Chapter

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Gender Differences in the Science Classroom: STS Bridging the Gap

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Are we holding on to hope that somehow we can help students change to accommodate school science programs? If females and males differ in their way of knowing, why haven't schools developed appropriate teaching strategies that are more responsive to these differences? What types of transformations are needed in science education to help us bridge the gap in terms of gender issues? The focus of this chapter is on gender issues and the effects of inclusionary approaches to science teaching, specifically Science, Technology, Society (STS) techniques. Research is beginning to emerge that shows STS and other problem-centered practices to be more inclusionary and to stand out as powerful alternatives for making science more meaningful for all students.

"Ugly Duckling" Effect

Science education has long been plagued by what can be coined the "ugly duckling effect," an effect which a great number of students, especially females, are suffering from in science education. In the story "The Ugly Duckling," the young ducklings wouldn't accept the orphaned young swan because it was too different and too ugly. These differences blinded the ducks to the possibilities and potential for the cygnet. A similar scenario can be described for many female science students. Many females (and some males as well) have been thought of as being so different from the stereotypical science student of the traditional science classroom that their potentials in science have been overlooked.

But today schools are striving more than ever to create educational programs that are non-sexist and multi-cultural in their orientation (Oakes, 1990). The concern is for building science programs that will more effectively meet the needs of all students (NSTA, 1990). Equity in science education implies fairness in the distribution of services, equal access to programs, and the inclusion of non-discriminatory teaching practices in science. Since the advent of Title IX in 1972, segregation in our schools on the basis of gender has become a legal as well as a moral issue. Even though efforts spearheaded through Title IX have tried to provide for equal access to science courses and extracurricular activities related to science, research shows that students are treated differently based on a number of student attributes and traits, including gender (Good & Brophy, 1987). *How Schools Shortchange Girls*, a

1991 report by the American Association for University Women, points out many ways that girls are shortchanged in science and mathematics education (AAUW, 1992). For many educators, the hope is that female students will eventually change to accommodate the way that science is traditionally taught. Educators often do not consider that perhaps the problem is not with the individuals but stems from the way science is being taught in our schools. The question may not be so much, What is the matter with our students? but rather, How do we incorporate what we know about the development of male and female learners and then move towards more productive and inclusionary science practices and pedagogy? Without this consideration, females are often set off to the side in science and dismissed as not good enough, just as the ugly duckling was, because they have different needs, experiences, and beliefs. In many situations, blame and shame are cast upon the students if they do not succeed in science or choose not to participate (Kelly, 1987). As a result, most females move away from science and achieve success in other areas.

Explanations for the Effect

Much research and discussion has focused on this "ugly duckling effect" in science education, primarily characterizing the learners and defining the problem. Researchers have looked for, among other things, psychological and developmental explanations to describe differences between male and female learners (Kelly, 1987). A number of factors, including societal and parental pressures and childhood experiences, affect students' attitudes towards science (Kahle & Lakes, 1983). Female students have been shown to exhibit less positive attitudes towards science than their male counterparts (Skolnick, Langbort, & Day, 1982). They tend to view science as masculine and impersonal (Keller, 1982). Males tend to be more confident in their abilities when it comes to science (Kelly, 1987). As for the actual classroom performance, research has consistently shown that females do not perform as well as males in science classes. Many females view science classes as difficult (Kahle, 1983). And for females between the ages of nine and fourteen, interest in science and achievement levels decline (Hardin & Dede, 1978; National Assessment of Educational Progress, 1978, 1988). This type of research has provided useful information for science educators in terms of identifying differences.

It can be argued that this type of research only tends to reinforce the differences and perhaps even widen the gap between male and female science students (AAUW, 1991). Many attempts to deal with this effect have failed because they have been focused on the "problem" population and do not deal with the effect within the context of the regular classroom. The remedies have often taken the form of pull-out curricula, or fragmented curricula, which involved add-on components that failed to blend with other dimensions of the curriculum (Wilbur, 1991). This lack of integration and coordination often portrays the experiences as corrective rather than nurturing, reinforcing the idea that the students can be fixed to fit the mold.

