Gender Equity in Science

Barry R. Thompson
Larry Rogers
Carl Edeburn

South Dakota State University

A survey was administered at South Dakota State University to thirty female undergraduate students who were attending a physics class designed for science majors. The purpose was to ascertain the identity of the individual who most influenced the students to choose a career in science. The most influential person proved to be the respective mothers of the students, with fathers ranking as second most influential. Various interventions such as role models as guest speakers can be attempted in order to increase female representation in the scientific community. Perhaps the best guest speakers would be the parents of the students.

The fact that gender plays such a large role in human experience has made it an attractive independent variable in research studies. Statistically significant differences frequently have been found between males and females across the spectrum of human experience. One area of research has involved the classroom performance of students. Researchers have asked whether gender affects student performance in classroom settings. Do males, after a slow start, tend to outperform females over the course of their schooling? If so, what factors account for such differences? Are the differences products of differential abilities or of social attitudes? The authors of this article first address research which has been completed which indicated possible gender differences and strategies for improving female representation in the scientific field. This section is followed by a description of the study completed by the authors.

REVIEW OF LITERATURE

Fleming and Malone considered gender differences in 1983 when they studied the relationship between student characteristics and student performance. In their meta-analysis they documented an attitudinal shift that took place on the part of students during middle school. Fleming and Malone found that males in elementary school generally had more positive attitudes toward science than did their female counterparts. This attitudinal relationship reversed in middle school, and then reversed again, so that males once more had more positive attitudes toward science than females did once they were in high school.

Whatever the exact sequence of change, Peltz (1990), Klein (1989), and Blake (1993) agreed that differences in attitude and participation between males and females began to manifest themselves around the age of eleven and were firmly in place by the time of high school. These differences appeared to be persistent. The authors of the AAUW Report (1992) observed that gender differences in science achievement between seventeen-year-old males and females have not changed since 1978. As Sadker and Sadker noted (1994, p.146), "Girls are the only group in our society that begins school ahead and ends up behind." (It should be noted that Clark (1989), the AAUW (1992), Peltz (1990), and the Sadkers (1985) all have observed that young children enter school already in possession of established stereotypical gender perceptions. We therefore can conclude that the locus of the problem obviously is not merely within schools, but that schools reinforce existing social perceptions.)

Perceptions or attitudes are areas for research which could have a high correlation with achievement. In one study (Handley & Morse, 1984), one hundred and fifty-five seventh- and eighth-grade rural middle-school students were surveyed to investigate the significant relationships between male and female adolescents' attitudes and achievements in science. They found that "female students' attitudes toward more careers in science as being appropriate for females also correlated positively with their achievement in science" (Handley & Morse, 1984, p.602). In other words, more females tended to choose science as a career if they did well in science.

Other studies have also been conducted which addressed the relationship between attitudes and achievement. Weinburgh (1995) conducted a meta-analysis using eighteen sources from the period 1970-1991 in an attempt to investigate gender differences in students' attitudes toward science. She found that strong positive relationships were recognizable between attitudes toward science and achievement in science. This correlation was stronger for female students than for males, indicating that a positive attitude was more necessary for girls to achieve high scores than for boys.

Clearly, the authors of this article can conclude that gender attitudinal differences regarding science do exist. The authors also want to establish that we believe that equity implies equal representation in scientific careers by both genders. Dresselhaus, Franz, and Clark (1994) noted that only fifteen percent of the physics degree recipients at American universities were women. In contrast, a meta-analysis conducted by Linn and Hyde (1989), indicated that average differences in the quantitative ability levels between the genders had declined to essentially zero. Since ability levels do not seem to be at the core of the reason why females tend not to enter science at the same rate as do males, the question remaining seems to be how to improve the attitudes of females toward science in an effort to increase their representation in scientific careers.

Researchers have also addressed the question of identifying the various strategies that can be employed in order to improve the chances that females will choose a career in science. Several authors (Kahle, 1989; Gardner, Mason, & Matyas, 1989) have identified such strategies. Several authors have also noted that females have fewer opportunities to manipulate laboratory materials (Gardner, Mason, & Matyas, 1989; Rosser, 1990). The result is fewer experiences with hands-on science learning and thus perhaps fewer positive experiences in science. Through classroom experience the authors have found that setting up scientific instruments for future laboratory exercises is a low stress activity that introduces one to the manipulation of those instruments. Female students can be asked to help prepare for future laboratory exercises.

