JOURNAL OF RESEARCH IN SCIENCE TEACHING VOL. 32, NO. 1, PP. 3–27 (1995)

Letting Girls Speak Out about Science

Dale Baker and Rosemary Leary

Division of Curriculum and Instruction, College of Education, Arizona State University, Tempe, Arizona 85287-1911

Abstract

The purpose of this study was to try to determine what influences girls to choose science. Forty girls were interviewed in Grades 2, 5, 8, 11 using a semistructured protocol. The interview focused on feelings about science, science careers, peer and parental support, and how science is taught. To determine whether their responses were based on gender, each girl was asked to respond to questions as if she were a boy. The girls were highly self-confident and positive about science. All of the girls took a strong equity position and asserted that women can and should do science. The girls liked learning science in an interactive social context rather than participating in activities that isolated them such as independent reading, writing, or note taking. Those who chose science careers were drawn to them because of strong affective experiences with a loved one and a desire to help. The interviews were analyzed through the framework of women's affective and psychological needs.

Over the years many factors have been investigated to understand why so few women choose science careers. These factors are located primarily within the realm of school and society. However, despite the large number of studies conducted, this research tells us very little about which factors influence girls to choose or reject a scientific career.

Another relatively recent line of research addressing the women in science question has focused on women themselves. In particular, it focuses on women's decision-making processes in the context of the psychology of women. This research, embedded in feminist paradigms, employs a different set of assumptions, research designs, and psychological models from those normally found in the science education literature. Ground-breaking studies within this framework suggest that feminist perspectives hold greater promise for understanding the relationship of girls and women to science than those frameworks employed in the past.

Because we have chosen to investigate this promise rather than place our research in the more familiar context, we will first provide an overview of the methodologic issues involved in the feminist scholarship that influenced this study. Then we will present a brief review of the feminist literature used to interpret our data and contrast it with the lack of explanatory power of the literature within the traditional research paradigm.

Methodological Issues

Feminist researchers interested in the question of women and science have moved away from paper and pencil assessments and quantitative analysis toward a more qualitative and

Published by John Wiley & Sons, Inc. CCC 0022-4308/95/010003-25

contextualized understanding. Consequently, we chose to use in-depth interviews for this study. A shift in methods appear to be justified when data collected using the two approaches are compared. For example, gender differences in knowledge of science and technology issues were found using a Likert-scale questionnaire, but were not found in the transcripts of conversations with the same girls and boys (Solomon & Harrison, 1991). The conversations, unlike the questionnaire, revealed that the girls were confident about their technical competence. Furthermore, extensive interviews by Baker (1990) and Baker, Leary, and Trammell (1992) indicated that attitudinal differences toward science between school-age girls and boys are small, and that they are more alike in what they would like to learn about in science than they are different.

Holden and Edwards's study (1987), in which women wanted more situational details than were offered with a forced choice format, and Grant and Harding's (1987) study, in which women chose "not sure" because they said that the answer depends on the situation or on what you mean by *science* and *technology,* also emphasized the importance of context for women.

Interviews provide context for researchers, too. It is the vehicle through which they hear and understand girls' voices. Good interviews tell us not only what girls think, but why. The spoken and written word, the life stories they tell, are imbued with powerful emotions that are as important to understanding girls' lives as less value-laden but thinner data sources (Brown & Gilligan, 1992).

We have also chosen to use a sample of only girls. Feminist scholars have long advocated the abandonment of male–female comparisons in favor of looking at girls alone for two reasons. First, the approach avoids using a deficit model, or the assumption that male behavior is the norm, and allows the data to be understood in light of women's sociopsychological reality as expressed in educational preferences, needs, and goals (Campbell, 1988). Second, attempts to compare and contrast males and females lead to noncomparable, simplistic either/or categories that do not capture the sense of the data (Brown & Gilligan, 1992).

Our approach to analysis has been to place what girls are saying within the framework of women's decision-making processes and a female identity "defined in a context of relationship . . ." (Gilligan, 1982, p. 163) to better understand who chooses science and why. The next section provides the rationale for choosing this framework.

Women's Decision Making

There is a growing body of evidence that women make decisions about their lives differently from men (Almquist, Angrist, & Mickelsen, 1980; Angrist & Almquist, 1975; Arnold, 1992). These decisions arise from their expectations of multiple life roles, self-identity, and ways of interacting with people, objects, and experiences in the world. Nardi (1983) found that women make career plans in terms of personal life scripts that consist of a number of anticipated personal and professional roles. Gilligan (1982) found that highly achieving and successful women described themselves in terms of relationships. Their identity resided in their roles as mothers, wives, lovers, and children, and not in their academic or professional success. Similarly, Arnold (1992) found that academically outstanding women tended to judge success in terms of relationships, and made decisions that stressed a balance between work and family life. Younger girls and adolescents also describe their world in terms of relationships (Brown & Gilligan, 1992).

Eccles (1986) concluded that women may choose less technical occupations because they are more attractive and are therefore proactive choices. She concludes that these choices are based on both short- and long-term goals, self-identity, and basic psychological needs that are, because of socialization, different from but equal to those of men. One of these needs is the

inner sense of connection with others that Brown and Gilligan (1992) saw as the central organizing feature of girls' and women's development. Markus and Oyserman (1989) argued that women define themselves in relation to others and that their very self-concept is embedded in and arises from interactions and interpersonal experiences.

Belenky, Clinchy, Goldberger, and Tarule (1986) also spoke of the importance of connections and relationships for women's ways of knowing. In their framework, a woman who takes the epistomologic position of constructed knowledge is the woman who can construct her own knowledge from both objective and subjective experiences. Knowing is based on connections with people, ideas, objects, and the written word. Connections and relationships give rise to a moral component in attitudes, judgments, and behaviors. Thus, decisions take place in context and are evaluated in terms of their effects on others.

Further evidence of the importance of relationships is found in Brown and Gilligan's (1992) sample of school girls. Those girls with strong voices (a strong sense of self- and inner knowledge) who could deal with the need to stand up for who they were and what they believed, in the face of culturally constructed ideals of the feminine, had close confiding relationships with their mothers, who served as alternative role models.

Within science, despite strong socialization to the contrary, we find that women practice their craft in a way that emphasizes relationships and connectedness to the objects of study and the members of their research teams (Sheperd, 1993). This feeling of connectedness to nature has led to breakthroughs in fields such as primatology and genetics, but as many of the women scientists interviewed by Sheperd (1993) reported that it also leads to conflict with male mentors and colleagues, isolation, and slower rates of promotion. In extreme cases, the conflict between doing science in a related and connected way and the norms of science that emphasize hierarchy, distance, and objectivity, lead to dropping out of science.

We will now briefly examine the school and social factors that comprised the body of literature within the traditional research paradigm to support our claim that this research lacks explanatory power.

School Influences

Many studies indicate that schools fail to provide environments conducive to girls' learning. Textbooks lack positive female role models and often include sex-role stereotypes (Sadker, Sadker, & Klein, 1991). Teacher–student interactions are biased in favor of boys as early as elementary school. In the face of failure, boys are encouraged to try again and girls are allowed to give up (Oakes, 1990; Wilder & Powell, 1989). Pedagogy is often based on male learning styles, especially when competition is emphasized. Under all forms of instruction, girls have less access to science equipment, hands-on activities, and computers than boys (Kahle & Lakes, 1983; Sutton, 1991). Cumulatively, these experiences would logically seem to lead to lowered educational and career aspirations, including science, for girls. However, other nontraditional careers such as law (National Science Foundation, 1990) are attracting a large number of women, indicating that learning environments alone do not explain career choice.

