The Sisters in Science Equity Reform Project

Science Education

Equity

Learning Environments

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Description and rationale for format of proposed session

The proposed format is a paper session that describes the *Sisters in Science Equity Reform Project* that was conceived over the past 8 years to increase the interest and literacy of elementary and middle school age females in science and mathematics. In 1994 the *Sisters in Science* program was conceived to reach out to 4th and 5th grade girls to enhance their achievement in science and mathematics. Over the past 5 years the schools involved in the program have seen their Stanford nine science and mathematics scores increase significantly each year. In 1999 the *Daughters with Disabilities* program was established. This is a mirror program to the original *Sisters in Science* program however it targets a more inclusive approach including students with and without disabilities. The latest program that was developed from the original *Sisters in Science* program is called *Sisters in Sport Science*. The program focuses on using sports as a vehicle for science and mathematics achievement in the middle school. The girls who have participated in the program have seen their math and science grades increase significantly. Each year these three programs combined reach about 50 classrooms in 12 schools impacting approximately 500 – 750 students a year.

Perspectives or theoretical framework

While legal barriers to achieving gender equity have been removed, there are often barriers we still face. These are barriers of the mind. As Shirley M. Malcolm, of the American Association for the Advancement of Science (AAAS), said in her keynote address at the American Association of University Women (AAUW) conference "Girls Succeeding in Science, Math, and Technology: Who Works and What Works,"

> The effort to equalize educational opportunities for girls is far from complete. [She notes], 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." (Malcolm, 1997).

Many barriers still exist that prevent females from participating fully in science and mathematics throughout their lives. Some of these barriers include the organizational characteristics of mathematics and science, females' perceptions of mathematics and science, and still others come from outside influences such as parents and teachers lack of encouragement in exploring fields such as math, science, and technology (AAUW 1990, 1992; Kahle & Meece, 1994; and Baker & Leary, 1995). Reformists believe that fostering a safe and nurturing environment, promoting problem-solving skills, creating collaborative experiences, using hands-on learning, and allowing for open discussion about gender stereotypes are essential to encourage female students' success in science and mathematics (Allen, 1995; Mann, 1994).

Design

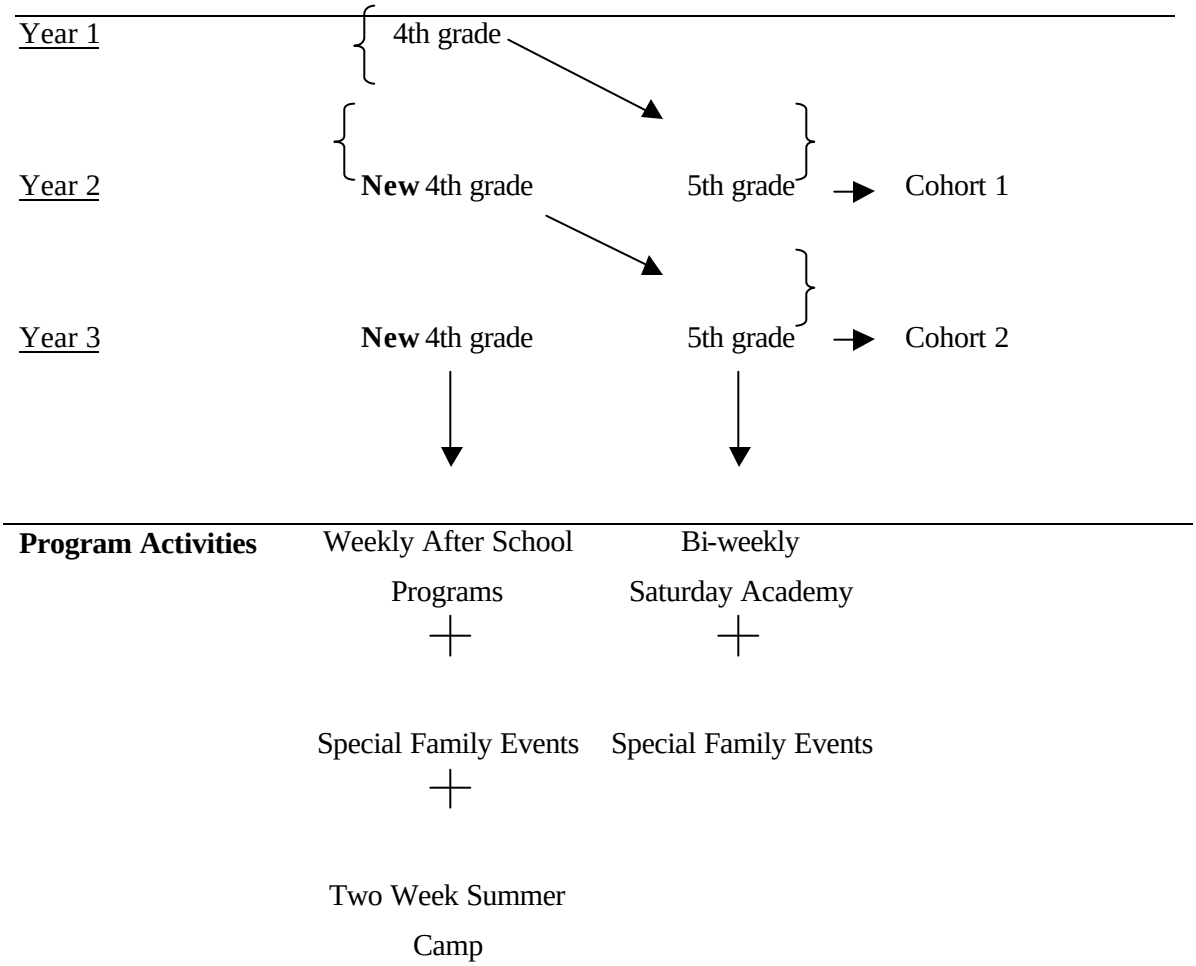
In the context of broadening the concept of teaching and learning for all students by uniting the active participation of parents and intergenerational role models with other factors that promote females' success in science, the Sisters in Science Equity Reform Project waas conceived. The project contains three programs sponsored by the National Science Foundation: *Sisters in Science (SIS), Daughters with Disabilities (DWD), and Sisters in Sport Science (SISS).*