Masculine terminology and pictures with males using laboratory equipment appear to dominate textbooks. Bazler and Simonis (1991) replicated a study originally conducted by Heikkinen (1973) in order to assess gender bias in chemistry textbooks. In their study, textbooks from the same publishers were compared across time. Of the ten original publishers, only seven were still publishing comparable chemistry textbooks in 1991. Of the seven textbooks, one changed dramatically in overall proportion of male/female images, four textbooks remained the same, and two increased the imbalance of illustrations favoring men. A suggestion by the authors is that the teachers should point out the degree of sexual bias present in the textbooks. One process would be to have the students count the numbers of males and females pictured in each chapter. This is a simple process that does not require the use of an established valid and reliable instrument.

Single-sex classrooms have also been proposed as a simple solution to this attitudinal problem. The legal complications have been avoided (Saltzman, 1994) by opening these classes to all students while still advertising that the object of offering them is to achieve an all-female atmosphere. One of the bonuses of such an atmosphere is the avoidance of class discussion dominance by male students.

This dominance can be avoided in coeducational classes through the use of several strategies which have been employed by the authors. One involves the use of cooperative learning groups. These groups can be designed as single-sex groups, or as coeducational groups in which specific roles are assigned to individual students. The teacher can then monitor the progress of each group without the complications of students shouting out during a class discussion involving twenty-four pupils. This approach also eliminates the legal ramifications associated with establishing single-sex classrooms.

Another strategy involves peer observations to monitor patterns of classroom questioning. A unique form of observation was proposed by the Sadkers and Long (Sadker, Sadker, & Long, 1997) in which the observer was handpicked by the cooperating teacher from among the school's administrative or teaching staffs. This approach was designed to reduce the stress associated with evaluation, thus limiting the chance that a teacher's entire teaching style would change self-consciously during the observation. The observer documents the number of times males and females are called on in class, and the levels of questions addressed to each of the participating students. This procedure should be followed more than once to better insure that the instructor is teaching the students and not performing for the observer. Similarly, the Sadkers and Long suggested teachers' use of students to tally questioning patterns, having first explained to them the importance of their involvement in classroom discussion.

An observer also can help the instructor to recognize the need for the use of gender-neutral language. The observer can document whether the term "he" is used every time the teacher refers to doctors or scientists. Similarly, the use of words that exclude women from serious consideration, such as "mankind," or that trivialize them, such as "girl" in place of "woman" when describing a job-seeker, can be identified and changed. However innocent their use, "words are powerful indeed (Sadker & Sadker, 1994, p.146)."

THE PRESENT STUDY

The power of the spoken word as well as the written word can be significant and identifying the most influential speaker may lead to a strategy for reaching gender equity. The present study was implemented to identify those individuals who had the greatest influence on females' decisions to enter and pursue a career in the area of science. Using an instrument developed by Koballa (1988) and adapted by the present investigators, a group of female South Dakota State University students in a physics class who are science majors were asked to complete the instrument. The thirty participants were asked to choose the five most significant persons who had a role in influencing their career decisions. They were then asked to rank these persons 1 - 5 with one being the person of greatest influence. Since there were twenty-eight choices or categories (Mother, Sister, Coach, etc.), each student in selecting their personal choices had to omit twenty-three other potential choices.

After the instruments were retrieved the data was tabulated and presented in Table 1.

As can be noted in Table 1, the person chosen most often by the participants was the mother. This is evidenced by the low number in the omissions column. Only seven of the thirty respondents failed to choose their mother as one of the five most "influential" career motivators. Further examination reveals that three (13%) of the twenty-three respondents chose the mother as the number one person, six (26%) chose the mother as second most influential, four (17%) as the third most influential, seven (30%) as the fourth most influential, and three (13%) identified their mother as the fifth most influential person when dealing with career choice.

Further examination of the omissions column indicates that the father (overall) was the second choice of this particular group of women. With only eight omissions, the father could be viewed as the second most influential person in the life of female students.

The third most influential person identified by this group of respondents was the "man science teacher" with thirteen omissions. This choice was followed by the "man veterinarian" with nineteen omissions.

None of the other twenty-four influences bears a need for further discussion as the number of omissions (out of a possible thirty) ranges from twenty-five to thirty. Perhaps in a future study, those nine choices receiving no selections (thirty omissions) could be eliminated from the instrument to make it more manageable and simpler to administer.