Mathematics ability and the number of math and science courses taken in high school are related to choosing a scientific or quantitative college major (Ethington & Wolfe, 1989; Ware, Steckler, & Lesserman, 1985). However, achievement and course-taking behavior do not explain career differences because the gender gap in these areas is not large enough to be practically significant (Oakes, 1990; Wilder & Powell, 1989).

An outstanding academic record does not necessarily translate into choosing science. Female Westinghouse Award winners avoid technical careers when they go to college (Camp-

bell, 1991), and studies of college women (Arnold, 1992; Oakes, 1990) indicated that those who are talented and academically successful drop out of science majors and change careers at a much greater rate than men, even when they are equally or better prepared.

Social Influences

Social influences are even more difficult to link directly to career choice, in that factors such as attitude or self-concept are constructed from multiple experiences. In the case of attitudes some studies conclude that more girls than boys dislike science and lack interest in science careers (Hueftle, Rakow, & Welch, 1983; Maple & Stage, 1991; Mullis & Jenkins, 1988; Ward, 1979). Other studies, especially of biology and chemistry, have found that girls have better attitudes than boys (Baker, et al., 1992; Steinkamp & Maehr, 1983). When attitude differences do exist, they are, like cognitive differences, too small to account for the differences we see in the number of males and females involved in science careers. In addition, the link between attitude toward science and doing well in science is weak for both girls and boys (Steinkamp & Maehr, 1983). However, even when girls do well and like science they do not necessarily choose science careers (Baker et al., 1992).

The American Association of University Women (AAUW, 1991) concluded that as girls grow up they lose confidence in their academic abilities, expect less from life, and lower their career aspirations. Girls expect to fail at tasks that are unfamiliar, difficult, or perceived to require high ability (Oakes, 1990). When they fail, girls internalize their failure, attributing it to themselves. This poor self-concept leads to taking fewer math and science courses (AAUW, 1991; DeBoer, 1984a, 1984b), but as noted earlier, taking math and science courses does not in and of itself lead to science career choices.

Parents may be the single strongest negative social influence on girls' science career choices when they hold different expectations for daughters than for sons and treat their children in ways that reinforce gender stereotypes (Campbell & Connolly, 1987). Negative influences include expecting math to be difficult, discounting the importance of higher-level math courses and home computers, and providing fewer opportunities for out-of-school science experiences for daughters (Kahle & Lakes, 1983; Oakes, 1990; Sutton, 1991).

Socioeconomic status (family income, parental education, father's occupation, and household possessions) is also an influence on girls. It is related to mathematics achievement, high school grades, SAT scores, and post-secondary plans, especially the choice of a scientific college major (Oakes, 1990). The advantage goes to the affluent, but that advantage is again very small.

To illustrate the relative lack of power of these variables, we next examine the results of two causal models developed by Ethington and Wolf (1989) and Peng and Jaffe (1979). These models were attempts to determine the cluster of factors that would predict a quantitative undergraduate major for girls using longitudinal data from the High School and Beyond Study and the National Longitudinal Study. Both models included variables that we have reviewed (e.g., achievement, attitudes, SES, course-taking behavior, self-concept, and family influences). Ethington and Wolf's model explained 8.9% of the variance in choice of a quantitative undergraduate major, and Peng and Jaffe's model explained 6%. Neither of these models, despite the number of variables involved, provide us with good explanations as to why women are not entering the sciences.

A further refutation of traditional variables comes from studies in the Scandinavian countries, especially Norway, where there is legislation against sex discrimination and for textbooks

that must pass inspection for gender inclusiveness, a well-off homogeneous population, the same curriculum for all students, and role models in the form of a female prime minister and cabinet members. Yet, the number of women who choose science and engineering is extremely low and declining (Sjoberg & Imsen, 1983).

Method

To determine what influences girls to choose science we used a volunteer sample of 40 girls in grades 2, 5, 8, and 11, who were interviewed using a semistructured protocol. They were asked to share their feelings about science, science careers, peer and parental support, how science is taught, and how they would teach science to girls or boys. To gain further insight, the girls were also asked to respond to the questions pretending to be a boy. The interviews were tape recorded and then transcribed. The transcribed texts of all the interviews were then read for emerging themes by a team of graduate students and the authors. Discussions concerning evidence for the existence of a theme and the type of evidence needed to categorize portions of the interviews within that theme took place over a summer. These discussions led to the identification of 7 themes (likes, dislikes, equity, career preparation, career choices, role models, and peers) that could account for almost all of the students' remarks. The interview transcripts were then reread by the authors, and the 7 categories were used to code the text of each girl's transcript using the Textbase Alpha program (Tesch, Sommerlund, & Kristensen, 1989). Textbase Alpha is a program for the management and coding of qualitative data, especially interviews. Interrater reliability for coding the students' statements into the theme categories was high (likes, 93%; dislikes, 97%; equity, 83%; career preparation, 96%; career choices, 93%; role models, 99%; and peers, 91%).

This 7-theme system proved cumbersome and overly detailed and resulted in a Tower of Babel rather than a way to facilitate young women's voices. Consequently, we looked for threads that were present within themes and provided links across the 7 themes that could provide insights into the relationship of girls to science. The authors again read the students' statements theme by theme and engaged in discussions. Equity, school, and social threads were identified as the central conceptual components that were present to varying degrees within each of the original 7 themes.

Results

As indicated in the Method section, the categories that developed from the data revealed that girls' relationships toward science are associated with what happens in school, the influence of society in general, and the girls' strong feelings of equity that persisted throughout the interviews. The results are therefore presented in terms of school science, societal factors, and equity. At first, these categories sound very much like those used in more traditional research. However, the critical differences lies in examining what the girls say through the lens of relationships and connections.

Although there were some grade-level differences, most views emerging at second grade remained constant across grade levels. Consequently, instead of providing quotations from students at each grade level to support the results, only those quotes that best represent the girls' overall position will be presented. When grade-level differences tell a different story, as well as in the equity section, where the girls' position becomes stronger with age, quotes from the different grades will be presented.

School Science

Girls in all four grades (2, 5, 8, and 11) were strongly positive about their school science experiences. When asked about school science they consistently responded with adjectives such as "fun," "interesting," "important," and "like." A positive reaction to science was sometimes tempered by the teacher, the instructional formats used in the classroom, the learning styles of the girls themselves, or the topic being studied. Much to our surprise, the students also enjoyed the cognitive demands of learning science.

The second graders primarily identified biologic topics—for example, plants, animals, and themselves—as their favorite subject matter.

> Student 1 (S1): We have this science book and it's real fun because you can learn about animals.
> Interviewer (I): Do you like animals?
> S1: Umm-hmm.
> I: What do you think would be your favorite thing to learn about?
> S2: Animals and trees.

However, the 5th through 11th-grade girls mentioned both physical and biologic topics as being among their favorites.

> S1: . . . We learned about stuff like Newton's Law of Motion and stuff like that . . . Usually it's pretty fun.
> S2: I like the pH and the pOH and all that stuff, and the bonding and stuff, and how chemicals really fit together, and materials.
> S3: I'd like to see zoology classes, which is invertebrates, vertebrae, um. We have an anatomy class but like, maybe a close look on health or something like that. Like the nutrition class. Basically, I like all the science classes here.

These girls would like to have a voice in the topics that they study instead of a curriculum generated and driven by some outside force.

> S: I'd, I, maybe when I came home I'd go write some stuff down that would be like good information from the kids and see what they would like to do and then out of that I'd pick different days to do what they wanted to do.