Eliminating the Effect

Research is beginning to emerge that holds promise for a brighter future for females with respect to science education. Approaches to science instruction and curriculum design are being examined and new models based on the needs, experiences, and beliefs of the learner are beginning to emerge. The central tenets of the majority of problem-solving approaches are based on the principles of constructivism. At the center of a constructivist approach are the ideas that knowledge is not passively received but actively constructed by the learner and that cognition is adaptive, allowing for personalized organization of the experiential world (von Glasersfeld, 1988). The majority of students today would not fall into this category of a "constructed-learner" (Belenkey, Clinchy, Goldberger, & Tarule, 1986).

It is important that a vision emerges for ways science could be taught that would bring female and male students together as a community of learners. The research tides seem to be shifting towards the sociological and structural questions in hopes of uncovering evidence and explanations that will provide for more inclusive constructs and validate a broader spectrum of the population. Our goals for the 1990s and beyond should not be centered on replacing a womanless curriculum with a manless curriculum, but rather to transform the curriculum to include everyone (NSTA, 1990). The hope should not be for gender-free science but for gender-balanced science. "Only when the curriculum reflects the diversity of experiences, roles and achievements present in our population will it begin to prepare students for the diversity of the world. Transforming the curriculum is one important step towards increasing that diversity and connecting students to the curriculum" (Rosser, 1990, p. 18). Connecting students to the curriculum and allowing them to construct their own understandings based on personal experiences is critical in creating meaningful science experiences for students whether they be male or female.

The problem-centered curriculum stands out as a powerful alternative for making science more meaningful for all students (NSTA, 1990). The types of problem-centered approaches characterized in this discussion are those that ensure science and technology are considered in a social context, with the assessment of their benefits for the environment and human beings being central to the approach. Rosser states that adopting this perspective "may be the most important change that can be made for all people, both male and female" (Rosser, 1990). These problem-centered approaches have been given many different labels. Perhaps the most commonly used labels have been Science, Technology, Society (STS), issue-oriented, project-oriented, and problem-centered. For this reason it is difficult to relate one specific approach to gender or, for that matter, anything else. But for this discussion, the characteristics of the instruction are more important than the labels.
Many gender issues that arise in today's science classroom result from the exclusionary pedagogical techniques that are still in place in traditional science programs (Belenkey, Clinchy, Goldberger, & Tarule, 1986). We need to be looking for approaches that are inclusive and have a normalizing effect on the differences between male and female learners. Our challenge is to develop approaches that integrate a number of essential, inclusive elements into the approach.

Perhaps one of the most important characteristics of an inclusionary approach to science teaching is the idea of connections. In the book *Women's Ways of Knowing*, the authors attempt to describe how women are taught and the way they learn science (Belenkey, Clinchy, Goldberger, & Tarule, 1986). Reactions to this book were interesting. Many women felt that the description and research set forth in the book matched their experiences perfectly. The interesting thing was that many men felt that the book accurately described their experiences and wondered why the book had the title it did. The authors also examined the work of successful women scientists. They found that the majority of these scientists "viewed all knowledge as contextual, experienced themselves as the creators of knowledge, and valued both subjective and objective strategies for knowing" (Belenkey, Clinchy, Goldberger, & Tarule, 1986). Most of these women were classified as "constructed-knowers." Research and work accomplished by these women emphasized connecting in some way. Connections between science and human beings were a very important concern. These connections could serve as the link to attract more women, people of color, and those white males not now attracted to science when science is taught in a traditional manner (Rosser, 1990). Students in the traditional science classroom have very few opportunities to personalize their learning by making connections with experiences from the real world. This notion of a "connected curriculum" should serve to connect students to

- themselves—by providing an environment for them to build positive feelings towards science-related personal attributes and skills
- science—by encouraging them to develop a personal interest stemming from their questions and experiences
- each other—by helping them establish relationships based on an appreciation of people's strengths and weaknesses
- the teacher—by creating a relationship built on providing personal support and mutual respect
- the real world—by encouraging them to get involved outside the classroom

These connections provide females and other students with an opportunity to see themselves reflected in the day-to-day experiences in the classroom. Emily Style (1988) believed that there must be many windows for students to look out onto the experiences of others and mirrors that reflect the personal realities of students. In a connected approach to science teaching there should also be opportunities for students to explore the real world and apply what they know to make stronger connections in their own minds. The concept of connectedness is central to many problem-solving approaches, including STS.

