Sisters in Science in the Community: An Informal Gender Equity Program

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Sisters in Science in the Community: An Informal Gender Equity Program
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SUMMARY: An article about the Sisters in Science in the Community™ Program.

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Introduction

Despite considerable attention in the last decades to the gender gap in attitudes and achievement in science and mathematics, girls continue to lag behind boys (Tolley, 2003; AAUW, 2004). Further, because of No Child Left Behind imperatives, the nation is once again confronting its high school dropout problem. Recent scholarly research has shown that across the nation 20-30% of the students entering ninth grade in any given year never receive a regular high school diploma. In schools with high proportions of low income and/or minority students, the dropout rates are often much higher. Research has also shown that dropout rates have not fallen in recent decades despite large increases in education expenditure per student and changes in the economy which make dropouts increasingly unemployable. The truth about the nation's chronic dropout problem was hidden for many years by inaccurate reporting. Now, however, the issue is near the top of the nation's education agenda. Recently, it was the subject of a *Time* magazine cover story and also the focus of a highly publicized research study funded by the Gates Foundation entitled *The Silent Epidemic (*Gates Foundation, 2006*)*.

A significant finding of the Gates Foundation study is that the majority of high school dropouts leave school not because they are failing academically, but because they have lost the motivation to continue. This project seeks to strengthen this motivation by making clear to students the connection between the world of school and the world of work. The project plans to provide students with education career information and guidance, the opportunity to develop plans and work closely with an adult who takes an informed professional interest in their current and future opportunities. These are interventions recommended by the Gates Foundation study to ameliorate the dropout problem. Many at-risk students do not hear the message that it is important to do well in school or some think that it does not apply to them. These students do not see the connection between their school performance and their future educational or career success. In fact, many in this target group misperceive a number of critical elements: 1) They believe that desirable jobs are within their reach whether or not they graduate; 2) They believe that they must have some singular lack of capacity to learn since they experience low test scores, and their parents (who often had similar experiences) tend to accept the test results; 3) They fear that if they make extra effort they will lose status in their peer group.

Gender Equity in Science Education: The Current State

The U.S. Department of Education established an ambitious testing plan beginning with mathematics and reading and then adding science (U.S. Department of Education, 2004). The federal government has committed to closing the achievement gap by improving teacher quality and implementing effective educational programs. Funds were made available for the professional development of pre-service teachers (U.S. Department of Education, 2004).

Unfortunately, conditions of many urban schools and the surrounding neighborhoods are appalling (Kozol, 2000). Lifelong learning in science, mathematics, and technology is impossible when students in urban school systems have no access to the internet and fewer textbooks, manipulatives, and science equipment than suburban students. In particular, females, minority students, and students from low socioeconomic backgrounds confront great structural challenges in choosing and performing well in the science, mathematics, and technology fields (Hammrich, Richardson, & Livingston, 2000; Schnorr & Ware, 2001).

For students and teachers with limited access to science exploration, innovative programs must provide an opportunity to examine hands-on science with the newest and most advanced science, mathematics, and technology resources. An awareness of cultural differences, including learning style, and relevance to real-world experiences are essential to the format, organization, and content of an effective program (Nieto, 2003).

Challenge: Barriers of the Mind

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

> 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" (Malcolm, 1997).

These "barriers of the mind" stem from a number of factors. Among the numerous factors are the organizational structure of scientific and mathematics instruction, females' perceptions of science and mathematics courses, parents' and teachers' lack of encouragement, authority figures' attitudes toward science, and the lack of support for females in science-based careers (Northrup, 2003). Researchers 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.

Challenge: Gender Gap and Science Education

The organizational structure of current science instruction plays an important role in diminishing the resilience of females in science. 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 (Clewell & Campbell, 2002). 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 (AAUW, 2000).

