



## **The Issue of Under Representation of Women in Science and Mathematics**



Swapnil Prabha  
Senior Seminar, Educational Studies

## **Abstract**

Are women naturally inept in math and science? What is discouraging women from entering the fields of science?

The social climate of science has been far too cold towards welcoming women for a long time now<sup>1</sup>. The effects of this climate are being felt constantly as less and less women are entering math and science fields today. The climate that Ms. Genorio is referring to here is defined in her paper as,

“the prevailing condition affecting life and activity. In an academic setting the climate is set by the expectations and past experiences of students, faculty members, and staff; by the history of the institution; and by the behaviors and goals that are expected and rewarded.”<sup>2</sup>

This suggests a vicious circle in which girls and women often get caught.

In this paper, I will evaluate, what has led to these disturbing statistics and why is it a major problem in the American society today. After a detailed analysis, I will present a powerful recommendation for ways of combating the low participation of women in math and sciences at its source – among lower age children.

## **Issue Assessment**

In 1992 Mattel Toys introduced a talking Barbie in market whose words were, “Math class is tough.”<sup>3</sup> Gender equity issues in science and math are a common topic of conversation in the world of education. Here is an interesting observation that I made. I typed the phrase “should women study math and science?” in Google search engine, which brought up the following results, ‘A Study on the Status of Women Faculty in

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<sup>1</sup> *Warming the Climate for Women in Academic Science*, by Angela B. Genorio

<sup>2</sup> Pg. 2, *Warming the Climate for Women in Academic Science*, by Angela B. Ginorio

<sup>3</sup> [http://www.nccc.org/Curriculum/sac52\\_math.science.girls.html](http://www.nccc.org/Curriculum/sac52_math.science.girls.html)

Science at MIT,' 'Women, Gender and Science Links,' '4000 Years of Women in Science' and many more. Out of curiosity I next replaced the word women with the word men in the same phrase. Google brought up the following results, 'Science News for Kids: Feature: Its a Math World for Animals,' 'PhDs.org Science, Math and Engineering Career Resources' and more such WebPages. It is bothersome to observe that for women the search results mostly concentrate on gender equity issues while for men the WebPages are about available opportunities in pursuing math and science.

***What is the issue?***

There is gross under representation of women in the fields of mathematics and science. This phenomenon starts becoming observable towards the end of middle school and then adds up to create major disparities at each successive level. I find the following statistics very provocative.

*What is the status of women working in the fields of mathematics and science?*

52% of population in U.S. is accounted for by females and 46% of labor force is females. Still, women represent only 22% of the science and engineering labor force.<sup>4</sup>

Here is a quote from a woman research associate, natural sciences Ph.D., "While top-notch post-doc positions were available to me, there is a great shortage of faculty positions. Having made the commitment to stay in Austin with my family, I found none. My only option was a non-tenure track position on soft money."<sup>5</sup> Referring to data available from the 1990's, there were only four tenured women in mathematics in top ten departments in the country. Women full-time professors in Chemistry went up from 3% to 4% between 1985 and 1990. If this is to be taken as a trend for growth over the years we will stand at about 7% today. The table below shows that in 1990's less than 14% of

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<sup>4</sup> Pg. 17, *Re-Engineering Female Friendly Science*, by Sue V. Rosser

<sup>5</sup> Pg. 15, *Warming the Climate for Women in Academic Science*, by Angela B. Ginorio

the full-time tenured faculty in the math and science departments in various colleges were women.

Department	Full Professor (Percent Women)
Biological Sciences	10.4
Engineering	0.3
Math/Statistics	9.9
Physical Sciences	4.4
All Fields	13.7

Table 1: Shows the percentage of tenured full-time faculty in the math and science departments at various colleges/universities in the 1990's.

