the teachers were provided with an interview protocol developed by Barman and Ostlund (1996) which incorporates Chambers' (1983) Draw-A-Scientist Test (DAST) to examine their perceptions of scientists. In addition, this protocol investigates how students view the way they study science in school and their ideas about the relevance of science to their daily lives.

When using the protocol, the investigator works with each student individually in a personal interview setting. Although each student is asked a set of standard questions and given a standard set of directions, each interview session is informal enough to allow the investigator to gain additional information about the students' drawings and to clarify any of their responses. The responses are audio-taped and later transcribed for further analysis. The set of directions and questions included in this interview protocol are:

- Will you please draw a picture of a scientist doing science? When you are finished, will you please explain your drawing?
- 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?
- Can you think of some ways you use what you learn in science outside of school?

The protocol also provides an opportunity for students to draw scientists from different ethnic backgrounds. Before the students are asked to draw their picture of a scientist, they are offered a set of colored pencils or crayons and told to feel free to color their drawing or any parts of their picture they would like to accentuate.

When developing the protocol, a concern was raised pertaining 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 a 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, two groups of ten fifth grade students were randomly selected. 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 a 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 student 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, students were asked to draw only one scientist.

Data Collection

One hundred fifty-four elementary and middle school inservice and preservice teachers from twenty-three states and the District of Columbia participated in the data collection for this project. The S & C article (Barman, 1996) which invited the teacher participation also contained step-by-step directions about how to use the interview protocol developed for this investigation and it explained how to analyze and record the drawing and interview data so that the teachers could report their findings in a uniform format. To analyze each students' drawing of a scientist, the Draw-A-Scientist Checklist (DAST-C) was used (Finson, Beaver, and Crammond, 1995). Each item on the DAST-C resprsents 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. A similiar analysis technique was used for the students' drawings of themselves studying science in school and for their views about the relevance of science to their daily lives (Barman, 1996).

Teachers sent their drawings and analyses to the managing editor of S & C where they were organized and compiled according to specific grade levels (e.g. K-2, 3-5, and 6-8). These groupings provided a useful mechanism for making comparisons between different aged students

and they made it possible to examine possible trends that may occur as children move from the primary grades to middle school.

Data were collected by the K-8 teachers for 1504 students. Half (50%) of these students were males and 50% were females. Of the total number of students interviewed, 235 were from grades K-2, 649 from grades 3-5, and 620 were from grades 6-8. The regions of the United States that were represented by these data were the East (7 states and the District of Columbia), the West (2 states), the Southwest (3 states), the Southeast (2 states), and the Midwest (9 states).

Analysis Techniques

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' Images of a Scientist

Common Stereotypes N = 1504	Responses/Grade Level (frequency in %)		
	K-2	3-5	6-8
Scientist Wearing a Lab Coat	29	41	52
Scientist Wearing Eyeglasses	17	28	46
Scientist With Facial Hair	5	9	26
Symbols of Research Displayed (e.g. lab equipment, etc.)	72	94	84
Symbols of Knowledge (e.g. books, clipboards, pens in pockets, etc.)	19	35	37
Technology Represented (e.g. telephone, TV, computers, etc.	18	15	20
Relevant Captions (e.g. formulae, classification, "eureka", etc.)	2	13	19

Male Gender Only	58	73	75
Caucasian(s) Only	69	80	74
Scientist is Middle Aged/Elderly	13	32	38
Scientist has Mythic Stereotypes (Frankenstein creatures, etc.)	8	11	13
Indications of Secrecy (Warnings of "private," etc.)	1	3	11
Scientist is Working in Lab	86	88	71
Indications of Danger	10	18	22

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

Activity Represented N = 1504	Responses/Grade Level (frequency in %) K-2	3-5	6-8
Seated at Desk Reading a Book	9	6	5
Seated as Desk Taking Notes	6	10	7
Participating in Activity	85	84	88

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: (1) students

who think they can use science outside of school, (2) students who only see themselves using science by repeating activities from school, (3) students who could generalize the use of science knowledge and processes to everyday situations, and (4) students who did not see any use of science outside of school (Table 3).