Researchers have reported that girls and boys have vastly different formal and informal science experiences that contribute to the gender gap in science achievement (Linn, 1990). There are indirect and direct experiences that contribute to such differences (Kahle & Meece, 1994). Despite having preparatory experiences fairly dissimilar to boys, some girls succeed academically in science regardless of the hindrances they face (Richardson, Hammrich, & Livingston, 2003).

Challenge: Gender Bias and the Education of Urban Teachers

In addition to gender, race, and quality of education, another challenge female students must overcome is the effect of classroom teachers' perceptions of gender. Female students continue to struggle against considerable gender inequities within the educational system (Jones, et.al., 2000). Stereotypical practices concerning females and males are second nature to many teachers.

Unfortunately, on average, pre-service teachers participating in teacher education programs spend less than 2 hours per semester discussing issues surrounding gender equity in the classroom (Stilles, 2002). 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 (Jones, et.al., 2000).

As proposed by Tharp, Estrada, Dalton, and Yamauchi (2000), five standards are necessary to improve achievement of students from culturally, ethnically, and economically diverse backgrounds. These standards are: 1) Teachers and students producing together; 2) Language and literacy development; 3) Making meaning by connecting schools to students' lives; 4) Teaching complex thinking; and 5) Teaching through conversation. Research findings show a consistent, positive relationship between classroom implementation of the five standards and an increase in student test scores (Doherty, Hilberg, Pinal, & Tharp, 2003).

Unique Features of the Program

The Sisters in Science in the Community (SISCOM) program, developed with NSF funding over a ten year period, is composed of a base program and associated subcomponents. The base program was developed as an in-school science program for middle school students. Among the subcomponents was the inclusion of sports applications to science as a means of increasing student interest, modification of the program as an out-of-school based in community organizations, and a career information based program. The SISCOM program addresses the rising public concern over the equity gap in science and mathematics; recognition of the significant impact informal science education programs targeting urban girls have on school success; and the call for systemic educational reforms that recognize the limits minority girls and girls with disabilities face in post secondary education and employment opportunities in these fields.

The SISCOM program uses sports applications as the context through which scientific and mathematical principles can be explored and explained. Thus, girls learn the underlying principles of science and mathematics embedded in the mechanics of performing a sport in a context that embraces the psycho-social-emotional connection to learning. For instance, each day, outside of the school setting, girls learn how to ride a bike, throw a ball, and/or jump rope. What they are not aware of are the scientific and mathematical principles laden in performing these activities. In the classroom, girls learn these scientific and mathematical principles in a context that is foreign to their everyday experiences. They learn about the trajectory of a golf ball without connecting this principle with the actual practice of hitting a golf ball. Community/family settings provide an environment that is non-competitive and non-threatening academically. What is unique to the concept of SISCOM is that the academic and the everyday experiences of girls can be bridged in a community environment. To this end, the teaching and learning process embraces both academic principles of learning and the psycho-social-emotional process of learning. The result is a sum greater than that of the parts.

Sports provide a unique and innovative approach to reaching girls in a friendly atmosphere. The AAUW (1998) publication *Gender Gap: Where Schools Still Fail Our Children* suggests that “Sports participation in general is linked not just to higher academic achievement but also to better physical and mental health and greater leadership capacity” (p. 74). Combined with the positive aspect of sports, the growing literature on neighborhood youth programs suggests that after-school activities provide adolescents with places where they can feel safe from the pressures of their families, schools and their sometimes dangerous neighborhoods (Halpern, Barker & Mollard, 2000; McLaughlin, Irby, & Langman, 1994; U.S. Department of Education, 2004).