Once the students got beyond the second grade, relevance became an important issue. The girls recognized that science is a part of their everyday lives, and they wanted to see that connection made in school rather than learn science out of context.

> S1: Umm, probably talk about more up-to-date things and things that are in most of our lives. Maybe something about the environment or something that's a hot topic and yeah, something that matters more. That, that'll, that'll help us more. 'Cause, some people think that science isn't used very much in everyday life unless you're a scientist. But that's not true. Science is used in, like, all different fields.

The girls also had strong feelings about how science should be taught. They showed a preference for problem solving and for hands-on activities. There were some differences by grade level, with the second graders being the only group that expressed a liking for the reading

and writing aspects of school science. This may be because reading was still a new skill for them and they were anxious to use it and demonstrate their new abilities.

I: How do you feel about science in school?
S1: Feel that it's fun.
I: It's fun? What makes it fun?
S1: Get to read and write.

By fifth grade, the girls began to express a strong preference for experiments and projects in place of the reading and writing activities. They wanted to do more experiments so that they could learn for themselves and "figure things out."

I: What are the things you like?
S1: When we get to actually do the experiment instead of drawing it and writing about it.
I: What do you do during the labs that you think is fun?
S2: How you, how the experiment is. You know, you get to see different things and how things work.

The older girls—that is, the 8th and 11th-grade students, also liked science in school, especially labs. They expressed strong feelings for more interaction with their peers in their repeated requests for group work, partners, and more discussion.

I: Why more activities?
S1: Because lecture, you just, I mean when she lectures you, she just goes on and on and on, and I can't stand sitting for that long and, and if I was a teacher I would understand how my students felt, that they couldn't sit for that long.
I: What kind of group, why did you say group activities?
S2: 'Cause it's fun working with different people and seeing what they do and what they like.
I: What do you think kids would like to do?
S3: Well, not as much like assignments and more like class work altogether or partners. Not just individuals . . .

These girls didn't want to passive learners and they acknowledged good student–teacher interactions when they experienced them.

S: . . . It's like communication back and forth instead of just sitting there. You know, her lecturing us and us just sitting here hearing it, and you know, trying to absorb it. We talk back to her so it's more like communication and it makes it more interesting to do that so we can, you know, we don't raise our hand. We just all, you know, answer her. It's easier to learn that way and she's, I think she's the best, you know, chemistry teacher that I could have.

By eighth grade the teacher had assumed an important role in the science classroom. Attitudes toward science were often dependent on whether the teacher made the subject fun or boring.

I: What makes science fun?
S1: Probably Mr. X. He's like, he's really funny and he's smart. He's really funny and he teaches science really good.

When science was perceived as boring or irrelevant the blame was often placed on the teacher.

I: What happened in sixth grade that made you decide you didn't like science?
S: Umm, my teacher was boring. She was a boring teacher and she didn't know how to teach, so ever since that I hated it. And my seventh-grade teacher used to always yell at us and he used to give us a ton of work, so I hate it.
S2: Well, it's very structured and everything because, like, we get points taken off if we're late or we don't participate. We have to answer all her questions and everything, so, I kind of like that part of it but sometimes she's a little harsh, like, if you have, like, a wrong answer, she'll be, like, "Well, I taught that to you. I expect you to know it."

The cognitive demands of science did not result in disliking science or in negative attitudes. This was especially evident in the responses of the 8th and the 11th-grade girls.

S: Well, because I pay attention, and you know, I do what I'm supposed to do. You know, the work I'm supposed to do, and I get good grades in there and the grades, you know, when you get good grades that tells part of how you, how good you're doing.

The girls expressed confidence in their ability to do science and were not afraid of the challenge of the work or of making mistakes.

I: What happens to you when you make mistakes in science class?
S: I make mistakes.
I: What do you do?
S: I correct them. I mean I don't think anything of that. I just think, "Oohs." Either I knew it or I didn't and if I knew it and I got it wrong, I just thought, "God, why didn't I think of that?" But, if I got it wrong and I did know it, I'm just like, "Well, I'll remember that."

Although the girls were positive overall about science, they did express some dislikes. For the second and fifth graders, many of these dislikes centered on topics. These younger girls didn't like working with reptiles, amphibians, insects, or dangerous things.

S1: Well, I don't like it when they, in our science book they showed us how, umm, eels and water snakes, umm, eat the water plants and stuff? And it's sort of sad and sort of disgusting also. Also, look at the maggots. Oooh.
S2: Well because there's a lot of explosives and things and there might be some that really are gross.

Tests bothered some of the girls, and pedagogy that isolated the girls and forced them to work separately were not favored. Upper elementary school is the point at which tests become important in school. Not surprisingly, dissatisfaction with tests and activities that were evaluated emerged at this time.

I: What kind of things happen in science that make you feel like you're not good at science?
S: Sometimes tests or when we're like doing a paper and it's, umm, umm, blank, weird, I don't know.

I: Do you do well on tests?
S: Yeah. Pretty good.
I: So why would the tests make you feel like you're not good?
S: 'Cause I'm scared that I'm not gonna pass.

By eighth grade, lectures, note taking, and reliance on the textbook increase, which results in being seat-bound and socially isolated.

I: What does he do that you really don't like in science?
S: I hate his lectures. Ohhh, I hate his note lectures. It's just a pain. He always goes like, eight pages of notes, notes for every chapter, and I just hate it. It's a pain to do all that.

Several of the students expressed dislike for and confusion with topics as presented in science textbooks.

I: What's wrong with the books?
S: Books. Oh. Well see, they always say, they say, Oh, well, see this guy created this thing, all right, and he says all this stuff, but then go two chapters, three chapters down and he says, well this guy created this thing and then like, you like, and then he says, so the other guy's wrong, but back two, three chapters it says this guy's right, you know? Says back and forth it's just like a little juggle back and forth, you know, this guy's right, this guy's wrong, this is a certain species but this can't be in the species although it lives in this, lives with them, can't be that species because that species is different bone structure and all this stuff.

Dissection was a controversial topic for many of these girls across all grade levels. In the earlier grades, where dissection had not yet been a part of the curriculum, societal myths dominated the girls' perceptions. They saw dissection as cruel and gross. From second graders:

I: Do you think it's gross when you have to dissect animals and a spider?
S1: Yes.
I: Do you? You don't like that part?
S1: I haven't done that part yet.
I: If you had to dissect an animal, like maybe a frog? What, what part would you want to do? Would you want to do the cutting up or the writing about it?
S1: The writing about it.
I: How come?
S1: Umm, 'cause I don't think I would want to do the cutting up.

This trend continued in varying degrees through the fifth and the eighth grades. From a fifth grader:

S: I don't think I'll take biology.
I: No? Why not?
S: I, well, I mean zoology 'cause I mean, you have to dissect animals and I could throw up.

And an eighth grader:

I: How about doing dissections? Have you ever dissected anything?
S1: No, it's not in our curriculum.

I: What do you think about that?
S1: I don't. Because I think it's cruel to kill a frog just so we can see the organs.
I: Okay.
S1: On a computer you can just do, umm, there's this new thing that's called "Dissecting Frog" on the computer and it shows you all the organs and where it goes and stuff like that.
I: Is that a big issue? Dissection? I mean do the people feel strongly about that?
S1: There's a lot of people who feel very strongly against it. It's gross.

The girls, especially the youngest, who were anticipating dissection, expressed many negative feelings about this activity. However, these negative perceptions became positive by the 11th grade, by which time the girls had participated in dissection activities. Many of these older girls responded that dissections were interesting and informative.

