Gender Differences in Students' Experiences, Interests, and Attitudes toward Science and Scientists

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ABSTRACT: The purpose of this study was to examine sixth grade students' attitudes and experiences related to science. The study involved 437 students who completed a survey designed to elicit students' perceptions of science and scientists, out-of-school science experiences, science topics of interest, and characteristics of future jobs. Results showed that for this sample there continue to be significant gender differences in science experiences, attitudes, and perceptions of science courses and careers. Males reported more extracurricular experiences with a variety of tools such as batteries, electric toys, fuses, microscopes, and pulleys. Females reported more experiences with bread-making, knitting, sewing, and planting seeds. More male than female students indicated they were interested in atomic bombs, atoms, cars, computers, x-rays, and technology, whereas more females reported interest in animal communication, rainbows, healthy eating, weather, and AIDS. In addition, when asked about future jobs, male and female students' responses differed by gender. Males saw variables such as controlling other people, becoming famous, earning lots of money, and having a simple and easy job as important. Females, more than males, wanted to "help other people." Students' perceptions of science showed that significantly more females than males reported that science was difficult to understand, whereas more males reported that science was destructive and dangerous, as well as more "suitable" for boys. *Sci Ed* **84:**180–192, 2000.

INTRODUCTION

Studies completed in the last three decades have shown that girls and boys have different interests and attitudes toward studying science and different perceptions of scientists and

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science careers. In addition, students often report having had different experiences with science in and out of school based on gender. These trends are important because, although more females than males enroll in postsecondary institutions and earn higher grades in science and engineering courses, significantly more males than females major in the natural sciences or engineering (Division of Research, Evaluation, and Communication, Directorate for Education and Human Resources, 1996; Keeves, 1991; Kotte, 1992; National Academy Press, 1991; National Science Board, 1998; Rosser, 1995). In this study, we examine the interests and experiences of young adolescent students and explore the contexts and implications of differences by gender.

ATTITUDES

Beginning as early as elementary school, boys have typically possessed more interest in studying science than girls (Clarke, 1972; Clark & Nelson, 1972; 1971; Kotte, 1992). In an initial study of gender and students' science interests, Kahle examined data from the National Assessment of Educational Progress (NAEP) and found that girls described their science classes as "facts to memorize," and "boring" (Kahle & Lakes, 1983). By middle school, girls' attitudes toward science tend to decline and this decline may persist through high school (Sullins, Hernandez, Fuller, & Tashiro, 1995). Kotte (1992) reported that, for students from ten countries, the differences between males and females' attitudes toward science widens as students move from elementary to secondary school. Furthermore, Kotte reported that the sharpest increase in gender differences in attitudes takes place between the ages of 10 and 14 years. In an examination of data from 19,000 eighth grade students who participated in the National Educational Longitudinal Study, Catsambis (1995) found that males were more likely to look forward to science class and to think science would be useful to their future, and were less afraid to ask questions in science classes than their female peers. Girls' less positive attitudes, according to Catsambis, existed even though they performed as well or better than boys, receiving better grades in science classes. In addition, Catsambis found that over twice as many middle school boys as girls are interested in a future career in science.

COURSE AND CAREER ENROLLMENT

The gender differences noted for career selection are also seen in precollege students' attitudes and course enrollments. Keeves and Kotte's (1992) examination of students from ten different countries found that males consistently held more favorable attitudes toward science than females, even though females were more interested in school and school learning in general. In this same sample of students, males also indicated that science was easy rather than difficult to learn, whereas females students were less positive about the ease of learning science.

Keeves and Kotte found that males, more than females, were more likely to be enrolled in physics and chemistry courses in secondary school. Biology was the only area where the number of female students exceeded the the number of male students enrolled. Keeves and Kotte also reported that, at ages 10, 14, and 18, male students had higher achievement in chemistry, earth science, and physics. The differences for biology were not significantly different for males and females.