*How do women pursuing graduate work in math and science fare?*

According to a study conducted by a division of the National Science Foundation, in 1999 while 186655 males enrolled in natural science, math and engineering programs, only 87754 women enrolled in the same programs.<sup>6</sup> Women who did enroll in these fields faced difficulties in terms of getting recognition for their work and earning respect or credibility among their colleagues. “I worked on five research projects as an undergraduate and graduate student and the recognition of my contributions was zero,” a white woman research associate, M.Sc. and J.D.<sup>7</sup> In 1992, 14.4 per cent of the total Ph D. (s) granted in natural sciences and engineering went to women. In 1999, out of 374 total Ph.D.s awarded to US citizens and permanent residents, only 76 were awarded to women.<sup>8</sup>

*How are women performing in math and science at an undergraduate level?*

According to one research, in 1998 even though 39.9 to 30.7 was the ratio of women to men who earned a bachelor's degree, the ratio of women to men earning natural science

<sup>6</sup> <http://www.awis.org/resource/statistics.html>

<sup>7</sup> Pg. 12, *Warming the Climate for Women in Academic Science*, by Angela B. Ginorio

<sup>88</sup> <http://www.awis.org/resource/statistics.html>

and engineering degrees was 4.6 to 7.5.<sup>9</sup> According to a paper published in 1995, “At the University of Washington, there has been only one woman for every five men among all undergraduates in engineering over the past five years.”<sup>10</sup> It has been observed that over the course of four years women are more likely to switch out of science majors to a non-science major. All these facts are a cause of concern, as we shall see later in this paper.

*How is the performance of girls going from elementary and middle school to high school in choosing their field of study?*

Studies have indicated that girls and boys tested at age nine in mathematics perform at the same level. Other studies reveal that the interest level for both boys and girls in math and science is same at middle school level. As they graduate from middle school to high school the following trends start to appear: “At a local high school, approximately equal numbers of sophomore boys and girls enrolled in science courses. By senior year physics, 150 boys and 46 girls were enrolled.”<sup>11</sup> It is interesting that in spite of more girls than boys being enrolled in most high schools across the United States, studies have indicated that twice as many senior boys as compared to girls have taken three years of physical science.<sup>12</sup>

Even though girls perform well in both science and mathematics at an elementary to middle school level, once they have to choose the courses they want to study, their enrollment in mathematics and science classes begins to decline.

“What leads to these trends?”

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<sup>9</sup> <http://www.awis.org/resource/statistics/2-23.gif>

<sup>10</sup> Pg. 8, *Warming the Climate for Women in Academic Science*, by Angela B. Ginorio

<sup>11</sup> Pg. 1, *How to Encourage Girls in Math and Science*, by Lucille Day et al.

<sup>12</sup> Pg. 3, *How to Encourage Girls in Math and Science*, by Lucille Day et al.

A lot of research has been done in this field, trying to explain these disparities in representation of women in the fields of science and math. In earlier years it was believed that women could not pursue science and math fields because their heads and hence their brains were too small. Rousseau, an eminent educational theorist believed that, “women were not qualified for research in abstract areas such as mathematics and science because their brains were unfit.”<sup>13</sup> However, referring back to US history, there was a time when more women were studying natural sciences as compared to men. In fact, there used to be a saying, “Science for ladies, Classics for gentlemen.”<sup>14</sup> This fact disputes the argument that women are not made for doing well in math and science fields. After all, what could have changed genetically to make them suddenly inapt in understanding mathematical and scientific concepts? Another theory related to biological differences was that women tend to be a lot more “feeling” or emotional and hence not suited for practical fields of mathematics or science. However, the following two examples give an interesting turn to the previous statement. In 1983, Barbara McClintock won the Nobel Prize for her discovery that genes can rearrange themselves on a chromosome. The direction of her research is said to have been informed by a “feeling for the organism.” Jane Goodall and Dian Fossey initiated the relational approach of studying and understanding primate behavior by focusing on one ape and tracing that primate’s interactions, thereby setting a new trend in wildlife observation.<sup>15</sup>

Now that the social environment has been studied more carefully, it has been discovered that factors like parents, teachers, peer prejudices, classroom environment and social stereotypes play an important role in the development of this pattern.