I: Did you do dissections?
S: Umm-hmm.
I: Did you like that?
S: Umm, I feel sorry for the animals, I really do, but I guess it's, it was REALLY interesting to find out what was inside 'em, how they were.
I: What did you dissect?
S: I dissected a frog and a spider and a, a little, not a scorpion, but one of those little shelled animals, I don't know. I don't remember what it was.
I: A little shelled animal?
S: Oh, I think it was a crawfish and, umm, we also dissected a peanut and stuff. That was weird.
I: Umm-hmm. Okay. But you like that kind of thing.
S: Yeah

Overall, the number of negative statements were few in comparison with the number of positive ones, and the 2nd and 11th graders had fewer negative things to say than did the fifth and eighth-grade girls.

The girls in this study were positive about science in school, as well as confident in their ability to do science despite the absence of role models. Statements by the girls suggested that schools provided few role models or activities that highlighted women's contributions to science.

I: Do kids ever do reports on women scientists?
S1: Some.
I: Do they do them on men scientists?
S1: Yeah. Uhh, lots of times we're doing them on, like, the Indians or the animals, the nervous system, camouflage for animals.
S2: Oh there have been women scientists. I don't know any, you know, off the top of my head.

And career day in high school came too late to influence the few students who mentioned it.

I: Have you been exposed to a lot of, like, career days where you've seen women in science and math jobs?
S: Umm, we had a career day last year in science and you got to choose which areas you wanted to go visit, and I took ones like nurse, vet, and seemed like most of the girls took that more than, like, chemists and stuff.

I: Do you think it would have made a difference if you had gone and seen a woman scientist that explained her job like a chemist?
S: Well, no, I don't think it would make too much difference because I don't have a strong enough interest anyway to really want to pursue a career in science.

Despite this absence of school role models, many of the girls aspired to science or science-related professions. These goals were often based on a desire to help people, animals, plants, or the earth.

S1: Be a nurse and help, like, I want to be a nurse that helps, umm, animals and stuff.
S2: I'd probably be a veterinarian 'cause I really like animals.
S3: Well I'll probably want to come and work with the earth, like, help the people to, like, go in a party to work and everything where, where it can save our earth and not die.

Many of the girls, including many of the older ones, had narrow and unclear ideas of which careers are science related and of exactly what scientists do. An eleventh grade student:

S: Well, I don't know if what I plan to do is called a scientist. I plan to study zoology, animal behavior? I want to work with animals. I want to save animals. I want to protect animals. See, what I want to do is, I want to, I'm very against animal cruelty, stuff like that, and I want to, like, help the extinct animals. I want to work them, I want to help. I want to work with the people explaining, you know, why not to kill the elephants for their tusks and all that.

Few girls at any grade level could relate the study of science in school to their personal career goals even when those goals encompassed science-related fields. The relationship between careers and science in general, and school science in particular, was unclear to most of these girls.

I: Do you think science is important?
S: Well if you're going to be a scientist, yeah, you need to learn a lot about it, but if you're not gonna be a scientist or have anything to do with science I don't really know.

Biologically based careers were seldom seen as science because of the absence of chemicals and electricity.

S1: Well, I don't know if what I plan to do is called a scientist. I plan to study zoology, animal behavior. I want to work with animals.
I: Would you like to be a scientist when you're an adult?
S2: Umm, close to a scientist, but . . .
I: Okay, what's the difference?
S2: I would say, like a professional scientist? Well, I mean, it's in the area of science but maybe a scientist does more with chemicals and chemicals and stuff like that than a vet would do. He does with it, you know, animals, bodies, and stuff like that.

Although these girls failed to make the connection between school science and their future careers, they planned to study more science based on interest, liking science in school, or because "it's fun" and interesting. This was particularly true for the second and fifth graders. A second grader:

I: Why would you pick science?
S1: 'Cause I think science is fun and I think I should learn about science more.

A fifth grader:

I: Do you think you'll pick science all 4 years [talking about high school]?
S1: Umm, well I'd try it the first year and if I really liked it then I would do it for the other years.

The eighth-grade girls were looking forward to high school and planned to take science because that's what you do in high school. Most were looking forward to studying biology.

S1: Mostly bio, I take advance biology my freshman year and, uhh, I will take mostly all sci, I have to take 4 years of science so it'll be biology and all the keep goin', I'll keep goin' for my 4 years and then hopefully I can get into CEU with my college courses.
S2: Probably science. I'm trying to, umm, go as far as I can through science, umm. I signed up for Biology 1-A next year and then I'm hoping to take science classes all through high school. I don't want to just drop out of it.
I: So in addition to the biology, what about chemistry and physics?
S2: Yeah. I suppose, umm, those go along with the biology. They're in high school and those will probably be courses I'm taking, too.

In 11th grade the focus shifted to college. The girls planned to study science to get into more selective colleges, not because of an intrinsic interest in science.

S1: Well, it will look good for college to have all this science background. It will probably help me in some college classes.
S2: Umm, so it looks good on college applications.

Only two students, an 8th and an 11th grader, expressed interest in the intellectual aspects of a science career.

In addition to having a poor sense of the relationship of school science to future careers, the girls often failed to see the relationship between science and math.

I: So do you think you're gonna need math if you're a scientist?
S1: Umm, I do okay in math and, umm, I think any math for certain parts but, umm, it's not as important to me as it is to my parents or the science part of it, is more important to me than the math.

Summary

Science in school was perceived positively by this group of girls across grade levels. They liked science, they planned to study more science, they were confident in their ability to do science, and many were planning to pursue science-related careers. They would, however, like to see science taught differently, and many would choose different topics for study.

When the girls expressed positive sentiments about school science it was because it met their needs for relationships and connection. Good teachers really communicate, and group work lets you work with your friends. Independent work separates and isolates, and decontextualized topics are uninteresting.

These girls were capable and willing. However, they did not see the link between school

science and the careers they were planning, and they did not see the link between science and math. The failure to see these links probably has more do with a deficiency in the curriculum than factors within the girls themselves. For example, they were provided with few role models of women scientists in the school setting, and what they learned in school was not linked to their lives.

However, these girls did not receive all of their information about science from school. Much of it came from contacts that these girls have outside of the classroom, both within their families and from the larger society in which they live. In the next section we examine some of these factors as expressed in the interviews.

Societal Factors

What girls like or dislike about school science is often affected by social factors. Girls who did science at home, who read about science, or who watched science-related television shows or movies mentioned these as experiences contributing to their attitudes toward science. However, not all of the messages received from these sources were positive.

Peers were not a major influence in determining whether the girls liked science or were choosing a scientific career. Most of the girls had high career aspirations. And overall, parents were supportive of, but did not have a negative or positive influence on, the girls' career choices unless the parents were involved in scientific careers themselves.

Many of the girls had developed science-related hobbies that in turn affected their perceptions of science.

> I: What do you like to study?
> S: Rocks. I, uhh, I, uhm, I collect them and I love to look at them and see what the sand and wind and water did to them and stuff, and I love, and I have a whole big collection. There's a, I have this big, huge case and it's from the ceiling to the wall or the ground.
> I: Where did you get them all?
> S: We have a cabin, and right across the street is a creek, and it has no water in it, and we collect rocks.

One girl's choice of literature, along with her other interests, directly influenced her understanding of science.

