Sisters in Science Equity Reform Project

by

Penny L. Hammrich, Ph.D.
Queens College
City University of New York

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Equity Studies Research Center
Powdermaker Hall 100
65-30 Kissena Blvd.
Flushing, NY 11367
Telephone: 718-997-5218
Fax: 718-997-5214

Editor in Chief: Sonia M. Rodrigues

Website:
http://qcpages.qc.cuny.edu/Education/new/equity_studies_research_center.htm

Author Contact Information:

Dr. Penny L. Hammrich, Dean
Division of Education
Queens College
City University of New York
65-30 Kissena Blvd.
Flushing, NY 11366
Telephone: 718-997-5220
Fax: 718-997-5222
E-Mail: Penny.Hammrich@qc.cuny.edu

Sisters in Science Equity Reform Project

The Sisters in Science Equity Reform Project (SISERP) addresses the need for urban girls in elementary, middle and high school to gain equitable access to science and mathematics education. Specifically, this need is based on the rising research-based public concern over the diversity gap in science, mathematics, and technology. SISERP offers six innovative science programs designed to foster gender equity and inclusion in science, technology, engineering, and mathematics (STEM) education; Sisters in Science (SIS), All Sisters in Science (ASIS), Sisters in Sports Science (SISS), Sisters in Science in the Community (SISCOM), Information-Sisters in Science Career Opportunities Matter (iSIS.Com), and Sisters in Science Dissemination and Outreach Project (SISDO) [see figure 1]. SISERP recognizes the significant impact intervention programs targeting girls of disadvantaged socioeconomic status can have on academic success. Furthermore, SISERP accepts the call for systematic reforms that understand the limitations girls face in postsecondary education and employment opportunities in these fields.

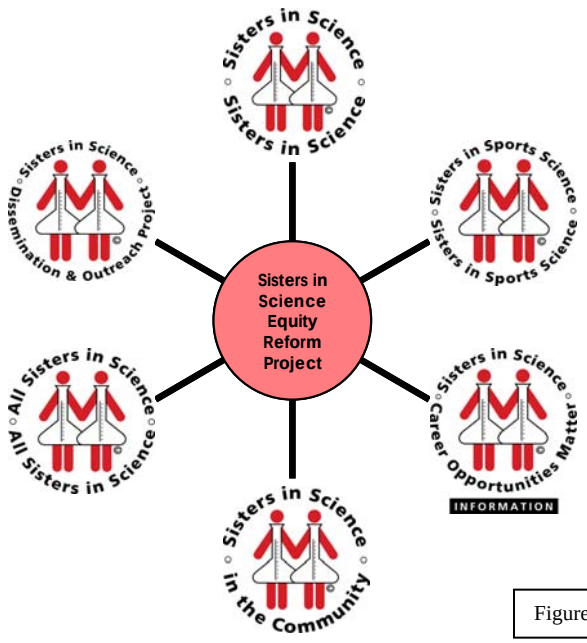

Figure 1: Components of SISERP

Recently awarded in February 2005, the American Association of Colleges for Teacher Education's (AACTE) Gender Equity Award in Women's Leadership, SISERP programs have been nationally recognized for exemplary accomplishments in programs and innovations related to leadership development and gender equity in education. Through such award recognition, sponsored by the AACTE's Committee on Women's Issues, SISERP programs serve as a model for others in the profession, advancing the agenda for women and girls.

Funded by the National Science Foundation, for over twelve years, SISERP programs focus on the diversity inherent in learning through various tools by which scientific and mathematical principles can be explored, analyzed, and communicated. By employing multiple vehicles to engage interest, girls are encouraged to become researchers and to explore the underlying principles. Rather than relying on teachers as the primary transmitters of information, the girls engage in the process and gather information from several sources and disciplines. In this fashion, girls are confronted with problems and questions inside and outside of the structured classroom. What they may not be aware of is that tools such as sports and technology can open the door for scientific exploration, and create a network of resources from which to gather information, either as primary or supplemental sources.