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<sup>13</sup> <http://www2.edc.org/WomensEquity/resource/MST/Digest/mathdig.htm#Math>

<sup>14</sup> Pg. 35, *The Science Education of American Girls*, by Kim Tolley

<sup>15</sup> Page 30, *Gender Balance: Lessons from Girls in Science and Mathematics* by Ann Pollina

*Expectations of parents:* Parents have traditionally been known to be a lot more protective about their daughters providing them with added support wherever needed as compared to sons. Studies have shown that this leads to girls developing lower self confidence in their abilities, specially in areas like math and science that are not necessarily a part of growing up or child development, like languages, etc. are.<sup>16</sup>

*Expectations of teachers/ school counselors:* Studies have shown that the teacher interaction with boys and girls differs in math and science classrooms. Teachers have been known to question and challenge boys in their math or science classes a lot more than girls. Their interaction with girls is mostly more social than challenging.<sup>17</sup> Also, when a boy gets a wrong answer for a problem in say math, his failure is attributed to lack of effort but if the same thing happens to a girl, her failure is generally attributed to lack of ability.<sup>18</sup> Such experience with teachers must build a sense of helplessness in girls. They start thinking that they cannot do well in science or math classes and hence do not opt for any such classes as electives, when given a choice. Angela B. Genorio says in her paper that, “There is some evidence that teachers’ beliefs regarding the appropriateness of science and math for boys and girls are more influenced by sex-role stereotypes than are students’ own perceptions.”<sup>19</sup> Another discouraging and very limiting factor for young girls interested in sciences is the attitude of the school counselors, who influenced by societal stereotypes, often fail to mention math and science classes as options for them.<sup>20</sup>

*Peer Interactions:* Starting at the end of middle school as girls get ready to enter high

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<sup>16</sup> Pg. 15, *How to Encourage Girls in Math and Science*, by Lucille Day et al

<sup>17</sup> Pg. 18, *How to Encourage Girls in Math and Science*, by Lucille Day et al

<sup>18</sup> Pg. 19, *How to Encourage Girls in Math and Science*, by Lucille Day et al

<sup>19</sup> *Warming the Climate for Women in Academic Science*, by Angela B. Ginorio

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<sup>20</sup> Pg. 7, “Missing Links,” by United Nations Commission on Science and Technology for Development.

school and choose classes they are at a development stage where attention from boys is getting important to them. As a result, many of their important decisions, including taking classes, get influenced by the factor of getting attention from boys. This makes them abstain from taking science classes as they fear that it will intimidate boys and prevent them from asking them out. Owing to peer pressure, girls start underestimating themselves and believe that they have to show themselves as inferior to boys to get their attention. Though this pattern of behavior seems amusing and seemingly harmless, leads to serious problems in the future.<sup>21</sup>

*Classroom environment:* We have already talked about the negative tone that teacher expectations and interactions set for girls in science and math classes. There is more that goes wrong in these classes than just that. For example, the way these courses are structured, the learning seems to be very individualized. Girls have been known to be social workers who work better in groups. Also, girls are known to learn a lot better if the subject matter is related to real world and is not so abstract.<sup>22</sup> These days however, almost no effort is made to bring in interesting discussions in math or science classes. Neither are historical perspectives provided very often in these classes.