> I: Well, you said you like science, tell me more about that. What do you like?
> S2: You see, I read this book, *Michael Faraday*, and he was a scientist, and I read about all the things he discovered and, you know, when he, uhm, like, like, where he made this, I can't remember what, but he made this, well, someone that, he just kept going on, and it was element or electricity and, uhm, and I got interested in that and I'd always been interested in zoology and veterinarian 'cause I had my own ranch and a lot of animals and a colt and stuff.

However, although these societal influences created positive attitudes toward science, some societal influences can send mixed messages, as one young girl demonstrated in her discussion of *Mr. Wizard*. (*Mr. Wizard* is a television show on the Nickelodeon channel. Many of the children mentioned watching it on their own, and some teachers incorporated it into their science lessons.)

> I: You and your mother do a lot of science at home?

S: Yeah. Umm, not too much, we just watch *Mr. Wizard* together.
I: What, uhh, types of things does *Mr. Wizard* do?
S: He, he takes these people, umm, boy or a girl, and they do science.
I: Do you think that you could be Mr. Wizard some day?
S: No.
I: No? Why not?
S: Because I'm a girl.

The girls in this study had high career aspirations. Nine girls aspired to non-science professions (attorney, journalist), 20 to science-related professions (veterinarian, physician, environmentalist), 5 to nontraditional careers (police, pilot, comedian), and 4 to traditional female careers (teacher, secretary, nurse). When the career choices were science related they were frequently based on the biologic sciences.

I: Would you rather take chemistry or biology?
S1: Biology.
I: How come?
S1: It's, umm, let me try to explain this. Umm, you see, my mom? She died when I was seven and, umm, she loved animals just like I do and she always, uhh, she always said try to do the best you can and, you know, she says, once she said I majored, she majored in music, biology, and something else? She said that it's, biology is different from chemistry because, it's hard to explain.
I: Do you think your mom would have been happy to know that you want to be a scientist?
S1: She knew I did.
I: Oh did she? When you were seven she did?
S1: She was, she was, she was a zoologist.
I: Oh really? So you think she would like you to be?
S1: Yeah. She, she said you can be whatever you want. She said I'll support you in what ever you want to do.
I: What would your mother and your father say about being a vet? How do they feel about that?
S2: My mom thinks it's really, really great to be a vet. You know, she was gonna be a vet but she changed her major to manufacturing engineer, so, uhh, you know, umm, I think, so she would be, she really, she said, you know, she, when you, "If you become a vet I'll be proud of you." So she'll be more, she'll be more proud of me if I became a vet than a scientist.

As demonstrated in these comments, the girls often gave affective and altruistic reasons for their choices stating that they want to help people, animals, plants, or the earth. Many of the responses were emotionally charged. On the whole, laboratory-based sciences and the physical sciences in general were rejected because the girls could not make these affective links. The few instances in which the girls chose a physical science career were all based on having experienced that science with a loved one.

I: An astronomer?
S1: Yeah.
I: Why did you pick that?
S1: Oh, 'cause I like the stars, you know, it's just neat. My grandpa, you know, he used to take me, well he still does a little bit, but you know, he takes me out on his wooden deck, 'cause he lives on the beach, you know, on the cliffs, and, you know, takes me

out in the middle of the night, dresses me up in sweaters, and he'll go, "Oh look, there's Mars," and boy oh boy, you know, I really used to like that. So that's probably why I like it.

S2: I know a lot about chemistry now. My, my mom's like, she's smart, she's like, really smart and she like, has no trouble 'cause, like, I know I sometimes have problems in working, like, she just (snaps her fingers) does them like that. So hopefully I'll grow out to be her.

Few of the girls were aware of the conflicts that can occur when attempting to balance a science career and a family. Only one girl expressed doubts about having it all.

I: Does that ever cross your mind—about the hours you'll be working?
S: Not really 'cause I don't, I don't really plan to get married or I don't really think I'm gonna have kids or get married. I think it's just . . .
I: If you, if you weren't planning on getting married and having kids, do you think that would be a factor?
S: Yeah, I think so.

Peer support for a career in science varied by grade level. Second-grade girls believed that their peers would support them if they chose to become scientists. By the fifth grade, only half the students thought that their friends would support them. In the eighth grade most thought that their friends would not be supportive. However, by the 11th grade, the girls again believed that their friends would support their choice of a science career. Eight grade:

I: What would your friends say if you told them you were going to be a scientist?
S: They'd probably ask me to think twice. I think there's a stereotype scientist usually who's always mixing chemicals and things like that and they really get under my skin and that's . . . depends on which kind of scientist I would become.
I: Do you have any friends who want to become scientists?
S2: No.
I: What would you say if a friend of yours wanted to be a scientist?
S2: I'd say that's a dumb occupation.

Eleventh grade:

S: They would probably support me too. They'd probably want to know more, like, why and would it, what led you to this? I mean, not that it's bad, they would just . . .

These girls were well aware of the negative cultural stereotypes of science and of scientists. They readily cited examples from the media, the general culture, and their homes. Most negative stereotypes were associated by them with the physical sciences.

I: If you were to draw a picture of a scientist, what would you draw?
S1: I would probably draw, like, they have an insect shirt on and they have, like, a cloth over so they don't get stuff on theirself and they have glasses to help them see.
I: When you think about a scientist what types of things enter your mind? What's the picture in your head of a scientist?
S2: When, like, on cartoons they show scientists doing things. Like, like, taking animals and mixing something to change them into an elephant, chicken turning into an elephant.

I: Are scientists in cartoons men or women?
S2: Men.

However, despite their awareness of these stereotypes, or because of it, scientists were seen by these girls, especially the older ones, as normal people.

S1: A scientist can look anything, be any person. It's just someone who knows a lot about science and works on making new things.
I: Could it be a man or a woman?
S1: Doesn't matter.
S2: Yeah, because unlike other people they, it's like being a scientist, you don't, if you find something out it's not really to help yourself. It's to help everybody and you're not, like, working for yourself, you're working to, for, to, like, find out facts that would make, like, life easier for other people.

Overall, the eighth graders held the strongest stereotyped views. Meanwhile, the 11th graders verbally recognized that one of the stereotypes of science is that science is a male profession. These older girls also stated that scientists are smart and curious, and that scientists work to discover new things and to help people.

The girls at all grade levels frequently used the expression "scientist scientist" to distinguish between individuals working in the biologic sciences and the physical sciences.

I: What's a scientist scientist?
S1: Scientist scientist is, like, the scientists that work at NASA with chemicals and stuff so, so, you know, they work with the periodic table and stuff like that.
S2: I wouldn't want to be a scientist scientist. I mean, I don't like chemicals and if you work with chemicals you could create bombs. Bombs create wars, you know?

These girls had little or no association with women in science careers who could serve as role models. Only a few were able to cite examples, and these were immediate family members. One girl's parents are both math teachers, another has a mother who is a manufacturing engineer, and a third girl's deceased mother was a zoologist.

One student was fortunate to have had a teacher who left an impression on her life.

I: Do you think a teacher is sort of a scientist?
S: Well, I had, the reason I say that is cause, uhh, last year I had a teacher who was a scientist. He is a scientist but he stopped going out on all his, you know, what he was doing. He used to study, he went out, he used to go off to islands and study things to bring back information, so he really is a scientist, except he devoted his life to teaching instead of that. He's still on to science you know, writes books about things, but, so, I guess, I mean, you have, he is a scientist but he's just sharing his knowledge with the students now.

The media, while affecting the girls' attitudes toward science and scientists, provided few role models of women in science. The images of scientists presented by the media were both positive and negative. This mixture then required the girls to sort through the messages.

I: Do you think there are more boy scientists or girl scientists?
S1: More boy scientists because, you know, you always see, like, on TV or anything, TV movies it's always, like, boys are scientists.