The ***Sisters in Science (SIS)*** program is a two-year intervention designed to address the achievement inequities in mathematics and science for females. In year one, fourth-grade female students, their teachers, and families participate in the program. In year two, the fourth graders now fifth graders continue to participate with their fifth grade teachers. A new group of rising fourth grade girls begins the first year of the program in anticipation of participation in the two-year intervention

The SIS program offers a multileveled intervention centered on the constructivist learning model. To this end, cooperative exploratory hands-on science and mathematics education tasks along with self-reflection are employed to facilitate learning. Within this

framework of constructivist learning, the SIS program was designed to provide instructional methods that demasculize and demystify science and mathematics, promote women role models and career information, and allow for active involvement in a "female friendly" environment. While girls are "doing" science and mathematics their self-confidence and self-perceptions of their ability to do science and mathematics is enhanced (Hammrich, 1997).

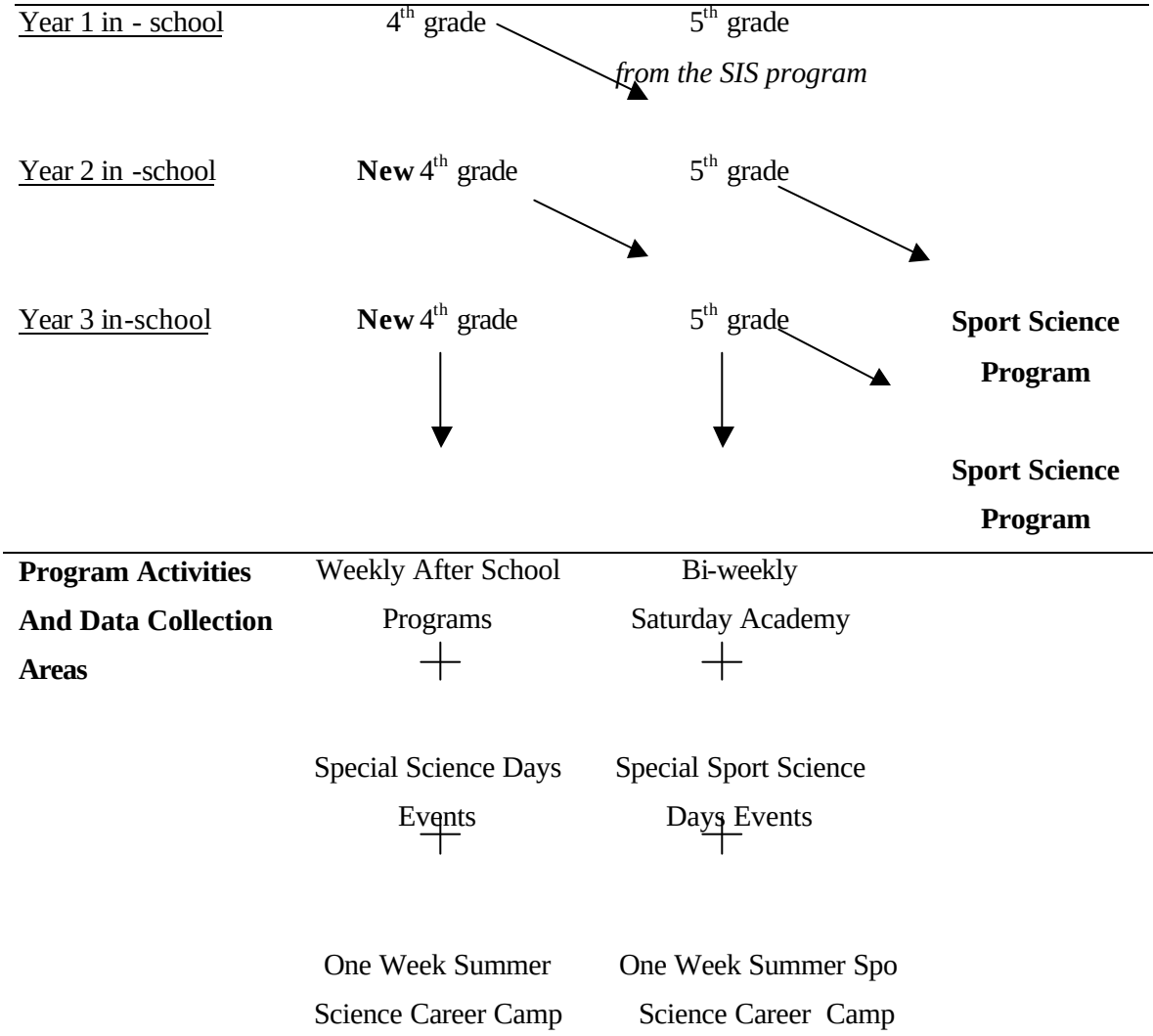
Figure 1. Two Year SIS Intervention Model



The second program, ***Daughters with Disabilities (DWD),*** was developed in 1998 to complement the SIS program. DWD represents a horizontal expansion of the SIS program to include girls with and without disabilities to provide for a more inclusive approach to education. The DWD program provides a two-year intervention (see Figure 2) for 4th and 5th grade girls with and without disabilities over a three-year period. The two-year intervention expands program activities that are conducted in the SIS program

to include girls with disabilities. The program also provides a sagway into the middle school *SISS* program.