In addition to the concept of connectedness, Wilbur (1991) identified six other attributes of a "gender fair" approach to science teaching.

- A "gender fair" approach acknowledges and affirms variation.
- It should be inclusive, viewing differences within and among groups of people in a positive light. Students should see themselves reflected in the approach and identify positively with personal messages they uncover.
- It should be accurate, helping students uncover information and ideas that are verifiable and capable of withstanding critical analysis.
- It should be affirmative, emphasizing the value of individuals and groups.
- It should be representative, presenting multiple perspectives of an issue.
- It should be integrated, weaving together the interests, needs, and experiences of both males and females.

When these elements are in place, assessments have shown that student attitude becomes more positive for middle school and high school students, especially female students (NAEP 1978, 1988).

And how is student attitude affected by STS instruction? The Iowa Chautauqua Program, an inservice program for STS teachers K–12, has been looking at just this question. The Iowa definition of STS has considered and incorporated the inclusive characteristics presented in this discussion. Some interesting changes in student attitude have been discovered. These attitude changes reflect more positive perceptions about science in general and specific teacher characteristics. But perhaps most important, the gap between female and male learners has narrowed.

Not until recently has evidence started to emerge on the differential gender effects of inclusionary approaches. Blunck and Ajam (1991) looked at the gender-related differences in students' attitudes towards science, science classes, and science teachers. The experimental design involved using a pretest/posttest measure of treatment and control groups. Using data collected by 20 Iowa STS teachers, the study found that female students enjoyed their STS science classes more than males. Before STS instruction, females exhibited more negative attitudes towards science. After their STS experiences, the attitudes of females shifted significantly. Female students also exhibited more positive attitudes towards their science teacher.

Perhaps the most exciting finding from this study is that STS instruction seems to be narrowing the gap that usually exists between female and male learners. Certainly the hope with an inclusive approach such as STS is that attitudes will change positively, but there should also be a hope that the gap will narrow. This study represents only the tip of the iceberg but does serve as an example of what can happen when inclusive constructs are incorporated into teaching practices. Figures 1 and 2 reveal changes in student attitude related to students' perceptions of science and their science teacher. Data reflect the percentages of students (male and female) responding on the pre- and posttests. The differences are significant at the <0.05 level.

Figure I

Questions where STS has shown a differential effect on gender-related differences in students' attitudes favoring females