I: Why do you think there are more boy scientists on TV?
S1: Well because, umm, like, on TV they always show, like, scientists as being an adventurous job and then they just always pick, like, boys that can, well, are more masculine or something so that they can, like, work better.

When positive female role models were provided they made a lasting impression.

S1: Well, I've, I was kinda, but what really made it was when I saw *Gorillas in the Mist.*
S1: When I saw *Gorillas in the Mist.* The movie? When I saw her working with the animals and saving them she just, like, became my hero. I really admired her for that and I want to do that too, so that clenched it. I, like, knew right then that I wanted to. But all my life I just, I loved animals, you know, but I didn't know I wanted to make a career out of it.

Most parents accepted their daughters' choices, but few of the girls had parents who could function as role models. Science careers were rarely discussed in the home except in the cases where one or both parents were themselves engaged in such a career path. Nevertheless, most students thought that their parents would be supportive of their choice to pursue a science-related career. Girls who had a family member in a science-related career were most likely to consider careers in science.

I: Do they [your parents] ever talk to you about what they'd like you to do?
S1: No. They just say, "What ever you want to do."
I: Do your parents ever talk to you at home about different occupations and scientists and jobs?
S2: Umm, no, they don't, they don't really talk about that. They, they're pretty boring on, they're pretty boring on science. My dad, he never talked about science. He never talks about it really 'cause when he was, when he was younger they didn't have the kind of science that we had, not that great.
I: What would your mother say if you told her you wanted to be a scientist?
S3: Uhh, my mother, she'd probably like that. Umm, she is really into math because my parents are both math teachers and, umm, they'd like me to be in the subject of math, but she also knows that's a big part of science too, and so that's, she'd probably like that.

Summary

In general, this group of girls is not getting a clear message from society at large as to who scientists are and what it is that scientists do. They received mixed messages from the media, where scientists were often portrayed as strange-looking males doing bizarre things in laboratories. However, when the girls did encounter positive messages these were very influential. The girls also lacked information on the variety of scientific careers available and on the relationship of science to many careers not perceived by them as "science." Stereotypes of science and scientists were prominent in their thinking. However, when asked to reflect, the older girls acknowledged that scientists are just ordinary people. It was clear that the mixed messages that the girls were receiving were in turn confusing their own thoughts. Only those girls who had a close friend or family member engaged in science refrained from stereotypes and presented positive images of both scientists and science-related careers.

The mixed thoughts of the majority become even more apparent when the girls spoke of equity issues.

Equity

Throughout the interviews the girls at all age levels expressed strong statements of equity. They repeatedly stated that liking science, achievement in science, and choosing a scientific career depended on the individual, not on one's gender. They adamantly disagreed with the statements that girls can't do science or that girls can't be scientists. They repeatedly stated that girls and boys are equal. When asked to respond as if they were a boy, the girls did not alter their positions.

However, despite their strong statements of equity, the girls also made stereotypical remarks about girls and boys. Some of these stereotypical beliefs extended to differences in how girls and boys should be taught. This was particularly true for the fifth and eighth-grade girls. The girls' statements give us some clues to how difficult it is to reconcile one's belief in oneself as a strong and capable person and notions of fairness with the cultural images of femininity and masculinity. Because the statements of equity became stronger with increasing grade, and because the patterns relating to stereotypes changed with grade, the equity statements are arranged by the girls' grade levels.

Overall, the girls did not see any differences between girls and boys vis a vis science. Second grader:

I: Okay. Pretend you're a boy. If you were a boy do you think you'd like science.
S1: Umm, yes.
I: Do you think you'd like it better than if you were a girl?
S2: No.

At this age they would not change the instructional format for boys if they were the teacher.

I: How would you teach so the boys would really like it?
S1: Probably the same way. If they can handle being in groups together.

These young girls were aware of cultural gender stereotypes and held many such negative stereotypes themselves.

S1: Girls are more quieter than the boys are. They're more embarrassed in our class.
I: To dissect frogs? Why do you think boys like to do that stuff?
S2: They're gross.

They also held negative, non-stereotyped images of boys.

I: Why are boys like that? Why don't boys try as much?
S: 'Cause they're lazy.

In fifth grade none of the girls agreed with the statement that girls cannot be scientists.

I: Some people say that girls don't make very good scientists. What do you think?
S1: I think that girls could if they really wanted to. They can do just as good as boys.
I: Okay. Umm, what makes you think that?
S1: Because they're people, too, and they're just equal.

These fifth-grade girls repeatedly said that girls are the equal of boys, that girls do science as well as or better than boys, and that doing well or liking science is dependent on the individual, not on one's gender.

I: You know, somebody told me once that girls can't be scientists. What do you think?
S1: I think that girls could be anything they really want to. Just anything, like boys.

Boys are still viewed negatively and stereotypically.

I: What about the boys? What do you think they want to be?
S1: Well, the boys were saying some of them wanted to be professional baseball players and that kind of thing.
S2: Well, 'cause they like to play, be basketball players and sports players and stuff.
S3: Boys sometimes aren't really interested and want to do sports instead of, umm, instead of science.

Although pretending to be a boy still did not alter the girls career plans, these fifth-grade girls perceived boys as different from themselves when it came to choosing pedagogy.

I: If you wanted to make the boys more interested, what do you think you would do?
S1: Maybe we could, uhh, discuss things that boys like, like, maybe have a, uhh, you know the computer thing that you can dissect frogs or something like that?
I: Umm hmm. Do boys like computers better than girls?
S1: Yeah. They like Nintendo a lot.

By eighth grade the equity statements became even stronger. Not only were the girls equal to the boys, but they were better. It was the girls who paid attention and who did the work while the boys goofed off.

I: If I said that to you, "Girls can't be scientists."
S1: I would say that's stupid. What gives you the right?
I: Convince me. Why? What would you say to me to convince me differently?
S1: Oh, there HAVE been women scientists. I don't know any, you know, off the top of my head, but I just think that's being unfair. That's like saying oh, "No men can be construction workers," you know, that's like sayin' that. That's really stupid to say that, 'cause I mean, umm, like girls are, like, supposed to be smarter than boys but, you know, then what they say is then the boys start getting smarter in high school, hopefully. Right, you know, that would, well, that's the old, yeah, how it's pictured to be and I think that would be, you know, stupid.

These eighth-grade girls were well aware of cultural gender stereotypes and still held many such views themselves.

I: Do you think girls like life science more than boys?
S1: No. 'Cause we had to just dissect stuff and, you know, guys were all showin' the eyeballs to everybody, so girls didn't like the dissecting part.
S1: 'Cause they, 'cause they think it's gross, you know, like, "Ohhhh, it's an eye!" you know.
I: And the boys don't?
S1: No, they're, like, "Oh let me rip into the worm," you know.

I: Do most of the girls like electricity?
S2: No. It's hard, they go, "I don't know how to do this."
I: Do guys like it?
S2: Yeah.
I: Why do you think that is?
S2: Oh maybe they want to be electricians and know all they're, I don't know.
I: What about boys? Do you think they would tend to rate science about the same?
S2: Well, no, higher actually.
I: You think they'd rate it higher?
S2: Yeah, 'cause, I mean, I guess it's, like, they're, umm, like, stereotyped or whatever to be a scientist, you know, like you, you're a boy, you know, you're meant to be a scientist and girls are meant to be housewives? You know I don't believe in that, but, you know.
I: Do you think most kids do?
S2: Yeah, 'cause they're, like, always going, "Aww, you're supposed to be a housewife and I'm supposed to be this big macho construction worker," you know, that, but, you know, I don't want to be like that. Sit around the house, clean house, I do enough of that already.