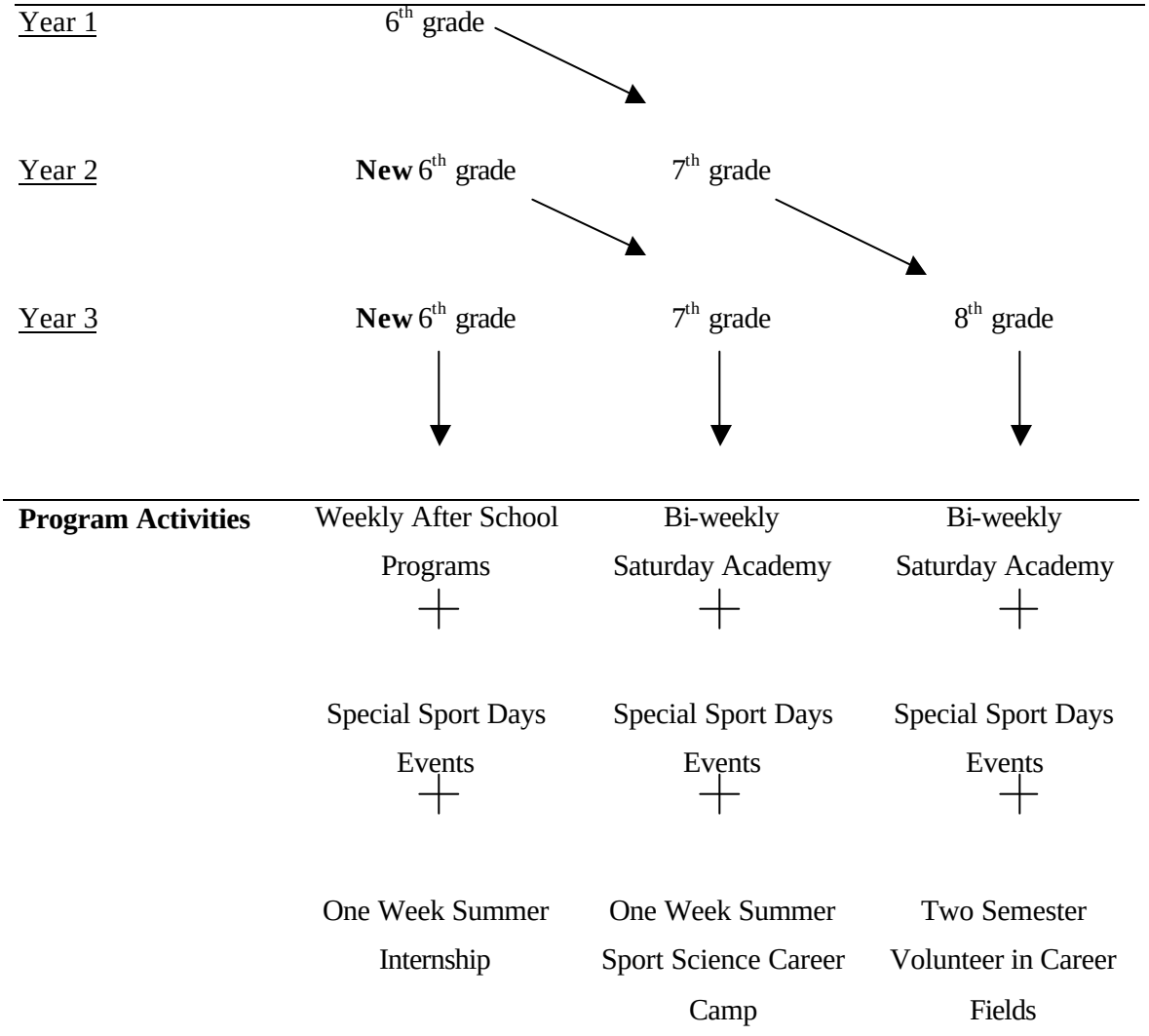
Figure 2. Two-Year Intervention Model Conducted over Three Years



The third program is Sisters in Sport Science (SISS)**,** which was started in 2000. SISS represents a vertical expansion of SIS to provide a longitudinal intervention at the 6^{th}-8^{th} grade levels. SISS supports and furthers the vision created by SIS in providing mathematical and scientific concepts through the vehicle of sports. In doing so, the program is successfully reaching girls on multi levels of intelligence's and strengthen the education of students in science and mathematics by creating an unique and diverse atmosphere.

The *SISS* program is designed as a three-year intervention involving middle school girls from six middle schools over a three-year period (see Figure 1). The focus is on providing a longitudinal intervention at the middle school level that expands on the efforts of the *SIS and DWD* programs, which targets the elementary level.

Figure 1. Three Year SISS Intervention Model



Method and Results

Sisters in Science

With respect to the SIS program analysis was primarily quantitative. Pretest-posttest comparisons were done at each grade level for the Science Attitude Scale, the DAST, and the achievement test. T-test for independent samples were performed for the attitude scale and the achievement test, while percentages were used to determine differences in perceptions on the DAST. The student data was analyzed in two cohort years (4^{th} and 5^{th} grade).

Results of the Science Attitude Scale showed that the girls attitudes toward science and the possibility of pursuing a career involving some aspect of science and/or mathematics were positive before program implementation. Anecdotal information regarding the girls revealed that while they enjoyed science and perhaps someday wanted to become a doctor or have a career in science, they were not aware that it was necessary to take science classes in the future. Therefore their attitudes did not match their understanding of how science courses fit into their eventual career path. However, their expressed positive attitude towards science is consistent with the research that states girls at this age level tend to enjoy science (AAUW, 1992). In the 5^{th} grade of each cohort year the fifth grade girls attitude continued to be positive and significantly higher than the fourth grade girls attitude. This maybe due to the fact that these fifth grade girls participated in fourth grade and chose to participate again in year two in the fifth grade.

The students perceptions for each cohort were measured by the Draw a Scientist test (Mason, Kahle, & Gardner, 1989). On both the pre and post tests for each cohort year a majority of the girls drew female scientists. There was no significant change.