A second unique feature of SISCOM is the focus on middle and high school science and mathematics. It responds to a dearth of attention to this level in public schools and fills a gap in the relevant literature. Middle and high school students often experience a drop in grades due to lack of organizational skills and difficulty adjusting to the requirements of several teachers. Girls and minority youth in the middle and high school years tend to struggle with self-esteem, physical fitness, skill development, goal setting, and problem solving. Sports are one ideal mechanism to empower girls and minority youth during these uncertain years to explore their self-identities. Research links physical activity for girls to higher self-esteem, positive body image, and lifelong health (AAUW, 1998, p. 20) and "... involvement in activities valued by school (athletics and the arts) leads to higher self-esteem, positive attitudes toward school, and less self-destructive behavior."(AAUW, 1998, p.77). By using sports as a vehicle for learning scientific principles, the SISCOM program responds to the call for creating innovative programs that provide access to the latest strategies in promoting science literacy in urban communities.

A third unique SISCOM feature is its efforts on truly inclusive STEM education that transfers from the regular and special education classrooms into the community and beyond. Historically, two critical barriers have challenged children with disabilities: their lack of appropriate science and math education in their home classrooms and their increasing sense of isolation and loneliness when leaving the protected school environment. While families and teachers try to emphasize recreation and leisure for students with disabilities, these are the same children who never are asked to participate in neighborhood activities or chosen for after-school sports. In fact, the primary concern reported by adults who have grown up with disabilities is a pervading sense of isolation and loneliness. SISCOM is a proactive effort to change that while also sparking academic achievement and future STEM careers.

Modes of Inquiry

Through use of minority athletes, university undergraduate and graduate students, and community based staff, SISCOM provides a weekly after school program, special Saturday sports events, and summer internships for sixth grade girls, bi-weekly Saturday Academies and career camps for seventh grade girls, and academic research internships for eighth grade girls. The sixth grade curriculum features science activities linked to tennis, fencing, basketball, and golf. The seventh grade units are centered on track and field, volleyball and soccer. All sport science activities are matched to the AAAS Benchmarks and state specific science and mathematics standards, and have an equity focus.

Project Results

The goal of the SISCOM program is to improve science achievement of economically disadvantaged middle school students in science, through the development, implementation, and dissemination of a replicable, model program for use with underserved youth, especially girls, in informal educational settings. A number of programs and interventions geared toward bolstering the STEM interest and achievement of urban youth have been implemented across the country. Key elements that have proven to be successful have been incorporated into the SISCOM program include the longevity of intervention, fostering community relationships, inquiry-based lessons that relate directly to students' lives, and student access to caring adults and non-stereotypical role models.

Data Collection Issues

The program participants proved to be a highly mobile group both within a year as well as between years. Compounding the problem was the fact that the community workers were committed to implementing the program, sometimes at the expense of data collection. In too many cases survey and pretest data were not collected from students joining the program after the data had been collected. The community workers felt that integrating the new participants into the program was more important than collecting the data. In support of the community workers' position is the fact that some of the participants did not join until the end of the program making their responses difficult to integrate with those for whom data were collected at the beginning.

In all, there were 44 participants for whom survey data were not collected. Pre Science tests were collected for some of these participants. In addition, survey data were collected for some participants for whom test data were not available.

The 43 students for whom there were incomplete data, 114 students participated in one year of the program, 23 in two years, and six in all three years. In all, there were 91 participants in Y1, 68 in Y2, and 41 in Y3. However, while the Y1 on-site program managers were enthusiastic about program implementation, they were the worst in terms of data collection.

Initially 83 students participated in the SISCOM program in five sites located in Philadelphia. Baseline surveys were collected from 74 (89.2%) of the program participants. Of those for whom there was completed baseline surveys, the participants ranged in age from 9 to 16 years with more than half of them being 12 or 13 years old (55.4%). While these participants attended grades 3 through 9, almost half were in grade 6 (45.2%). The majority of the program participants were girls (74.7%). All of the participants were from a racial or ethnic background with the majority being African American (58.1%).