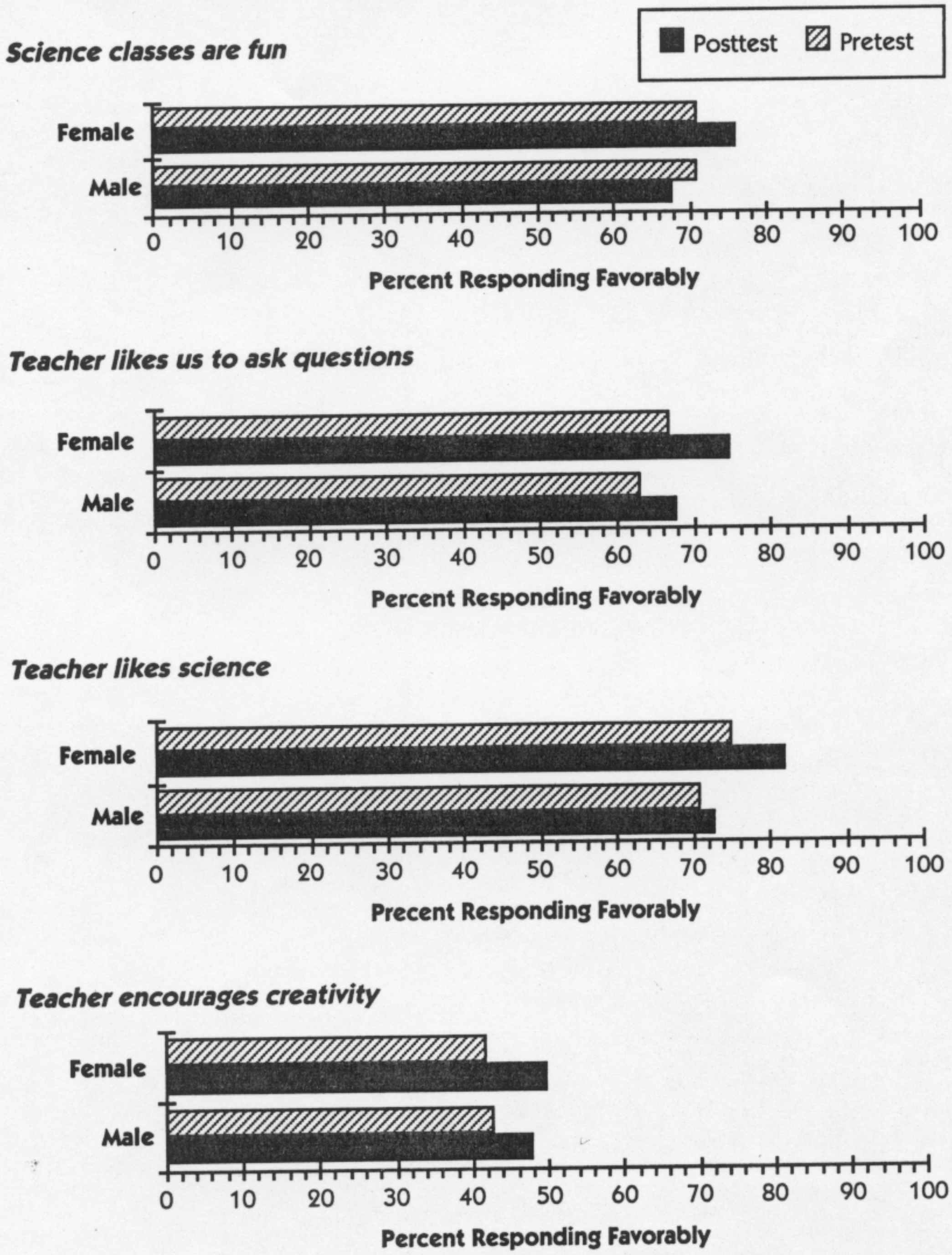
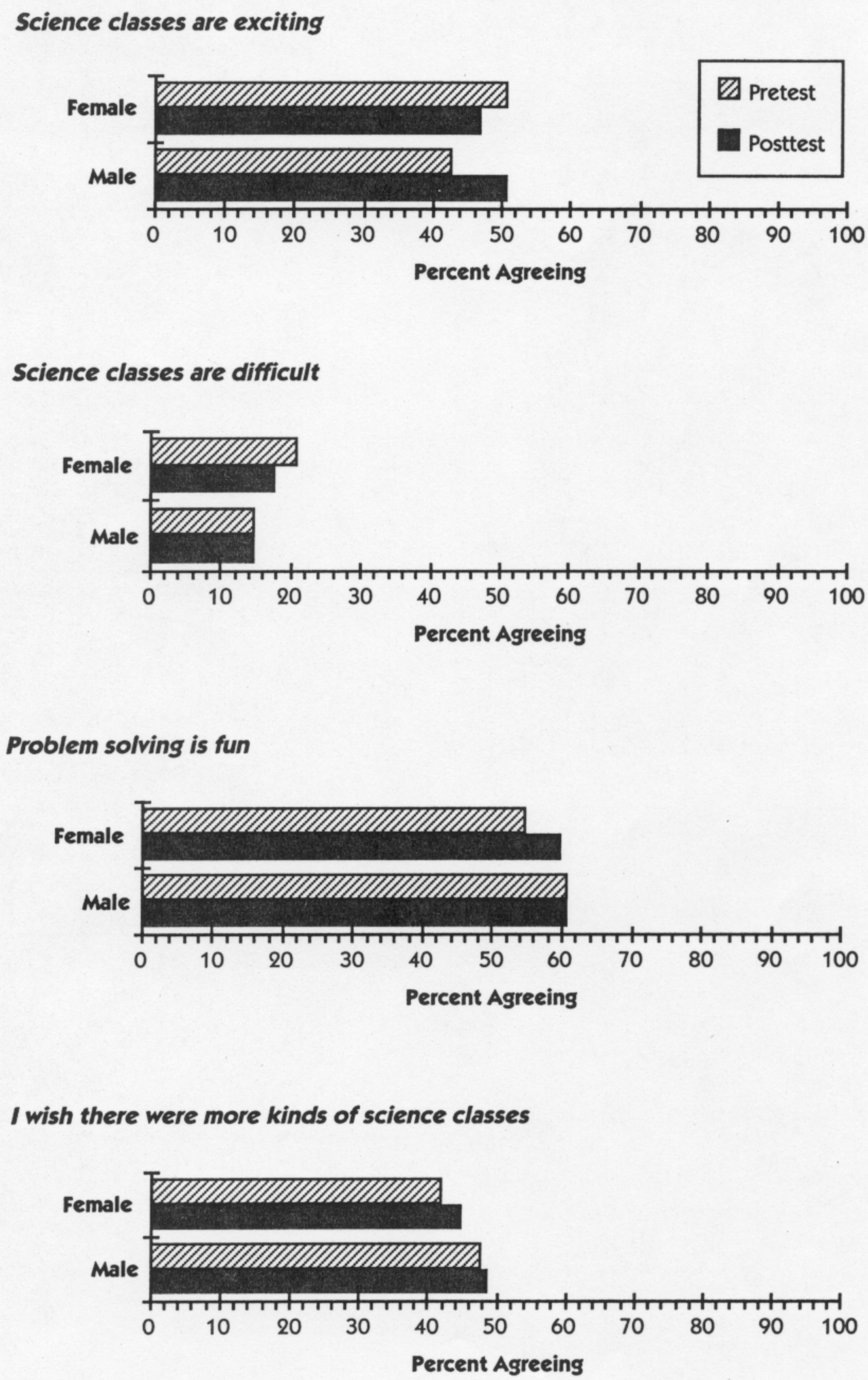