Table 3
Student Perceptions of Using Science

Category	Responses/Grade Level (in %)		
N = 1504	K-2	3-5	6-8
Students Who Don't See a Use for Science Outside of School	41	16	13
Students Who Think They Can Use Science Outside of School	59	84	87
Students Who See Themselves Only Repeating School Assignments	27	32	28
Students That Could Generalize Use of Skills and Knowledge of Science to Everyday Situations (e.g solving problems, making obserations, predicting weather and care for plants and pets)	32	52	59

Results

Students' Perceptions of Scientists

As shown in table 1, the students in this study had similiar images of scientists to those revealed in previous studies (Chambers 1983; Fort & Varney 1989; Finson, Beaver, & Crammond 1995; Huber & Burton 1995). Most of the scientists were depicted as white males. The primary students represented females in their drawings more often (42%) than the students in grades 3-5 (27%) and grades 6-8 (25%). In the case of ethnic background, 69% of the K-2 students, 80% of the 3-5 students, and 74% of the 6-8 students depicted their scientist as a Caucasian.

The students in each grade category drew scientists with several types of stereotypic

features. However, there is an tendency for students in grades 3-5 and 6-8 to include more of these features in their drawings. For example, a greater percentage of the older students included things like lab coats, eyeglasses, and facial hair in their drawings. Most students in grades K-2 and 3-5 (86% and 88% respectively) depicted their scientist working indoors, whereas 29% of the middle grade students drew their scientist in some other type of environment. In addition, the majority of students in all three groups pictured their scientist working in surroundings that were not secretive or dangerous.

The mythical stereotype, such as Frankenstein creatures or Mad Scientists, was not a predominant feature represented in most of the drawings from all three groups (8%, 11%, and 13% respectively). This indicates that the majority of the students tend to have images of scientists as regular people and that the view of scientist as a "crazed person" was a minority view among the students interviewed in this project. In addition, all three groups of students tended to see scientists as young adults rather than middle-aged or elderly.

Students' Perceptions of School Science

According to the students interviewed in this project, it appears the emphasis placed on activity-oriented science over the last few decades has made a difference in how students are studying science. In each category, the majority of students pictured themselves studying science by doing some type of activity (85%, 84%, 88% respectively) instead of taking notes or reading a book (Table 2).

Students' Perceptions About Using Science Outside of School

As shown in table 3, more students see a use for science outside of school than those who do not. As these students become older, they have an increasing tendency to recognize this relationship. In addition, more than half of the K-2 students (32%) who fall into this category are able to generalize the use of science knowledge and skills to everyday situations other than just repeating the activities they do in school. This same trend is shown in the data for students in grades 3-5 (52%) and 6-8 (59%).

K-8 Teachers' Perceptions About Participating in the National Study

When the teachers submitted their data and analyses to the managing editor or S & C, they were asked to also include their names and mailing addresses. Of the 154 teachers who submitted data, 50 current addresses for preservice teachers and 77 addresses for inservice teachers were received. A survey instrument was developed and sent to those 127 teachers. Responses were obtained from 31 (62%) of the preservice teachers and 60 (78%) of the inservice teachers surveyed. In addition to specific demographic information, the survey instrument asked the following questions:

- Why did you participate in the S & C study?
- How did you learn about the study?
- Do you think this study had or will have an impact on your teaching?
- Did you share your data with any of your peers? If so, what were their reactions to this information?
- In the future, do you think you will conduct your own classroom research? Why or why not?

Survey Results

Demographic Data

As indicated in table 4, the majority of inservice (83%) and preservice teachers (84%) that participated in the study were females. This is not surprising because the focus group for this study was K-8 teachers. Of the inservice teachers who responded to the survey, the greatest number were those who taught for 1-5 years (34%) or 10-15 years (23%). The inservice respondents were primarily undergraduate seniors (65%). There was a fairly even distribution of inservice teachers from the five different school district categories listed on the survey. In relation to teaching assignment, it appears responses were obtained from fewer teachers from grades K-2 (14%) than teachers from grades 3-5 (32%) and grades 6-8 (24%). However, these data may be a bit deceiving because 22% of the respondents listed multiple grade levels for their teaching assignment and there was no way of determining whether these teachers taught one or

more primary grades or a combination of upper level grades.