Educational Expectations and Perceptions of Educational Expectations

Two points need to be made about the students' educational expectations and what they think their parents expect. First, program participants have very high educational expectations with 73% of them expecting to at least graduate from a 4 year college. Second, 24.1% of the participants did not know what their mother expects of them and 20.5% or what their father expects. For those who did indicate what they thought their parents expect, 67.8% thought that their mothers expected them to be at least a college graduate and 71.3% thought that their fathers expected them to be at least a college graduate. When asked about how important it was to get good grades, 86.8% responded that it was important or very important.

Academic Self-Concept

The program participants were asked 24 items relating to academic self-concept. The mean score on this scale was 7.7 although the median was 4. Of the items in this scale, one-third of the participants agreed with the statement "people are born with mathematics ability." This figure was three times that for any of the other items (see Appendix A: Academic Self-Concept for further details).

Student's View on Why it is Important to Go to School (Appendix B)

The students were asked to indicate how important nine items relating to why it is important to go to school. Scores on this scale ranged from 0 to 7 with a mean of 3.83. Again, the relatively low percentages are noteworthy. While parental expectations to succeed and personal satisfaction were cited by a higher percentage of the program participants than any of the items, both of these percentages were just over 50%. Nonacademic reasons ("I have nothing better to do," "It's a place to meet my friends," and "I play on a team or belong to a club") were cited less frequently than the more academically focused reasons. Teachers do not appear to play a significant role as might be expected. The relatively low percentage of the students who felt that what they learn in school is related to future job options is both low and characteristic of students their age in general (Wimberly and Noeth, 2005).

External and Internal Support for Doing Well in School is Important

The program participants were asked a series of questions about the importance of learning science from their own perspective, from what they perceive their mothers' views to be, and from what they perceive their friends' views are (see Table 1). Three scales, each composed of five items, were constructed and tested for reliability (see Appendix C: External and Internal Support for doing Well in School for further details). On the average the students' scores were the highest (x = 2.7) and their friends' the lowest.

Table 1

Summary Statistics for External (mother and friends) and Internal (program participant) Support for Doing Well in School

Scale Name	Scale Content	Mean	St. Dev	Cronbach's α*
Student Supports Science	Student's perception of importance of science	2.7	2.03	0.875
Mother Supports Science	Student's perception of mother's support of importance of science	2.27	1.81	0.802
Friends Support Science	Student's perception of friends' support of importance of science	1.52	1.7	0.794

***** Cronbach's α ranges from 0 to 1. The closer the value is to 1, the higher the reliability of the scale.

Why School is Important

The students were asked a series of questions relating to why they thought it was important to go to school. On the whole, the responses were a bit discouraging (see Appendix B: Student's View on Why School is Important for further details). Only two responses received more than 50% of the program respondents citing them as important reasons for going to school. It is readily apparent that parental expectations are very important as this item was cited by more respondents as important than any of the other items. Personal satisfaction received the second highest percentage. "School is not a place to meet friends" was cited least often by the program participants. Did the program participants feel that this was an inappropriate response? Are the program participants reacting to the emerging view that school is "work" and not a place for fun?

Why is it Important to Learn Science?

Students were asked about why they felt it was important to learn science (see Appendix D: Why it is Important to Learn Science for further details). There are two interesting points to be made about the students' responses. First, the percentage of students who felt strongly about any of the items was less than 30%. Second, the percentage of the students who responded positively was remarkably similar across the items.

Positive Attitude about Science

The students were asked sixteen questions designed to capture their attitude about science, the usefulness of science, and their attitude toward learning science. On this sixteen point scale, which had a reliability of alpha = .802, the mean was 6.78 with a range of 0 to 13 (see Appendix E: Positive Attitude about Science for further details). The items most highly correlated were "I am good at science" and "I like science" (r = .675) and "I am good at science" and "I want to get a job in science" (r =.569).

Parents

The program participants appear to have relatively supportive parents in that 48.2% of the participants reporting talking about school and school issues more than once a week at home. However, on the Parent Involvement Scale, where participants were asked to report on seven areas on whether or not their parents either helped them or limited their activities in the face of poor grades (see Appendix F: Parent Involvement Scale for further details), the mean parental involvement score was 1.86. Also, it appears that parents are more apt to reward good behavior and are less apt to impose limitations (i.e., amount of television watched or time "out" on school nights).