EXPERIENCES

Recent feminist theories have shed light on the relationships between girls' prior experiences, their attitudes, and their subsequent science course enrollments. Researchers

have documented that science-related experiences for boys and girls are not the same over childhood and adolescence. Kahle and Lakes (1983) were among the first to show that girls reported having very different out-of-school experiences in science than than their male peers. Significantly more boys than girls indicated that they had visited a factory, a weather station, or an electric plant. More boys indicated that they read science articles, watched science television shows, and completed science projects. Even within the same science classrooms, studies have shown that male and female students often have very different experiences. Jones and Wheatley (1989, 1990) found that males had more opportunities to conduct experiments, carry out demonstrations, and manipulate equipment.

There is growing evidence that science experiences impact science career selection. Baker and Leary (1995) conducted in-depth interviews with girls in grades 2, 5, 8, and 11 to determine what influences girls to choose science. Their interviews showed that, although girls reported liking science and believing they could do well in the subject, these girls were influenced by their perceptions of interpersonal relationships. Specifically, girls that chose science careers indicated that they were drawn to them because of strong affective experiences with a loved one such as as a parent or grandparent. During the interviews, girls with positive attitudes toward science attributed their attitudes, in part, to extracurricular experiences such as doing science at home, reading about science, or watching science-related television shows.

Baker and Leary (1995) also found differences in reported attitudes as students progressed from middle through high school. Eighth grade girls in the study reported that they thought girls, in general, liked science, but they thought that their friends would not be supportive of a girl's career choice in science. However, by eleventh grade this trend was reversed with girls indicating that friends would support a choice of a science career, but they believed that girls in general do not like science. Furthermore, Baker and Leary found that the girls in their sample rejected physical sciences because these areas were not viewed as helping or caring, instead preferring areas such as biology that would allow them to help people, animals, or the earth. Overall, girls reported that science experiences they had with other people they loved or admired impacted their acceptance of science as a career option. The theme that emerged from the Baker and Leary study is that, like the women in Gilligan's (1982) study, these girls defined themselves through experiences and relationships with others.

IMAGES OF SCIENCE AND SCIENTISTS

The stereotypic "mad scientist" image of scientists has been documented through a number of studies such as the "draw-a-scientist" task (Chambers, 1983). Chambers's initial study of a large sample of elementary students found that less than 1% of the 4807 students drew a female scientist (Chambers, 1983). In a more recent study (Barman, 1997) of 1504 students from 23 states, the District of Columbia, and 3 additional countries, it was revealed that students still perceive scientists as white males with lab coats, eyeglasses, and facial hair. Even though there was equal representation from both genders in the study, only 25% of the middle school students included a female as a scientist in their drawing.

Students' perceptions of science carry over into their selection of topics for science fair and research projects. Jones (1990) examined precollege students' research and found that significantly more males completed research in the physical sciences, whereas girls' research was more likely to be in the area of biology. Biology has been traditionally viewed by girls as a more caring branch of science that focuses on living organisms and human health. Physics, on the other hand, is often viewed by girls as having to do with war and destruction.

STUDY CONTEXT

Significant changes have taken place in the numbers and roles of women in the work force, since the early studies published over 20 years ago that documented differences in girls and boys attitudes. Women have entered the workplace in large numbers and many more women are involved in science fields at a variety of levels. Some fields such as medicine and veterinary medicine are now enrolling more females than males. How have these societal changes influenced children's perceptions of science? In this study of a sample of sixth grade students, we examine students' attitudes and perceptions of science. These results are then compared to the gender-typic views held by students in the past.

RESEARCH QUESTIONS

1. Are there gender differences in out-of-school experiences related to science?
2. Are there gender differences in students' interests in science topics?
3. Are there gender differences in students' attitudes toward science?

STUDY PARTICIPANTS

The present study reports data from a sample of U.S. students. A total of 437 sixth grade students from five schools participated in the study (51% male, 49% female; 26% African American, 42% Euro-American, 9% Hispanic, 15% Asian-American, and 8% other). The schools are located in rural, urban, and suburban communities located near large cities in the southeastern United States. Teachers were selected based on their willingness to volunteer. Students who participated in the study were randomly assigned to their classes by computer prior to the opening of school and the initiation of the study. Teachers gave the instrument during their sixth grade science classes and provided students with unlimited time to complete all items.