Results from the science/mathematics process skills instrument in cohort one indicated a mixture of statistically significant changes for the girls participating in the program. This was a combination of small losses and small gains for the six schools involved. We entered each school with a commitment to service all 4^{th} grade classrooms. Therefore no control groups existed within the schools. In other words no "control vs. experimental' group analysis was warranted. Clearly, to the extent that the instrument was appropriate to the problem, a majority of the outcomes did meet the expectation of an increase in the science process skills. Of the skills tested, all of them appeared in the fourth and fifth grade Philadelphia curriculum.

Achievement was also measured using the grade four Stanford Nine science scores. All six schools 4th grades tested at each school saw an increase in their scores over the years of SIS intervention.

Daughters with Disabilities

The DWD program is in its third year of implementation. Over the course of the three years 28 girls in fourteen classrooms from five schools have been actively involved in different aspects of the program. In year one we found that the girls had difficulty with the assessment instruments used in SIS. Therefore, a single instrument was devised that is a simplified version of the three instruments used in SIS. The instruments was shortened and had a more appropriate reading level for the population being served.

While no pre or post test comparisons were made of the students' responses, what was evident was they all tended to have relatively positive attitudes about science and mathematics but lacked any real concrete experiences with the subjects. This insight was not just evident in the student responses by validated insights developed on sight visits and conversations with teachers.

Unlike the prior program, SIS, the DWD program experienced struggles with issues regarding access to students and other logistics. Finding reveal that there was an average of less than 2% of students in the special education classrooms that were female. In addition, we found a few classrooms where there were no girls at all in the designated special education classes; we also found that a few, if any, of the students had sensory, physical or significant disabilities. In fact, the vast majority of all students seen in the special education classes had mild learning or behavior disabilities. We also noticed that many of the special education teachers served as gatekeepers in deciding which girls were good candidates for the program. Hence, we sought to change the teacher attitudes. In year two we combined the efforts of the DWD and SIS programs to create a unique inclusive approach. This approach lead to more participation of the students and teachers.

Sisters in Sport Science

The specific outcome improvement sought by the SISS program were in the areas of attendance, parental awareness, grades and self-esteem. Of the parents surveyed prior

to and after their daughters' participation in the program, parents increased their awareness by 60^ (33% awareness at the beginning to 83% at the end of the year). At the beginning of the program we had 89 girls registered with 88 attending regularly. We saw additional students participating throughout the year with an average of 80% of the same girls participating throughout the program.

The SISS program is in its second year of implementation. Findings to date show that the girls in the program have increased their interest and achievement in science and mathematics and the relevance of science and math to the sports in which they have participated in so for within the program. For example, eighty percent of the respondents could remember scientific facts that were learned during the program sessions. Respondents mentioned facts about angles, measurements, reflection, and awareness of careers in science. Seventy percent of the respondents felt that the SISS sessions reinforced the science instruction that they had received in school from their teachers. One hundred percent of the respondents felt that learning the sport was what they liked most about the program. The girls in the program have an increased understanding of science and math learning and see the relevance of science and math to their everyday lives. Informal conversations also show an increase in girls' awareness of careers in science and sports. More specifically, T-test results showed that the girls achievement scores in both mathematics and science increased significantly ($p < .05$) during the year pre to post.

Implications

All three programs seek to break barriers girls face in their interest and achievement in science and mathematics by creating a more positive learning climate for girls and their families, and increasing the knowledge base and understanding of parents with respect to their influence in promoting girls' interest and achievement in science and mathematics. The SIS is showing the most powerful results, now in its eighth year of implementation, while the DWD program remains challenging for gaining access and logistical concerns. The most recent program SISS is looking promising given the data during the first two years.

While programs that address the equitable achievement for all students in science and mathematics are not new, these three programs are working in collaboration to create an inclusive longitudinal intervention that allows the girls to continue in programs aimed at helping them succeed in science and mathematics. It will also allow the researchers to longitudinally track girls who participated in SIS or DWD and then continue to participate in the SISS program creating a second level of intervention or double treatment.

In conclusion, one project or one group of committed science, mathematics, or special educators alone cannot tear down all of the barriers for girls with or without disabilities in the areas of science, mathematics, and technology. One set of dedicated teachers, mentors, or undergraduates by themselves cannot change the often negative course of employment or postsecondary education for future female scientists or mathematicians. But these projects are clearly a start. On-going, proactive involvement by the girls themselves can both teach important science and mathematics skills, while simultaneously expanding new horizons through early awareness.

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