All these factors, start influencing girls when they are still in middle school, encouraging them to stay away from math and science classes in high school. This is summarized by the results of a study of seventh-graders, “The difference wasn't in performance-males and females performed comparably in math and science courses-but in the fact that females consistently underestimated their abilities. Because of this lack of confidence, the females begin taking fewer math and science courses than their male schoolmates, a trend

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<sup>21</sup><sup>21</sup> <http://www.sdsc.edu/~woodka/Chapter1.html>

<sup>22</sup> *Gender Balance: Lessons from Girls in Science and Mathematics*, by Ann Pollina.

that accelerates in high school.”<sup>23</sup> Now if a female wants to pursue an undergraduate degree in science she first has to fight against the disadvantages that her schooling has placed her in and then fight to find her own place in college. If a woman does decide to pursue Math or Science as her field of study, people tend to consider her out of the ordinary, sometimes in a positive way but more often in a negative manner, while if a man wants to study math or science it is nothing abnormal. In order to make an appreciable difference in such behavior, we need to make some vital changes at the middle school level itself, before important decisions are made regarding future fields of study.

***Why is under representation of women in math and science so important?***

*Performance in Undergraduate Programs:* Most undergraduate colleges, specially those following a liberal arts curriculum, these days require certain minimum number of credits in natural science and math disciplines. If a woman wants to graduate from these colleges, she will be required to take certain classes at the college level, even though she may not have taken any math or science classes in high school. This leaves her in a very unprepared position and the probability of her doing badly in these classes increases.

Some high schools do require every student to take classes in various disciplines, but the atmosphere in these classrooms is such that girls often end up doubting themselves and not learning much, as we have discussed previously. Hence, the ultimate effect is that girls are ill-prepared for undergraduate college.

*Future Science Based Career Prospects:* Most undergraduates who enter a four year program do not know what they are going to major in. Women entering these colleges also lie in this pool. Due to requirements some women may find themselves forced to

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<sup>23</sup> <http://www.sdsc.edu/~woodka/Chapter1.html>

take math or science classes and they may then be surprised to learn that they enjoy these subjects. However, as discussed above they may have to work extra hard to do well in these classes or may also never do as well as they would like to simply because they were not prepared enough. This affects their undergraduate performance and hence their chances of getting into a good graduate school or Ph. D. program. It is interesting to note that it is not the women who suffer by these disparities, but also the world of science itself. Many great discoveries have been made by women scientists. Marie Curie, driven by her passion (something women are stereotypically known for) sacrificed her life to discover Radium.<sup>24</sup> Earlier in this paper we read about the discoveries made by Barbara McClintock, Jane Goodall and Dian Fossey, who all claimed to have been helped by just those female attributes that people often claim incapacitate women for doing well in math and science.

*Future Non-Science Based Career Prospects:* It is wrong to assume that if someone is studying mathematics or natural sciences, they are going to enter the academic world as researchers or scientists. The analytical and logical abilities and thinking developed as a result of studying these subjects, is of use in many professions that may not be directly related to these disciplines. For instance, consider the following table:

Field of Study/Profession	Reqd. Mathematics (high school level and above)
Business Admn., Economics, Psychology and Architecture	3 years
Programs in Art, History, Law and Sociology	2 years
Airline Pilot, Veterinarian, Astronomer	4 years
Policeman, Firefighter, Carpenter, Bank Teller	2 years

Table 2. This table shows how important studying mathematics is for doing well in various professions and programs.<sup>25</sup>

<sup>24</sup> <http://www.aip.org/history/curie/brief/index.html>

<sup>25</sup> Pg. 4, *How to Encourage Girls in Math and Science*, by Lucille Day et al.

So, even if girls did not want to go on into mathematics and science fields necessarily, they would still be handicapped in a lot of other interesting fields, as mathematics is required in many fields. This limits their choices and options. This translates into inability of their being able to work in many highly specialized jobs that tend to pay more, thereby translating into income disparities. This has been proven through various studies as well. For example, “Most women who work have an economic need to do so. They are single, divorced, separated, or have spouses whose incomes are insufficient to maintain their family’s living standards. Yet women earn on average 59 cents for every dollar earned by a man.”<sup>26</sup>

*Moral Implications:* A girl whose interests may lie in math, may not even think of pursuing it as a career because she has been brought up in a society where women are not “supposed” to pursue math. She may enjoy studying Physics but may not put in extra effort to do well in it, thinking that it would not help since she is a girl and hence not capable enough to do well in it. I feel that any trend that leads to these feelings of inequality and helplessness where one is not free (not directly, but indirectly owing to societal pressures) to pursue what one desires, is a problematic trend and should be changed. However, realizing that we live in a practical world, I now move to more practical reasons why we need to change the existing patterns.