INSTRUMENT

Instrument Development

This study is part of a larger international study of cross-cultural comparisons of children's interests, experiences, attitudes, and perceptions of science. The original study was designed to "shed light on some of the issues that may be important for an informed discussion on culture, gender, and science education" (S. Sjoberg, personal communication, August 17, 1998). The international study goals included making comparisons of the interests of pupils and the actual contents of curricula, and textbooks.

The survey instrument "Science and Scientists," was developed by an international team of science educators (Sjoberg, Mehta, & Mulemwa, 1995). These educators drafted a preliminary version of the instrument, based on items used in previous research (Sjoberg & Imsen, 1988), and piloted it in their respective countries, Norway, India, and Uganda. The initial version was developed in English and was translated for different countries. The goal was to develop an instrument that could be used in all parts of the world. The pilot test provided the basis for refining the items and developing the final version of the instrument (S. Sjoberg, personal communication, August 17, 1998). Face validity was established by review of the instrument by an international panel and subsequent field testing in three countries. Several other studies have emerged from this international effort to explore the relationships between culture, gender, and science, including studies in

Iceland (Hjartardottir & Arnadottir, 1998), Sweden (Backman, 1997), Norway (Myrland, 1997), India (Chunawala & Ladage, 1998), and Spain (Vazquez & Manassero, 1997).

Instrument Description and Analyses

The instrument included seven subtests: Scientists as Persons; Out-of-School Experiences; Things to Learn About (interests); Importance for Future Job (future job characteristics); Science in Action (perceptions of science); Scientists at Work; and Me as a Scientist. In this study of a U.S. sample, the same instrument and procedures recommended for the international study have been used to allow future comparisons of this sample of southeastern U.S. students with the larger multinational sample. However, the results of the subtests, Scientists as Persons, Scientists at Work–Draw a Scientist, and Writing, Me as a Scientist were not reported because these subtests did not relate to our study questions that explored students' experiences and interests in science. Reliability was determined by calculating internal consistency for each subtest. Cronbach's coefficient alpha statistics for each subtest included: Out-of-School Experiences (0.95); Things to Learn About (0.97); Importance for Future Job (0.70); and Science in Action (0.67).

The subtest, *Out-of-School Experiences: What Have I Done?*, includes an inventory of experiences that may have a bearing on the teaching and learning of science. The items were designed to elicit background differences for students of different cultures. The Out-of-School Experiences subtest asked students to respond to the prompt "Have you ever done this outside of school?" for tasks such as "used a saw," or "made your own clothes." The original instrument asked students to choose between "often—many times," "seldom—once or twice," or "never." After piloting the instrument with students, we found that some had difficulty quantifying the amount of prior experience that they had with activities. Our interests were in finding out whether students had had prior experiences or not with each activity, not in trying to quantify the number of experiences that they had had. As a result of these issues, we gave the instrument as designed for the international study, but for analyses the often and seldom categories were collapsed into one category that indicated student prior experience. Chi-square analyses were conducted to determine if gender differences in student experiences were present.

The next subtest, *Important for a Future Job*, was designed to explore the hopes and priorities that students have for their future and how this may affect their approaches toward learning. For example, the subtest includes items that are both other-oriented and person-oriented as well as ego-centered or instrumental. This subtest includes a list of aspects that might be important for the choice of a future job. The student is asked to judge the personal relevance of each item.

Students were given these directions: "If you were free to choose any job or occupation you like, what do you think is important? Below is a list of things that may be very important to you, and you may indicate whether you consider this aspect to be very important, of some importance, or not important. Place a tick at the appropriate place for each factor." The Important for a Future Job subtest included items such as "work with people instead of things," or "control other people." Items included extrinsic rewards such as earning lots of money and becoming famous as well as items such as having more time for friends and family, as well as developing new knowledge and skills. The three items were coded as follows: very important (2), of some importance (1), and not important (0). A *t*-test was used to examine differences in responses by students' gender.