DISCUSSION

Although this investigation is only generalizable to this limited population of South Dakota State University female science majors, there are some interesting indicators that raise several pertinent questions. For example, if parents are the greatest influences for females to choose a career in science, how can we as educators effectively approach the process of working with parents in order to reach gender equity in science. Gardner, Mason, and Matyas (1989) wrote of incorporating role models as guest speakers in the classroom. Perhaps the best role models to ask are the parents of the students instead of female scientists, engineers, or any number of examples of females in male dominated professions.

When comparisons are made to other Midwestern populations, interesting consistencies and inconsistencies can be found. Koballa (1988) surveyed a sample of 257 middle school aged students from central Texas. Better than ten percent of his sample indicated that the three most credible people to convince Junior High School girls to take elective high school physical science courses were in order father, woman science teacher, and mother. In his sample the father was the most influential while in the South Dakota sample the mother was the most influential. The similarity however was that parents ranked in the top three in both studies. Further research could be conducted in order to ascertain why matriarchal and patriarchal importance varied between the two populations.

Table 1

Those Who Have Influenced Careers

Individual of Influence Rank	Totals(%) 1	2	3	4	5	Omissions
Mother	3(13)	6(26)	4(17)	7(30)	3(13)	7
Father	2(9)	4(18)	5(23)	7(32)	4(18)	8
Brother	0	1(25)	2(50)	0	1(25)	26
Sister	0	0	0	0	5(100)	25
Woman scientist	0	0	2(50)	0	2(50)	26
Man scientist	0	0	1(50)	0	1(50)	28
Woman science teacher	1(25)	3(75)	0	0	0	26
Man science teacher	4(23)	4(23)	3(18)	3(18)	3(18)	13
Woman college student	0	1(33)	0	1(33)	1(33)	27
Man college student	0	1(50)	0	1(50)	0	28
Girl high school student	0	0	0	0	1(100)	29
Boy high school student	0	0	0	0	0	30
Girl junior high student	0	0	0	0	0	30
Boy junior high student	0	0	0	0	0	30
Man doctor/dentist	0	2(40)	3(60)	0	0	25
Woman doctor/dentist	0	1(25)	2(50)	0	1(25)	26
Man school counselor	0	0	2(50)	0	2(50)	26
Woman school counselor	1(50)	1(50)	0	0	0	28
Man principal	0	0	0	0	0	30
Woman principal	0	0	0	0	0	30
Man veterinarian	2(18)	1(9)	3(27)	4(36)	1(9)	19
Woman veterinarian	1(20)	1(20)	1(20)	1(20)	1(20)	25
Woman coach	0	0	0	0	1(100)	29
Man coach	0	0	0	0	0	30

(Table continued)

Table 1

Those Who Have Influenced Careers (Continued)

Individual of Influence	Totals(%)					Omissions
Rank	1	2	3	4	5	
Man coach	0	0	0	0	0	30
Girl cousin	0	0	0	0	0	30
Boy cousin	0	0	0	0	0	30
Nurse (gender not specified)	0	0	0	0	0	30
Me/myself	0	0	0	1(100)	0	29

Future study can extend beyond the area of careers in science. Random samples from many different college majors can be asked to complete the above instrument. The sample can include both males and females. Perhaps parents may not have as big a career influence on males.

CONCLUSION

Gender equity in science has been interpreted by the authors as equal numbers of males and females in the various careers in science. Many initiatives can be employed in order to improve the attitudes of females toward science and consequently achieve this definition. Examples are as follows:

1. Females can set up laboratory equipment.
2. The students can evaluate textbooks for gender bias.
3. The teachers can use gender-neutral language.
4. Schools can try single-sex classrooms.
5. Teachers can try single-sex cooperative learning groups.
6. Teachers can employ peer observations.
7. Teachers can use parents as role models.

There are approximately equal numbers of both sexes in the world and this percentage should extend to those in science careers. We as educators can employ the above ideas in order to help achieve "equity in science."

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Barry R. Thompson is currently an Assistant Professor of Education at South Dakota State University. He taught science in the Virginia public schools before earning his Ph.D. in Science Education form the University of Virginia. His research interests include: gender issues relating to science, hands-on science learning in rural school settings, Martial Arts exercise therapy for the elderly and its relationship to balance, and constructivist teaching practices.

Larry Rogers is an Assistant Professor of Education at South Dakota State University. He is the Associate Director of the Program for Rural School and Community Renewal. His research interests include social studies instruction, constructivist teaching, and rural educational issues (e.g., curriculum of place).

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