Classroom Contexts

The students were asked about 19 different "contexts" they may have experienced on a regular basis in their science classrooms ranging from watching experiments to performing experiments, from taking notes from material written on the board to making presentations. On average, the students reported experiencing from none to all 19 of the items. The mean was 6.4.

An interesting pattern results when the data are sorted by the percentage of students indicating that the activity is regularly done in their science classrooms. Four of the five lowest percentages are related to technology. The five items with the highest percentages pertain to traditional teacher practices. It is the sixth lowest item that should be of concern to anyone focused on student achievement. Three-quarters of the students report that they are not tested or quizzed on a regular basis.

Table 2

Science Classroom ‘Contexts” Sorted by Reported Use percentages

We use computers.	16.9%
We use calculators.	18.1%
We check each other’s homework.	22.9%
The teacher uses a computer to demonstrate ideas.	24.1%
The teacher uses an overhead projector.	25.3%
We have a quiz or test.	26.5%
We work on science projects.	26.5%
We can begin our homework in class.	27.7%
The teacher gives a demonstration of an experiment.	28.9%
We use things from every day life in solving science problems.	31.3%
We ourselves do an experiment or practical investigation in class.	31.3%
We discuss our completed homework.	34.9%
We work from worksheets or textbooks on our own.	38.6%
We work together in pairs or small groups.	39.8%
The teacher uses the board.	41.0%
The teacher shows us how to do science problems.	42.2%
The teacher checks homework.	44.6%
The teacher gives us homework.	45.2%
We copy notes from the board.	45.8%

On a gross level, these percentages do not differ significantly from year to year.

Summary

Student gains: By and large, students showed positive results from participation in the program in that 77% maintained or improved their self-confidence. Participants are entering adolescence when peer pressures exert strong pressure for self-doubt.

Science knowledge: A pretest of the participants’ science was administered before their participation in the SISCOM program. The pretest consisted of 30 items taken from a recognized middle school science test. In Year 1, participant scores ranged from 3 correct answers to 18 correct answers. The mean number of correct answers was 9.37. Almost one-third of the participants scored between 8 and 10 correct answers. Of the students who participated in both Year 1 and Year 2 of the project and who took the science knowledge tests in both years, **ALL** demonstrated higher scores on their Year 2 tests ranging from a 7.6% increase to a 48.1% increase with 50% experiencing a 30 percentage point gain or more

Student participation: Recruitment did not pose a problem. Despite the changes in venues, student participation rates remained healthy. However, attendance and retention were issues. Getting students to attend the program sessions proved to be a problem. During fall 2005, on average, students attended 59.8% of the sessions. In spring 2006, the percent rose very slightly to 62.8%. Cognizant of the problem, SISCOM staff had the community workers meet the students at convenient locations and transport them to the events. Despite their best efforts, some students simply could not make it.

Of the 91 students who participated in Year 1, only 17 continued in Year 2, and of these 17 only 6 continued in Year 3. However, given the life conditions these economically disadvantaged students face, to have 7% participate in a voluntary, out-of-school program that was forced to move sites is significant. Further, almost 20% of the students participated in two years of the program (Y1-Y2 and Y2-Y3). These percentages are conservative in that they do not include those 43 students from whom there were incomplete data.

Community workers: There were significant improvements in how the community workers implemented the program – both data collection and activities. The manual of activities and protocols developed in the project demonstrate the viability of a model that can be implemented in other venues.

Conclusions

What remains to be seen is what happens to these participants in the long run. It is expected that while the higher achieving students continue to do better as an absolute measure, the gap between those students at the higher end of achievement on the baseline science test and those students at the lower end of this test will close. It is NOT expected that the gap will be eliminated, however, because higher achieving students will continue to grow. The gap would only close if the lower achieving students improved and the higher achieving students remained the same. It is expected that the SISCOM program will have a positive effect on all of the participants.