The *Things to Learn About* subtest includes an inventory of possible items that could be included in a science curriculum. Care was taken in the design of the instrument to include similar scientific content into different contexts (such as light and optics, how the eye can see, what are colors and how do we see different colors, etc.). The rationale for

the subtest was to explore whether different contexts of application may appeal differently to different groups of pupils or different cultures.

For the Things to Learn About subtest students were asked to to imagine that you could decide what to learn about. They were then directed to ". . . tick the ones that look interesting to you, leave the others blank." Students indicated their interests in things such as "why birds and planes can fly," or "rockets and space travel." Each tick was later coded as a 1 and blank spaces were coded as a 0 for subsequent chi-square analyses.

The *Science in Action* subtest includes a list of possible word associations and the student is asked to indicate the ones that they find suitable. The subtest is designed to elicit attitudes toward science and perceptions of contributions of science. The authors of the instument suggest that the word "science" may mean different things to different students and the word may trigger different emotions, or give different associations (S. Sjoberg, personal communication, August 17, 1998).

The student directions for the Science in Action subtest stated: "When you think of 'science,' what comes to your mind? Place a tick mark at the words that you connect with science, leave the others blank. You may tick as many places as you like." A yes tick was coded as a 1 and a blank was coded as a 0. Frequencies and chi-square values were calculated for each item.

RESULTS

Out-of-School Experiences

There were significant differences for 23 of the out-of-school experiences, as shown in Table 1. More males than females reported prior experiences outside of school with a variety of tools and objects, including rifles, batteries, electric toys, fuses, microscopes, and pulleys. More females that males reported prior experiences such as bread-making, observing birds and stars, knitting, sewing, and planting seeds. However, there were no gender differences for 29 of the school activities, including experiences such as climbed a tree, ridden a bicycle, or used a wrist watch.

The gender differences noted in these extracurricular experiences support the historical supposition that boys tend to have more experiences in the physical sciences and girls tend to have more experiences in the biological sciences. However, although the girls in this study reported they had biologically oriented experiences (bird watching, making bread) they also reported having done more hand work (knitting, weaving, sewing).

Student Interests

The results of student-reported learning interests (Table 2) showed that males reported significantly more interest in learning about the listed science topics from a variety of areas. There were 20 different topics in which more males than females reported being interested in learning, and there were only 6 topics in which more females than males indicated interests.

Although there were exceptions to the general claim that boys are more interested in the physical science areas and girls are more interested in the biological science areas, students' reported interests fit these gender-typic patterns. Boys more than girls wanted to learn about planes, cars, computers, light, electricity, radioactivity, new sources of energy, and x-rays. More girls than boys wanted to learn about rainbows, healthy eating, colors, animal communication, and AIDS. The large differences in these sixth grade boys' interests in the physical sciences suggests that science content–related interests may begin early.

TABLE 1
Percent of Out-of-School Experiences by Gender (N = 437)

	Males	Females	Chi-square	*p*
Higher male reports				
Used an air gun or rifle	73.5	35.5	63.7	0.000
Made bow and arrows, sling, catapault, or boomerang	71.0	43.3	34.3	0.000
Used a car jack or changed wheels on a car	61.4	25.1	57.3	0.000
Made a cart or wheelbarrow	40.2	20.5	19.6	0.000
Chopped wood or collected firewood	89.1	74.8	15.3	0.000
Charged a car battery or other battery	66.2	51.6	9.4	0.002
Played with electric batteries and bulbs or motors	85.1	71.4	12.5	0.001
Used electric toys (cars, torches, etc.)	94.6	87.7	6.4	0.011
Made a fire using wood or charcoal	89.7	80.0	7.9	0.004
Changed a fuse or attached electric lead to plug	71.8	46.9	27.7	0.000
Studied the inside of a radio, TV, video, or similar	68.8	47.3	20.3	0.000
Mended a bicycle tube	67.1	35.7	42.3	0.000
Used a microscope	87.9	79.0	6.4	0.011
Used a rope and pulleys for lifting heavy things	75.3	52.8	24.1	0.000
Used a saw	92.0	72.6	29.0	0.000
Higher female reports				
Made bread or pastry	71.9	89.2	20.3	0.000
Watched a bird make its nest	52.7	62.2	4.0	0.044
Made your own clothes	12.3	32.2	25.1	0.000
Knitted, or made baskets or mats	26.7	51.4	28.8	0.000
Observed or studied the Milky Way or the constellation of the stars	57.8	68.4	4.9	0.025
Used needle and thread for sewing	69.5	92.0	35.9	0.000
Planted and watched seeds grow	73.3	83.2	6.2	0.012
Weaved cloth or textiles	53.0	77.0	8.10	0.004