Program Goals and Objectives

SISERP programs have been developed to address the issue of gender equality in the sciences. Specifically, the six programs have been designed to impact students, their families, teachers and school administration. The primary goal of SISERP programs is to provide urban school aged girls with access to meaningful science, mathematics, technology, and engineering instruction in an environment unencumbered by the restrictions of stereotypical practices regarding gender.

The objectives of the SISERP programs:

1) Broaden the participation of females in science based disciplines academically and professionally
2) Foster gender-equitable and inclusive practices inherent in achievement across the curriculum
3) Develop a fair and equitable policy for science and mathematics achievement for female students
4) Create relationships between educators and researchers to overcome the gender inequalities that exist within the educational system

Project Rationale and Theoretical Perspective

Challenge: Gender Gap and Science Education

While programs that address the issue of equitable achievement for all students in science and mathematics are not new to science education, using multiple vehicles to garner interest and achievement while focusing on career trajectories provides females with a real-world approach to science and mathematics. Sports and technology offer an inventive method for reaching girls in an unperturbed environment while they learn specific science concepts.

While legal barriers to achieving gender equity in American society have been removed, many barriers still stymie females. Shirley Malcolm of the American Association for the Advancement of Science (AAAS) was on target in her keynote address to the American Association of University Women (AAUW) on *Girls Succeeding in Science, Math, and Technology: Who Works and What Works* (1997):

> The effort to equalize educational opportunities for girls is far from complete. . . . Unlike some other nations, female students in the United States are legally guaranteed access to math and science courses. While our legal barriers to this education have been removed, there are often still barriers we face; these are 'barriers of the mind.'

What are these "barriers of the mind" that prevent females from pursuing academic and professional careers in science, mathematics, technology, and engineering? They include the organizational structure of scientific and mathematics instruction, as well as females' perceptions of science and mathematics courses. Other barriers stem from societal influences such as parents' and teachers' lack of encouragement, authority figures' attitudes toward science, and the lack of support for females in science-based careers. Reformists believe that fostering a safe and nurturing environment, promoting problem-solving skills, creating collaborative experiences, educating teachers, offering hands-on learning tools, and allowing open discussion of gender stereotypes are essential for encouraging female students' success in technological fields.

During the past 12 years, the Sisters in Science Equity Reform Project (SISERP) focused on two major obstacles preventing equity in science education. As evidenced by 12 years of research in the area of equity in science education, the gender gap and gender bias in the classroom tend to inhibit females from exploring careers, both academic and professional, in the sciences. Increasing evidence also shows that the gender gap in science may be better understood in terms of the supposed masculine nature of science and technology (Tolley, 2003). Therefore, assigning science a masculine moniker impacts the learning styles of females and the current instructional patterns of teaching science, mathematics, technology, and engineering in classrooms around the world. The assertion is that the general learning style of females does correlate with the manner in which science is presently taught.

The organizational structure of current science instruction plays an important role in diminishing the resilience of females in science (AAUW, 1998). Historically, science education has been taught as a competitive and individualistic discipline. Science instruction and science-based professions have been viewed as isolated enterprises that are objective in nature. The underlying discernment is that the barriers girls face in science often overshadow the very characteristics girls hold that promote their resilience in the actual practice of science, including seeking personal relevance; working cooperatively; valuing

interdependence; and having keen observational, verbal, and writing skills (Kruschwitz & McClintock, 1994).

In addition to gender, race, and quality of education, another challenge female students must overcome is the effect of classroom teachers' perceptions of gender. Throughout world history, gender bias has been a problem that many women have strived to surmount. While women work hard to conquer gender bias in all aspects of daily life, female students continue to struggle against considerable gender inequities within the educational system.