Appendix A

Academic Self-Concept

Most people can learn to be good at math.
You have to be born with the ability to be good at math.
I'm confident that I can do an excellent job on my math tests.
I'm certain I can understand the most difficult material presented in math texts.
I'm certain I can understand the most difficult material presented in English texts.
I study to get a good job.
When I sit myself down to learn something really hard, I can learn it.
I'm confident I can understand the most complex material presented by my English teacher.
When I study, I make sure that I remember the most important things.
I study to increase my job opportunities.
I'm confident I can do an excellent job on my English assignments.
When studying, I try to work as hard as possible.
I'm confident I can do an excellent job on my English tests.
I'm confident I can understand the most complex material presented by my math teacher.
I'm certain I can master the skills being taught in my English class.
If I decide not to get any bad grades, I can really do it.
When studying, I keep working even if the material is difficult.
I study to ensure that my future will be financially secure.
If I decide not to get any problems wrong, I can really do it.
I'm confident I can do an excellent job on my math assignments.
When studying, I try to do my best to acquire the knowledge and skills taught.
If I want to learn something well, I can.
I'm certain I can master the skills being taught in my math class.
When studying, I put forth my best effort.

Mean: 7.70 Standard Deviation: 7.27 Range: 1 - 24 $\alpha = .946$

Appendix B

Student’s View on Why School is Important

I go to school because I think the subjects I'm taking are interesting and challenging
I go to school because I get a feeling of satisfaction from doing what I'm supposed to do in class
I go to school because I have nothing better to do
I go to school because education is important for getting a job later on
I go to school because it's a place to meet my friends
I go to school because I play on a team or belong to a club
I go to school because I'm learning skills that I will need for a job
I go to school because my teachers expect me to succeed
I go to school because my parents expect me to succeed

Mean: 3.42 Standard Deviation: 2.69 Range: 0 - 9 $\alpha = .817$

Appendix C

External (Mother and Friends) and internal (Student) support for "Doing Well in School"

Do well in science at school
Do well in mathematics at school
Do well in English at school
Have time to have fun
Be good at sports

Mother	Mean: 2.27	Standard Deviation: 1.81	Range: 0 - 5	α = .802
Friends	Mean: 1.52	Standard Deviation: 1.68	Range: 0 - 5	α = .794
Student	Mean: 2.70	Standard Deviation: 2.04	Range: 0 - 5	α = .875

Appendix D

Student's View on Why it is Important to Learn Science

To get the job I want.
To please my parents
To get into the high school or university I prefer.
To please myself.

Mean: 1.33 Standard Deviation: 1.44 Range: 0 - 4 $\alpha = .758$

Appendix E

Positive Attitude About Science

I enjoy learning science
Science is boring.
Science is an easy subject
Science is important to everyone's life
I would like a job that involved using science.
I like science.
I am good at science.
I understand most of what goes on in science class.
There is only one correct way to solve a science problem.
Learning science is mostly memorizing facts.
Science is useful for solving everyday problems.
All students can do well in science if they try.
I would like science much more if it were not so difficult
Although I do my best, science is more difficult for me than for many of my classmates
Nobody can be good in every subject, and I am just not talented in science
Science is not one of my strengths

Mean: 10.16 Standard Deviation: 3.19 Range: 0 - 15 $\alpha = .813$

Appendix F

Parent Involvement Scale

Check on whether you have done your homework.
Help you with your homework.
Give you privileges as a reward for good grades.
Limit privileges because of poor grades.
Require you to do work or chores.
Limit the amount of time watching TV/playing video games.
Limit the amount of time going out with friends on school nights.

Mean: 1.87 Standard Deviation: 2.15 Range: 0 - 7 α = .818

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