Table 4

Demographic Information About Respondents

Inservice Teachers: N = 60

Males - 17%
Females - 83%

Number of Years Teaching:	Teaching Assignment:		
1-5 yrs. - 35%	K - 3%	6 - 17%	
6-10 yrs. - 13%	1 - 3%	7 - 5%	
10-15 yrs. - 23%	2 - 8%	8 - 2%	
15-20 yrs. - 14%	3 - 5%	Multiple Grades - 22%	
20+ yrs. - 15%	4 - 12%	Science Coordinator - 8%	
	5 - 15%		

Setting of School District in Which Respondent Taught:

Rural District - 17%	Large City (50-100,000+) - 22%
Small City (1-10,000 people) - 15%	Inner City School - 18%
Medium City (10-50,000 people) - 28%	

Preservice Teachers: N = 31

Males - 16%	Year in School:
Females - 84%	Freshman - 0
	Sophomore - 0
	Junior - 0
	Senior - 65%
	Graduate Student - 35%

Teachers' Answers to Survey Questions

When asked why they participated in the study, the majority of inservice teachers indicated that they were interested in learning more about the way their students perceived scientists. Several inservice teachers also indicated that by contributing to this project, they would be helping construct a national profile of how elementary and middle school students view

scientists and studying science. These teachers said they were anxious to see how their students compared to other students in the United States. Most of the preservice teachers responded to this question by saying participation in this study was either a requirement of a science education class or their instructor strongly encouraged them to take part in this project.

The majority of inservice teachers (65%) indicated that they learned about this study by reading S & C (Table 5). A smaller percentage (10%) heard about of the study through a college class and 25% indicated that they had been told of the study from a professional colleague. On the other hand, most of the preservice teachers (90%) said they learned about the study from a college class and only 10% indicated that they were informed of this study by reading S & C.

Table 5
Inservice & Preservice Teachers' Responses

Survey Questions	Responses		
	Reading S & C	College Class	Other Source
How did you learn about the S & C Study?			
Inservice Teachers	65%	10%	25%
Preservice Teachers	10%	90%	0
	Yes	No	Unsure
Do you think participating in this study has had an impact on your teaching or will impact you as a future teacher?			
Inservice Teachers	75%	25%	0
Preservice Teachers	77%	10%	13%
Do you plan to conduct further research?			
Inservice Teachers	70%	13%	17%
Preservice Teachers	71%	13%	16%
Did you share your results with peers?			
Inservice Teachers	85%	15%	-
Preservice Teachers	74%	26%	-

Inservice Teachers N = 60
Preservice Teachers N = 31

A large percentage of the inservice teachers (75%) felt participating in this study did have an impact on their teaching and 77% of the preservice teachers felt their participation would impact them as a future teacher. Several inservice teachers said the results of this study have caused them to pause and self-evaluate their teaching practices. These teachers indicated that they plan to invite scientists (especially women) to their class to talk about their work. Other teachers stated that they were planning to intergrate more science in language arts. For example, in their language arts classes they plan to have their students read a biography of a famous scientist who is a woman or from some other minority group. In addition, several inservice teachers said that they were surprised by the results of this study. They would have never predicted that their students would have included so many stereotypical features in their drawings of scientists.

Several preservice teachers stated they were glad they participated in the study because the strategies they used in the interview protocol could also be employed in other areas to identify prior knowledge of their students. They also indicated that they now know that they will have to make a deliberate attempt to show their students how science is used in their everyday lives.

When asked if they planned to conduct further classroom research, 70% of the inservice and 71% of the preservice teachers said yes. Several of the inservice teachers indicated that they are interested in doing more classroom research but felt in order to do so they needed the type of guidance provided in the S & C article (Barman, 1996). Others stated that they have already started to think of additional ways they can collect information about their students and their teaching. A few of the preservice teachers stated that they believed research would be an integral part of their teaching. They felt that by continuing to do classroom research they would validate their teaching practices.

A large number of the inservice (85%) and the preservice (74%) teachers indicated that they shared the results of their research with peers. Several inservice teachers reported that the results were discussed at faculty meetings and that their peers were interested in the information. One middle school teacher stated that she shared the information from this study with some high school teachers. The high school teachers, however, were not very interested in the information and didn't see any relevance in asking high school students about their ideas of scientists and studying science.

Several preservice teachers stated that they discussed the results of their research in their science education classes. In these classes, they tried to identify ways they could help students examine their ideas about scientists and science. Interestingly, one preservice teacher indicated that when she shared her results with peers, some of them said if they had been asked to draw a scientist they would have included some the same stereotypical features respresented by most of her elementary school students.