With this in mind, it is paramount that gender biases in the classroom are dispelled through heightened awareness and education in the "best practices" for gender equity (Hammrich, 2002). Current research on gender equity and the classroom has shown that the first step toward gender equity in classroom teaching practices is self-evaluation. In order for teachers and school administrators to promote gender equity in the classroom, educators must be conscious of their own gender biases. Stereotypical practices concerning females and males are second nature to many members of our society. The notion that "girls do this" and "boys do that" is deeply entrenched in the American educational culture.

SISERP Programs: Meeting the Challenges

SISERP was established in the interest of providing equitable avenues for all students to pursue academic success in STEM disciplines. Incorporated into the six components of SISERP are comprehensive science curricula based on national standards, thorough gender equity focused professional development for pre-service and in-service teachers, family education programs, informal and formal science explorations, and educational components such as Saturday academies, summer camps, and after-school programs.

Sisters in Science (SIS):

SIS is the first program developed under the SISERP umbrella. The SIS program is a multifaceted educational intervention aimed at increasing young urban girls' interest and achievement in the sciences. The program has been designed to encourage positive attitudes towards science. Program components include an after school program, teacher training, family education and summer camp.

All Sisters in Science (ASIS):

ASIS was created to address concerns about girls with disabilities in elementary public schools who are widely underserved in inclusionary settings and undereducated in the areas of STEM. A critical outcome of such poor STEM educational experiences is the negative way that students with disabilities perceive science and math -- either they have no further interest in these areas or they are denied the opportunities to pursue further education because of their limited or non-existent knowledge base. Through the professional development of hundreds of special education teachers both pre-service and in-service, the

utilization of mentors, and the creation of a family education program, the project has a direct impact on students, teachers, parents, and the STEM curriculum.

Sisters in Sports Science (SISS):

SISS is unique in its use of sports as a vehicle for science exploration. The program provides hands-on, inquiry based sports science activities that allow girls to develop a repertoire of experiences, which can then be used as the foundation for learning scientific concepts. Girls participating in the program are engaged in STEM activities that are fun, creative, and promote scientific literacy and career awareness. The program components provide girls with a structured, yet free-choice learning environment that meets their developmental needs for learning science and increasing their self-esteem, while at the same enriches their formal learning experience.

Sisters in Science in the Community (SISCOM):

The SISCOM project creates a much needed link between science educators and community/ faith based organizations. The program has been able to engage adolescents and their families in STEM activities during non-school hours. By fostering a supportive network among the university and community/ faith based organizations, SISCOM bridges formal and informal science education. Through a comprehensive hands-on, inquiry-based curriculum, program participants can take their heightened awareness in the sciences into the classroom.

INFO-Sisters in Science Career Opportunities Matter (iSIS.com):

The iSIS.com program is an intense science program for urban high school girls. Combining technology, hands-on science explorations, and a yearly research project, the girls are introduced to a wide number of STEM related careers. In an effort to promote awareness, the program teaches the girls the different aspects of scientific research. This 3 year intervention matches the girls with females in science based careers. The scientists guide the girls through the process of research and completion of their project.

Sisters in Science Dissemination and Outreach Project (SISDO):

Sponsored by the National Science Foundation, the SISDO project has been developed as a clearinghouse for information critical to the reform of equitable teaching practices in STEM education. The dissemination project provides teachers and researchers with research based information promoting the "best practices" in a movement toward gender-equitable science education. Not only does the program support various publications specific to gender equity and science education, it also sponsors a yearly national conference and monthly gender equity focused professional development opportunities for classroom teachers.

Data Sources and Program Evaluation

The effectiveness of SISERP in achieving its goals/objectives, targeting each constituency and addressing needs, is determined through internal and external assessments employing multiple methodologies. The data sources used to evaluate the effectiveness of the project and document success include surveys, pre- and post- test results, standardized test results, focus groups, targeted interviews, and digital portfolios. The evaluation process is designed to not only describe and evaluate what occurs, but to explain what succeeded and why. This information offers the greatest potential to transform learning and improvement achievement.