This no doubt is a challenging issue with many obstacles and challenges but there is hope. For example, NSF is devoting its attention and considerable resources towards overcoming this issue. Look at the following NSF program:

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<sup>26</sup> Pg. 5, *How to Encourage Girls in Math and Science*, by Lucille Day et al.

### **“Promoting Mathematics and Science Education for Girls**

The National Science Foundation has been one of the most active organizations in studying why girls fall out of the math and science pipeline, and in developing programs designed to encourage girls to stay interested in math and science and pursue careers in these fields. The NSF dedicated nearly \$7 million to programs for Women and Girls during Fiscal Year 1994 -- a 200 percent increase over the previous year.”<sup>27</sup>

My initiative joins other attempts such as the one described above to address this important concern and opportunity.

### **Reform Initiative**

*My reform composition focuses on breaking the stereotypes and providing a comfort zone for women, or rather girls as I am going to focus on middle school girls, so that they do not feel threatened by their male counterparts in Math/Science.*

The ideal place to start ‘interfering’ in the current system would be seventh/eighth grade. Studies show that at this level girls perform just as well as their male counterparts in mathematics and science subjects. But towards the end they start to show inclination towards non-science and mathematics fields due to the various factors discussed above. It would hence make appreciable difference if we implement our reform program at the middle school level before we have already lost a few girls to the existing trends.

The ultimate goal is getting as many girls as possible to pursue science and math fields.

This goal can be achieved by meeting several other smaller goals, that I will call ‘pillars,’

<sup>27</sup> <http://www.sdsc.edu/~woodka/Chapter1.html>

which will provide a comfort zone, support and resources for girls who are interested in these subjects.

*Pillar 1: Sense of Community and Belonging.*

Due to the ongoing brainwashing in our society, girls who are interested in mathematics and science find it difficult to meet other girls with similar aspirations. They are too shy to acknowledge their interests for fear of being laughed at or considered abnormal or supernormal. As a result, they often become anti-social and get labeled as nerds. Also, studies have shown that girls work better in groups. Traditionally, mathematics and science classes have been highly individualized, where students need to work on problems individually. Though recently a shift in trend is taking place, providing these girls with additional support could instill in them a sense of belonging, may enable them to connect with other girls who share similar interests.

I propose initiating a club headed by a female math/science teacher who is passionate about our cause. The membership of this club would primarily be girls with a few selected boys. Although we do want a community for girls interested in math and science, we also want to prepare them for the real world. They will have to learn to interact with boys confidently in order to be successful and make the right choices outside of the club. The first activity that the first entering group of this club should indulge in is naming the club. This will give them sense of ownership to the club and they will feel closer to it. As a club, they can come together regularly to meet few times a week, share experiences,

interests, mathematical or scientific problems and reflect on themselves and each other. Since girls do work better in groups, a club would provide them with a chance of starting study groups and homework groups. They could also discuss various topics that interest them in math or science but generally go untouched in regular classes, like, history of Pythagoras theorem, how did calculus come about, what are Newton's contributions to math/science, etc. Another important aspect of the club is Public Relations work and recruitment. Even though we want a reasonably large member group, we do not want any uninterested people in the club. We would like our members to be driven and have strong interest in math and science. To enable this, a monthly newsletter is a must. The head teacher of the club should also visit various math and science classes and try to recruit worthwhile candidates.