Figure 2

Areas of students' attitudes towards science where STS has shown a normalizing effect favoring females



Most recently Mackinnu (1991) has investigated the differential gender effects of STS instruction compared to a textbook approach. Over 700 students and fifteen teachers were involved in this study. The experimental design involved using a pre- and posttest scheme with treatment and control groups. Before instruction, females showed more negative attitudes towards science than their male counterparts. But after instruction, those female students in STS classes showed more improvement in their attitudes than those taught by a comparable textbook approach. "This means that STS instruction does minimize the gap between male and female attitudes towards science for the teachers involved in this study" (Mackinnu, 1991, p. 118). Comparison of the t-tests on pretest and posttest scores showed a decrease in the number of classes with significant differences between males and females.

The Transformation Process

Given the fact that the majority of researchers agree that school science programs must be transformed and restructured to better meet the needs of both male and female students, STS and other inclusionary approaches are emerging as viable alternatives to traditional science programs. The attempts to restructure school science programs must address gender-related issues. For too long, we have focused on creating interventions to "fix" students so they accommodate a traditional science classroom setting instead of recognizing the qualities and potentials of these non-stereotypical science students, much as the potentials of the ugly duckling were overlooked.

As the research on inclusionary practices continues to grow, the challenge becomes one of developing approaches that will allow individuals to see themselves reflected in their science experiences. STS is only one of many approaches that is focused on bridging the gender gap. The challenge for science educators who are involved in these efforts is to collect evidence on the gender effects of their instruction. Inservice programs should stimulate awareness and the development of innovative approaches to deal with the problem. Too often we are quick to dismiss the idea that gender issues still exist within our science classrooms. It is the sensitivity of the teacher to these issues in the science classroom that will, in the long run, make the biggest difference of all.

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