Evaluation instruments track and measure:

- Student achievement indicators in math and science
- Students' awareness of STEM careers and college preparation requirements
- Families' participation in science activities and attitudes toward and comfort with STEM
- Youth workers' comfort with teaching inquiry-based science
- Activities contributing to sustainability
- Effectiveness of capacity building activities
- Quality and quantity of professional development

SISERP: Current Program Results[1]

Utilizing the SISS curriculum, the most current SISERP program is founded on an educationally sound gender equity science program. The SISS program curriculum is designed as a 3-year intervention involving 529 girls from six middle schools, their teachers, college students, minority athletes, and mentors. It offers a second level of intervention in the middle schools for the elementary girls involved in the SIS program in the fourth and fifth grades. Findings over the past two years show that the girls in the program have increased their interest and achievement in science and mathematics and have noted the relevance of these subjects to the sports in which they have participated to date.

[1] Data is available for the other SISERP components.

Table 1: Sisters in Science Pre- and Post-test Mean Scores and Standard Deviations

Sport/Science	N	Pre-test m	SD	Post-test M	SD	GAIN*
Basketball/Motion	32	27	16.5	77	23.3	50
Fencing/Forces	40	39	21.4	86	14.2	48
Golf/Mechanics	50	34	19.4	93	8.6	59
Soccer/Mechanics/Engineering	35	28	19.0	88	12.2	60
Tennis/Geometry	52	29	22.1	84	17.3	55
Track (Field)/Aerodynamics	33	36	22.3	90	12.5	54
Track (Running)/Biomechanics	42	33	15.5	60	18.7	28
Volleyball/Aerodynamics	48	28	19.4	77	22.5	49

The sports science curriculum is standards based and has an equitable focus. The entire curriculum includes 40 activities driven by science and mathematics standards that feature a sport as the vehicle through which science or mathematics is learned. Pre-tests were administered at the beginning of the day's activity, and post-tests were administered at the conclusion of the day's activity. The pre-tests and post-tests were identical instruments. Four questions were asked for each activity. The students' responses were open-ended, allowing the girls to express their understanding of the content. Each question was scored as correct or incorrect.

Gain scores were analyzed using a simple *t* test. Based on raw scores, the percentage of correct responses was used as the measure. The data consistently show statistically significant mean increases in content knowledge from pre-test to post-test, ranging from 28 to 60 percentage points ($p<.001$ or $p<.0001$ in each case). Looking at these gains in a different way, in every case, the lower quartile on the post-test exceeded the upper quartile on the pre-test. All results from the after-school program and Saturday academies are summarized in Table 1.

Report card grades from the first and last marking periods were also compared. The *t*-test results showed that the girls' achievement in both science and mathematics increased significantly ($p<.05$) during the year, pre to post.

Finally, it is important to note that of the sixth graders who completed the program, 67% returned as seventh graders. Furthermore, 54% of all students who completed the seventh-grade program returned to participate as eighth graders. These retention rates speak volumes about the students' attitudes toward the program.

Conclusion

SISERP concentrates on the need for urban females' to gain access to quality STEM education by utilizing a variety of approaches to foster gender equitable science education. Specifically, this need is based on the rising public concern over the equity gap in STEM education; recognition of the significant impact intervention programs targeting urban girls have on school success; and the call for systemic educational reforms that recognize the obstacles minority females face in the academic and professional STEM arena. SISERP programs respond to the call for systemic educational reform by creating innovative programs that provide access to strategies furthering gender equitable science education.

References

American Association of University Women (1998). *Separated by sex: A critical look at single-sex education for girls*. Washington, DC: Author.

Hammrich, P. L. (2002). Gender equity in science and mathematics education: Barriers of the Mind, In J. Koch & B. Irby (Eds.), *Defining and Redefining Gender Equity in Education*. Greenwich: Information Age Publishing, 81-98.

Kruschwitz, K., & McClintock, P. C. (1994). What works for girls: Teaching math and science in an all-girls setting. *Independent School*. 12-20.

Tolley, K. (2003). *The science education of American girls: A historical perspective.* London: Routledge Falmer.