Importance for a Future Job

There were statistically significant differences by gender for four of the characteristics of future jobs (see Table 3). More males than females wanted to "control other people," "have an easy job," "become famous," "make and invent new things," and "earn lots of money." More females than males wanted to "help other people."

Science in Action

The *Science in Action* subtest measured students' perceptions of the attributes of science. Significantly more males than females perceived science as involving: power; ease of understanding; potential to help the poor; destruction and danger; creation of societal problems; and better suitability for boys (see Table 4). More females than males perceived science as difficult to understand and as involving experiments. Both male and female

TABLE 2
Student-Reported Learning Interests (N = 437)

Subject	Males (%)	Females (%)	$p<$
Males more interested:			
What an atomic bomb consists of and how they are made	72	40	0.000
Atoms and molecules	43	23	0.000
Why birds and planes can fly	55	33	0.000
The car and how it works	70	30	0.000
Chemicals and their properties	54	32	0.000
Computers, PCs, and what we can do with them	69	50	0.000
Dinosaurs and why they died out	70	57	0.009
Electricity, how it is produced and used in the home	42	24	0.000
Important inventions and discoveries	50	37	0.005
Latest developments in technology	68	46	0.000
Light and optics	47	31	0.000
How a nuclear power plant functions	50	23	0.000
How radioactivity affects life and my own body	48	31	0.000
Rockets and space travel	60	38	0.000
Satellites and modern communication	54	35	0.000
How science and technology may help disabled persons	48	31	0.000
How scientists think and work	33	23	0.000
Sounds and music from birds and other animals	54	35	0.002
New sources of energy: from the sun, wind, etc.	44	30	0.003
X-rays and ultrasound in medicine	54	43	0.023
Females more interested:			
The rainbow, what it is and why you can see it	45	65	0.000
What we should eat to be healthy	36	53	0.000
What are colors and how do we see different colors?	41	52	0.026
Clouds, rain, and snow	52	54	0.000
How birds and animals communicate	58	71	0.003
AIDS: What it is and how it spreads	26	35	0.043

students saw science as useful for everyday life, important for society, interesting and exciting, creating pollution, and boring. The Science in Action subtest item that asked if science is more suitable for boys should be interpreted with caution because there was not a parallel item asking if science was more suitable for girls.

DISCUSSION

The results of this study show significant gender differences in science experiences for sixth grade students. The middle school years are a time when gender differences in achievement and attitudes typically widen. When young girls and boys entering puberty lack the same science experiences and begin to encounter their peer's stereotypic beliefs about areas of study, the potential for the gender gap to widen is enormous.

The data from the subtest "*Things to Learn About*" showed that males reported having