Educational Implications of Project

Implications for Science Teaching

The data from this study show some positive trends in K-8 student views about scientists and studying science. The majority of the students depicted scientists as realistic people and not mythical creatures like they are generally pictured in cartoons. They also had a tendency to exclude indications of secrecy and danger in their pictures, which may indicate they see scientists as engaging in projects that are beneficial and not harmful.

In relation to students' perceptions about studying science in school and using science outside of school, the data also provides a reason for optimism. Many students saw themselves doing activity-oriented science in school and, even at an early age, they recognize a use outside of school for the knowledge and skills they learn in science.

An obvious concern raised by the data is related to the students' perceptions about gender and ethnic origin. Previous studies have shown students view scientists as primarily white males (Krause 1977; Chambers 1983; Schibeci & Sorenson 1983; Fort & Varney 1989; Huber & Burton 1995) and the results from this study indicate this trend has not changed. It appears a greater emphasis needs to be placed on highlighting women and minorities in school science, starting with the primary grades and continuing through middle school.

Although most of the students did not represent their scientist as a mythical or "mad" person, several did include other stereotypes, such as eyeglasses, facial hair, and lab coats. In addition, many students also drew their scientist indoors in a laboratory. This suggests a need in the elementary and middle school science curriculum to create opportunities for students to see scientists in a variety of settings and roles. For example, science units could include videotapes featuring expeditions and investigations which present scientists outside of the laboratory in a variety of surroundings. Videotapes of scientists who are from different ethnic backgrounds and female scientists could also help students broaden their views about the type of indviduals who can become scientists. Resources, like Dragonfly (Project Dragonfly 1996), could help teachers present students with an inclusive image of science and scientists. Dragonfly

is a publication in which students interview scientists. Through these interviews, the readers not only learn about their scientific work but also are given insight into the scientists' personal interests. Science classes could also incorporate live communications with scientists. Internet connections or live telecasts can involve classes in discussions with scientists from around the world.

Although many students did see a use for science outside of school, several students did not fall into this category. In addition, some who did see a use for science outside of school could only see their application as repeating an activity they had done in school. To help students make better connections between school science and what they do outside of school, it is important to engage students in discussions about what they did in class and how it could apply to their everyday occurences. For example, when the students are taking specific measurements or doing some type of classification exercise, it would be helpful to demonstrate how these same skills are used at home by the students and their families. Or, if the students are studying types of fungi, such as yeast and mushrooms, activities like baking bread and mushroom tasting may help the students see a connection between these organisms and their everyday experiences.

Implications for Teacher Education

This project has also revealed some important information related to K-8 teachers and their perceptions about the value of engaging in classroom inquiry. First, the fact that over half of the inservice teachers learned about the study by reading S & C, demonstrates the important role educational journals play in providing a network for educators to share ideas. An important lesson can also be learned from the fact that 90% of the preservice teachers were informed about the study via a college class. College instructors involved in methods classes can provide an important service for students by introducing them to these journals and by directing their attention to special projects like the national study. By so doing, their students will hopefully see the professional benefit of reading these journals on a regular basis.

Second, most of the inservice and preservice teachers surveyed felt that participating in

the national study either did have or would have a positive impact on their teaching. They also viewed engaging in research as beneficial to them and their students in improving instruction. Only 13% of both the inservice and preservice teachers said they did not plan to engage in further research. The rest of the teachers surveyed either said they planned to do additional research (70% and 71%) or they were not sure if they would conduct further research (17% and 16%). Several of the inservice teachers felt that for them to engage in more classroom research they needed the type of guidance provided in S & C (Barman, 1996). For these teachers, it appears it was important for them to have a set procedure to follow in gathering and analyzing the data. This demonstrates another important role science educators can play in the professional development of teachers. Through university courses and inservice workshops, science educators can provide the support, guidance, and information teachers need to engage in classroom inquiry.

Finally, according to one preservice teacher, some of her peers stated that their drawings would have included the same stereotypic features that appeared in the K-8 students' pictures. As science educators, it is critical to be aware of the perceptions our preservice teachers have about scientists. Their perceptions could very likely perpetuate further misconceptions about science and scientists among their students. Therefore, excercises, like Draw-A-Scientist, followed by a classroom discussion about the drawings is an appropriate activity for science methods classes. In addition, including examples of activities that allow students to observe male and female scientists in multiple roles as well as from different ethnic backgrounds can provide opportunities that will help preservice teachers identify ways to expose their own students to similiar experiences and, hopefully, help their students develop realistic ideas of scientists and the scientific enterprise.

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