These eighth-grade girls, like the fifth graders, held negative opinions about the boys in general. About half of these girls would teach boys and girls differently, whereas the other half would make no distinction in instructional format. And if these girls were male they would not be interested in science or science careers, but would instead prefer sports or other macho things.

At the 11th grade the strong equity position continues, as do the gender stereotypes and negative opinions of boys in general.

S1: Because, uhh, it's a generalization and you can't generalize about all girls 'cause lots of girls are smarter than guys in science and some guys are smarter than girls. It just depends on the in—the in—the individual. It's just a generalization but . . .
S2: It seems like boys' brains are more geared for math and science and things like that and girls seem to do better in English and you know, different.
I: What ARE girls supposed to be like?
S3: Dainty and, and, uhh, petite, and they're not supposed to do anything and everything but . . .
I: What are boys supposed to be like?
S3: Oh, the big man of the, the everything, and macho.
I: Is that the way it works?
S3: No, but that's the way it's, it's set to work, as they say.

However, the 11th-grade girls would not teach the boys and girls differently.

I: Would you do anything different to make science more interesting for boys?
S1: No. The same.

Research has shown that peers can have an effect on opinions expressed by students. Therefore, the girls were asked how their friends felt about science and science careers. The answers for friends and for self were the same for the second graders. These young girls thought that their friends liked science and would choose to become scientists, and that their friends would support them if they choose to become scientists.

By the fifth grade only half the students believed that their friends would support them if

they decided to become scientists. They also believed that boys did not want to be scientists but intended instead to pursue careers in professional athletics.

In the eighth grade most of the girls thought that their friends would not be supportive of a girl's career choice in science. However, they believed that girls in general like science.

I: What would your friends say if you told them you were going to be a scientist?
S1: They'd probably ask me to think twice. I think there's a stereotype scientist usually who's always mixing chemicals and things like that, and they really get under my skin and that's . . . depends on which kind of scientist I would become.
I: Do you have any friends who want to be scientists?
S1: No.
I: What would you say if a friend of yours wanted to be a scientist?
S1: I'd say that's a dumb occupation.

This trend reversed for the 11th-grade girls. They thought that their friends would support their choice of a science career but also believed that many girls do not like science.

I: What do the girls say about science?
S1: Well they just think it's boring and stupid 'cause they have to sit and listen to lecture for so long, and there are a million other things they'd rather do.
I: Like?
S1: Like, I don't know. Girl things like shopping and . . .
I: What do you think your friends would say if you told them that you were going to be a scientist?
S1: They would probably support me too. They'd probably want to know more, like, why and would it, what led you to this? I mean, not that it's bad, they would just . . .

Summary

Even though these girls respond that girls and boys are equal, that girls can do science as well as or better than boys, and that girls can be scientists, the girls were aware of, and themselves held many, cultural gender stereotypes. When asked to respond to questions as they thought their friends would, many of the girls used cultural gender stereotypes to explain their "friends'" answers. The relationship between liking science and receiving support for pursuing a science career flip-flops between the 8th and the 11th grades. Girls at these ages held some of the strongest equity positions, but also seemed well aware of cultural beliefs. They held many of these beliefs themselves. Like the girls in Brown & Gilligan's (1992) study, our respondents are caught in a paradox. They are struggling with establishing and standing up for who they are and the cultural feminine ideal.

Conclusions

The girls in this study took a strong equity position and rejected most cultural stereotypes about women even though they may have held negative stereotypes about boys. They liked science and were confident in their ability to do well in science. They did not appear to be avoiding science. They expected to take science in high school and believed they needed science to get into college. However, the relationship between school science and scientific careers was unclear to most of the girls.

These girls preferred "doing science," especially in a group, over reading about science.

They liked both physical and biologic topics, but were interested in choosing their own topics for study. They also wanted to learn about topics that had relevance to their lives. Dissection, before the girls actually experienced it, was the most problematic aspect of school science for them. Some girls perceived dissection as either gross or cruel. However, the older girls who had participated in dissection activities found them to be interesting and relevant. Teachers were able to make science fun or boring, but we did not have evidence that teachers had much of an influence on career choice. The topic of science and science-related careers was not part of these girls' curriculum.

Peers did not seem to have a large effect on a girl's choice of a career either. Influential role models were infrequent in the school curriculum, whereas the media and society in general provided both positive and negative role models for the girls. Parents and other significant family members had little influence on the girls' choices unless they themselves did science as an occupation or an avocation.

Biologically based careers were often not seen as science because of the absence of chemicals and electricity. The term *scientist scientist* appeared frequently as the girls' way of differentiating the physical from the biologic sciences. The physical sciences were largely rejected because the girls did not see physical scientists as helping or caring. When the girls chose science careers, they did so out of a desire to help people, animals, or the earth, and/or because the girl experienced or associated science with someone they loved and admired. Girls who did not choose scientific careers were choosing other challenging professional and non-traditional occupations.

If we try to explain these results in the absence of a theory of girls' psychological needs we reach a dead end. The girls seem to have all of the pieces needed to choose a scientific career, and they are not deterred by the cultural stereotypes. Many of the girls even say that they would like to pursue a scientific career. However, we know that despite interest and intentions few of these girls will end up in science. On the other hand, if we look at what the girls say through the lens of relationships and connections we have a clear picture of what draws these girls to science and what may also lead them away.

Relationships, which include caring, responsibility, and affective needs, provide the standard by which these girls make judgments concerning science. Their strong equity position can be interpreted as a rejection of competition and the hierarchical ordering of individuals, both of which make positive interpersonal relationships difficult to establish and maintain. Equals are more likely to be friends and reducing competition results in working together better. The expression of negative gender stereotypes by these girls can be interpreted as the intrusion of cultural values into this expression of psychological needs.

The response to how science is taught and the role of the teacher are also mediated by relational and affective needs. The girls dislike instruction that isolates them, such as reading the textbook or taking notes while listening to lectures. They prefer instruction that permits them to interact with others, such as working in groups or discussing the issues with their teachers and classmates. Dissection was a big issue because to many of the students it appeared cruel. Most of these girls want to help animals, not hurt them, and until dissection is experienced firsthand the girls do not see how dissection can be anything but hurtful. The teacher who connects with the students is a "fun guy," and the one who does not is boring. These traits of fun or boring are then attributed to the content as well.

Both physical and biologic science are interesting to study in school, but physical science careers are avoided because they seem unrelated to the girls' concerns. Biologic science careers are perceived as helping people, animals, and the earth. It is this potential to be helpful that draws girls to these careers. The intellectual challenge of science and the puzzle solving that

males often cite as reasons that draw them to science are, for the girls, replaced by relational and affective needs that have a moral component.

The girls with the strongest commitment to scientific careers learned to love science through the love of a parent or grandparent involved in science. The descriptions of these experiences are highly emotionally charged and focus more on the interpersonal relationships than on the science itself. The girls do not separate their feelings about the mother who had died, the mother who "teaches me everything," or the grandparent who explains the stars on cold evenings on the beach from their feelings for science. These feelings are one and the same. When the emotional impact is strong enough, a movie such as *Gorillas in the Mist* can have the same effect.