TABLE 3
Students' Reported Important Characteristics for Future Jobs

Characteristic	Mean (SD)			
	Males	Females	*t*	*p*<
Control other people	0.68 (0.76)	0.44 (0.65)	3.38	0.001[b]
Make my own decisions	1.72 (0.49)	1.80 (0.41)	−1.65	0.100
Developing new knowledge and skills	1.62 (0.58)	1.60 (0.57)	0.40	0.691
Have an easy job	0.80 (0.80)	0.58 (0.70)	2.98	0.003[b]
Have an exciting job	1.85 (0.39)	1.86 (0.37)	−0.25	0.805
Become famous	1.02 (0.85)	0.79 (0.83)	2.74	0.006[b]
Help other people	1.55 (0.57)	1.74 (0.47)	−3.57	0.000[c]
Time for my own interest and hobbies	1.47 (0.60)	1.45 (0.58)	0.26	0.791
Make and invent new things	1.37 (0.70)	1.09 (0.74)	3.96	0.000[c]
Earn lots of money	1.54 (0.63)	1.41 (0.57)	2.25	0.025[a]
Have more time for my own friends	1.44 (0.61)	1.38 (0.65)	0.90	0.062
Get a secure job	1.78 (0.52)	1.84 (0.42)	−1.20	0.230
Use my talents or abilities	1.85 (0.43)	1.83 (0.43)	0.45	0.654
Have more time for my family	1.72 (0.51)	1.66 (0.51)	1.27	0.203
Work with people instead of things	1.31 (0.71)	1.34 (0.62)	−0.05	0.643

[a]*; [b]**; [c]***.

more interests in the physical sciences than their female peers. Males indicated they are interested in atomic bombs, atoms, cars, computers, x-rays, and technology. These areas include many of the fundamental areas of applied physics and engineering. Females, on the other hand, continue as in the past, to report more interest than males in science

TABLE 4
Student Perceptions of Science in Action by Gender (N = 437)

	Male (%)	Female (%)	*p*<
Perception by more males			
Power	0.58	0.44	0.003
Easy to understand	0.53	0.41	0.015
Helping the poor	0.30	0.14	0.000
Destructive and dangerous	0.28	0.16	0.003
Creates problems for society	0.26	0.15	0.006
Most suitable for boys	0.14	0.06	0.006
Perception by more females			
Difficult to understand	0.41	0.51	0.047
Doing experiments	0.75	0.84	0.025
No significant differences			
Useful for everyday life	0.74	0.76	NS
Important for society	0.61	0.60	NS
Interesting, exciting	0.61	0.59	NS
Creates pollution	0.23	0.15	NS
Boring	0.19	0.25	NS

NS, not significant.

aesthetics and biology, including animal communication, rainbows, healthy eating, and AIDS. It is important to note that members of both genders reported being interested in all the topics, but that the percent of students of each gender differed in their reports of interests in topics.

For students in this sample of the class of 2001, there continue to be significant gender differences in science attitudes and perceptions of science courses and careers. The characteristics of these gender differences are highly similar to those identified in students of the 1980s (Sjoberg & Imsen, 1988). In the sections that follow we explore multiple interpretations of the impact and implications of these gender differences on students' interests, achievement, and careers.

The "Out-of-School Experiences" subtest revealed that boys continue to have more extracurricular experiences that are related to the physical sciences such as prior use of rifles, batteries, electric toys, fuses, and pulleys, whereas girls have more experiences in biology such as watching birds or planting seeds. It is not clear how differences in experiences impacts females and males as they attempt to learn more formal school-based science.

One interpretation of these findings could be that females' lack of physical science experiences puts them at a deficit for learning physics concepts. The inference for this deficit interpretation (Hyde & Jafee, 1998) is that, if females had more frequent and early experiences, then their achievement and interest in the physical sciences would be greater as they continue in their education. Constructivist-based research suggests that informal science experiences lay the critical foundations for deep conceptual understandings (Strike & Posner, 1992). There is additional research that suggests that not only will early use of science-related tools and toys affect students' development of science concepts but that early use of these items influences girls' development of attitudes toward science (Kelly 1978; Tracy, 1987; Kroeger, 1990). So, are girls at a deficit for learning physical science as a result of a lack of early experiences? The answer is not clear. The instrument was limited in the types and numbers of items that students had available for selection. One could argue that different items could lead to different conclusions about the depth and quality of prior science experiences. Another view of these differences is that girls are not deficit but instead boys are deficit in biological experiences that may lead them to careers such as medicine or biology.