Relational values such as cooperation, working with people, and helping others are characteristics of women in general (Belenky, et al., 1986), but are also important to adult women working in technical fields. Researchers involved in the Women and Technology Project at Bank Street College found that women approach computers relationally. That is, they want computers to be used to help and to make connections with people (Center for Children and Technology, 1991). These feelings are not limited to the United States. Female engineers in Norway (Sjoberg & Imsen, 1983) also want to use their jobs to benefit society and other people. However, according to Rhode (cited in Noddings, 1990), these values have been undervalued in professional cultures and are missing in professional schools and organizations.

The absence of these values during the training of women scientists and during their professional lives may account for the low number of women in science. Women's decision to discontinue science is often a consideration of multiple goals. This is especially so when women are faced with the choice of investing time in one activity over another that more effectively meets their psychological needs (Eccles, 1986). Among college women, Arnold (1992) found that dropping out of science was not related to achievement or interest, but occurred because women's needs and goals as expressed in a desire for marriage and children were more important than their need for high-status careers. This choice was already apparent to one girl in the study who said if she were interested in marriage and children she would not be a scientist.

These data speak strongly about how girls see science, and the need for science educators to address the female perspective. One such study has been conducted by Martinez (1992), who enhanced uninteresting science experiments by increasing their cognitive, mastery, and social appeal. Not surprisingly, from our perspective, he found that the girls in the study responded positively to the social aspects of the enhanced experiments, whereas the boys responded to the mastery aspects. More information is needed on how these relational and affective dimensions influence girls' life choices, as well as information on how to integrate these dimensions into science classrooms and the scientific workplace.

References

Almquist, E., Angrist, S., & Mickelsen, R. (1980). Women's career aspirations and achievements: College and seven years after. *Sociology of Work and Occupations, 7*, 376–384.

American Association of University Women. (1991). *Summary: Shortchanging girls, shortchanging America.* Washington, DC: Author.

Angrist, S., & Almquist, E. (1975). *Careers and contingencies.* New York: Dunelllen.

Arnold, K. (1992, April). *The Illinois valedictorian project: Academically talented women ten years after high school graduation.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

Baker, D. (1990, March). *Gender differences in science: Where they start and where they*

go. Paper presented at the annual meeting of the National Association for Research in Science Teaching, Atlanta, GA.

Baker, D., Leary, R., & Trammell, R. (1992, March). *Where are the gender differences in science and what do they mean*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, Boston, MA.

Belenky, M., Clinchy, B., Goldberger, N., & Tarule, J. (1986). *Women's Ways of Knowing*. New York: Basic Books.

Brown, L.M., & Gilligan, C. (1992). *Meeting at the Crossroads: Women's Psychology and Girls' Development*. Cambridge, MA: Harvard University Press.

Campbell, J. (1991). The roots of gender inequity in technical areas. *Journal of Research in Science Teaching, 28,* 251–264.

Campbell, J., & Connolly, C. (1987). Deciphering the effects of socialization. *Journal of Educational Equity and Leadership, 7,* 208–222.

Campbell, P. (1988). *Rethinking research: Challenges for new and not so new researchers*. Washington, DC: Department of Education, Women's Educational Equity Act.

Center for Children and Technology. (1991, October). Women and technology: A new basis for understanding. *News from the Center for Children and Technology,* 1–4.

DeBoer, G. (1984a). Factors relating to the decisions of men and women to continue taking science courses in college. *Journal of Research in Science Teaching, 21,* 325–329.

DeBoer, G. (1984b). A study of gender effects in science and mathematics coursetaking behavior among students who graduated from college in the late 1970s. *Journal of Research in Science Teaching, 21,* 95–103.

Eccles, J. (1986). Gender-roles and women's achievement. *Educational Researcher, 15,* 15–19.

Ethington, C., & Wolfe, L. (1989). Women's selection of quantitative undergraduate fields of study: Direct and indirect influences. *American Educational Research Journal, 25,* 157–176.

Gilligan, C. (1982). *In a different voice*. Cambridge, MA: Harvard University Press.

Grant, M., & Harding, J. (1987). Changing the polarity. *International Journal of Science Education, 9,* 335–342.

Holden, G., & Edwards, L. (1987). Parental attitudes toward child rearing: Instruments, issues and implications. *Psychological Bulletin, 106,* 29–58.

Hueftle, S., Rakow, S., & Welch, W. (1983). *Images of science: A summary of results from the 1981–82 national assessment in science*. Minneapolis, MN: Minnesota Research and Evaluation Center.

Kahle, J.B., & Lakes, M.K. (1983). The myth of equality in science classrooms. *Journal of Research in Science Teaching, 20,* 131–140.

Maple, S., & Stage, F. (1991). Influences on the choice of math/science major by gender and ethnicity. *American Educational Research Journal, 28,* 37–60.

Markus, H., & Oyserman, D. (1989). Gender and thought: The role of the self-concept. In M. Crawford & M. Gentry (Eds.), *Gender and Thought* (pp. 100–127). New York: Springer-Verlag.

Martinez, M. (1992). Interest enhancements to science experiments: Interactions with student gender. *Journal of Research in Science Teaching, 29,* 167–177.

Mullis, I., & Jenkins, L. (1988). *The science report card: Trends and achievement based on the 1986 national assessment*. Princeton, NJ: Educational Testing Service.

Nardi, B. (1983). Goals in reproductive decision making, *American Ethnologist, 10,* 697–714.

National Science Foundation, (1990). *Women and Minorities in Science and Engineering*. Washington, DC: Author.

Noddings, N. (1990). Feminist critiques in the professions. In C. Cazden (Ed.), *Review of Research in Education, 16* (pp. 393–424). Washington, DC: American Educational Research Association.

Oakes, J. (1990). Opportunities, achievement and choice: Women and minority students in science and mathematics. In C. Cazden (Ed.), *Review of Research in Education, 16* (pp. 153–222). Washington, DC: American Educational Research Association.

Peng, S., & Jaffe, J. (1979). Women who enter male-dominated fields of study in higher education. *American Educational Research Journal, 16,* 285–293.

Sadker, M., Sadker, D., & Klein, S. (1991). The issue of gender in elementary and secondary schools. In G. Grant (Ed.), *Review of Research in Education 17* (pp. 269–334). Washington, DC: American Educational Research Association.

Sheperd, L. (1993). *Lifting the veil: The feminine side of science.* Boston: Shambhala Publications.

Sjoberg, S., & Imsen, G. (1983). *Gender and science education.* (Monograph No. 3). Oslo, Norway: Center for Science Education, University of Oslo.

Solomon, J., & Harrison, K. (1991). Talking about science based issues: Do boys and girls differ? *British Educational Research Journal, 17,* 283–294.

Sutton, R.E. (Winter, 1991). Equity and computers in the schools: A decade of research. *Review of Educational Research, 61,* 475–503.

Steinkamp, M.W., & Maehr, M.L. (1983). Affect, ability and science achievement: A quantitative synthesis of correlational research. *Review of Educational Research, 53,* 269–396.

Tesch, R., Sommerlund, B., & Kristensen, O. (1989). *Textbase Alpha Users Manual.* Desert Hot Springs, CA: Qualitative Research Management.

Ward, B. (1979). *Attitudes toward science: A summary of results from the 1976–77 national assessment of science.* (Report No. 08-S-01) Denver, CO: Education Commission of the States.

Ware, N., Steckler, N., & Lesserman, J. (1985). Undergraduate women: Who chooses a science major? *Journal of Higher Education, 56,* 73–84.

Wilder, G., & Powell, K. (1989). *Sex Differences in performance: A Survey of the Literature* (College Board Report No. 89-3, ETS RR No. 89-4). New York: College Entrance Examination Board.

Received July 15, 1993
Revised May 23, 1994
Accepted August 12, 1994