As science educators, the authors believe that all students should have a wealth of interesting experiences from a variety of science areas as they grow up. Our beliefs are likely filtered through our more narrow view of science as relevant, interesting, and exciting. Some feminists have suggested that it may be wrong to encourage (or demand) equality of experiences for males and females because educators should honor and value the differences that exist rather than expecting all students to fit the same mold with regard to their interests (Noddings, 1998). This raises the critical question of "so what" that emerges as we look at gender differences and ponder the significance.

From the perspective of power, equity, and financial resources, encouraging girls in the physical sciences can open doors that lead away from traditional lower paying jobs held by women. Balancing the numbers of males and females in engineering and physical science careers can transform the environments and cultures of these fields, thus changing the field for future generations. But, as Noddings (1998) noted, "the classical pragmatic way of problem posing in our society is to cast problems against the current social structure. In working this way we fail to criticize the structures themselves" (pp. 17–18). Noddings suggested that the "mad idealist" (p. 18) perspective is to turn our societal perspectives upside down so that valuing mathematics (or science) competence is no greater or less than that of child care. In other words, instead of trying to figure out how to change girls so that they can become scientists in our current society, we would change society to value

girls' perspectives and interests (even if they are not related to science). However, Noddings noted that, until we can transform our society's values, we must work within them to help students understand how to make well-informed decisions and choices about future occupations (Noddings, 1998).

IMPLICATIONS

For more than two decades we have been aware of the gender differences with regard to interest in science careers, perceptions of scientists, and science-related experiences. In spite of broad-based intervention programs such as EQUALS, Family Science, and others that have worked to alter the gender differences in science career selection and course enrollments (Kreinberg, 1989), the present study suggests that the future pipeline of scientists and engineers is likely to remain unchanged. Girls in this study report fewer experiences as well as interests in the physical sciences. Boys reported they had fewer experiences and interests in the biological sciences. These gender differences in sixth grade adolescent girls are likely to continue to exist for these individuals into young adulthood. If this sample is representative of the larger population of adolescents, then the profile of prospective scientists and engineers for the class of 2001 looks very similar to the stereotypic profile of the last 20–30 years.

One of the unexpected results that appeared in this study was the emergence of relational or connected knowing that was reported by both males and females. Males perceived science as "destructive and dangerous," "creates problems for society," and as "helping the poor." Males reported characteristics for future jobs included "help other people." For learning interests, males also reported being interested in "how radioactivity affects life and my own body," "how scientists think and work," and "how science and technology may help disabled persons." None of these characteristics fit the traditional stereotype of prospective scientists as isolated loners more interested in machines and technology than in helping people. In many ways, these characteristics seem much more like the types of "connected knowers" described by Belenky, Clinchy, Goldberger, and Tarule (1986).

According to Belenky et al. (1986), connected knowing is oriented toward establishing relationships that help us understand others' perspectives. The males in our study appeared to have science interests within social contexts. However, the finding that males also reported that science is "most suitable for boys" suggests that they may be separate knowers who are characterized as "doormen at exclusive clubs" (Belenky et al., 1986, p. 104).

The boys and girls in our sample, like boys and girls everywhere, are embedded in their culture and are shaped by it. The out-of-school experiences available to them, and chosen by them, are expressions of the values and attitudes of the larger culture. As long as the culture maintains the traditional views of what is appropriate for girls (bread-making, knitting, or sewing) and for boys (mending bicycle tires, changing a fuse, or playing with motors) and conveys the ideas that science is more appropriate for boys than for girls, it is likely that adolescents will bring these values and attitudes to school. The school may be the only place in their environment where students can encounter different values and attitudes about science, yet the research reviewed earlier indicates that schools themselves are not yet free of gender bias.

Our findings, as well as data from many other sources, are clear in their implication. Teachers cannot escape the responsibility to present science as equally appropriate for girls and boys, to expect girls to use the tools of science with facility, and to expect both boys and girls to engage thoughtfully in science activities. The evidence from this and other studies shows that we cannot continue to avoid the issue. To continue the status quo without transforming the culture is to condemn girls to remaining on the sidelines of science.

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