### *Pillar 2: Mentors and Role Models*

At times when one feels completely hopeless and is on the verge of giving up, it is a known fact that nothing works better than seeing an example of a successful person that you can relate to at some level through shared interests. "Those women who had networks, peer groups, or mentors were more likely to persevere than those women who were isolated."<sup>28</sup>

I recommend that additional emphasis be laid on providing the club with role models who can give them reassurance and guidance wherever needed, by acting as their mentors. I suggest that even though the club does have an experienced teacher as its head,

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<sup>28</sup> Pg. 15, *Warming the Climate for Women in Academic Science*, by Angela B. Ginorio

most of the hands on work, like felicitating debates & discussions, helping students with homework, etc. be done by these mentors in collaboration with the students themselves. A good place to start looking for these mentors would be to look for female students in the math and science departments of colleges and high schools in the area. Other than this continuous mentoring, I propose that the club organize mini-lectures at least twice a semester, where women who are actually working in the fields of science and mathematics will be invited to come talk to the club about their experience and the opportunities available out there waiting for the students to grab them. I suggest having a special lecture once a year, where a social leader who agrees with the “mantra” of this initiative comes and talks to the students about the important work that they are engaged in and how it will affect the society one day. The purpose of this guest lecturer would be to show support of the society to these students. .

### *Pillar 3: Additional Resources and Activities*

Due to lack of resources in classroom, the additional support that is needed to grab the interest of girls and motivate them to learn better cannot be provided. Also, having people come talk to you is not always the only way of gaining inspiration. Reading success stories of other women often leaves lasting impressions. We also want to prepare these girls for future and hence need additional resources to prepare them to enter high school. So as to provide a diverse range of options and opportunities additional resources are needed.

I recommend a well-stocked functioning library available to the members of the club. A

good way of assembling this library would be to get the students along with their mentors involved. Some suggestions for books are, "Math Literacy and Civil Rights," by Robert Moses, "She Does Math." Edited by Marla Parker, etc. The library should mostly have mathematics and science books along with biographies/autobiographies of scientists and mathematicians. It would be important to have high school level math and science books, to prepare them in advance for high school. A library would give an opportunity for a summer reading program. The purpose of this summer reading would be to establish links between math, science and non-academic or real world. It is very important to connect math and science with social concerns, like conservation of environment, preservation of equality and peace, etc. It is a known fact that disputing countries are sometimes brought together by the scientists of those countries. Science is a field where an individual or a group of individuals cannot do everything on their own. They need to rely on others as well. This lesson of interdependence would help the members rely on each other and create a positive inter dependence among all of them.

#### *Pillar 4: Providing Adequate Challenge*

Girls often go unchallenged by their teachers in math/science classrooms, who tend to interact with them at a more informal level. I recommend that this club be used as a means of providing this much needed challenge to its members.

I suggest encouraging the members to enter various contests and help them train for these contests as well. To prepare the students for serious contests it could be a good idea to hold competitions within the club and have awards like pizza coupons to add incentives

and make it more fun. In my experience in college, I am ashamed to admit that I participated in only one contest and I am even more sorry to admit that in that one contest I was the only girl from our college participating. At the risk of making excuses for my actions, I would like to claim that the reason I did not want to participate in anymore contests was because I did not feel respected in that setting. Even before the contest started the impression I got was no one expected much from me. There is nothing more destructive to your self esteem and confidence than feeling dispensable. I believe that through participating in various math and science contests the members of this club can learn and achieve a lot.

*Pillar 5: Safety Zone does not end with School Day*

Even though children spend a lot of time in schools and it is considered their second home for many good reasons it is still not their home. A home is often where a child lets all his or her guards down and is most vulnerable. It is hence important to get parents on our side and get them involved in the program as well. Research had shown that most children, specially daughters tend to hold their parents as the ultimate authority on everything. In such a scenario it is really easy for them to get influenced by the parents. Hence, it would be really beneficial for the program's success if parents were to support it as well.

The support of parents needs to be solicited at the very beginning when their child becomes a member of the club. They should be made to realize that these subjects are beneficial even if their child may not necessarily enter the world of pure sciences. Once

their support has been won, they can benefit the club by getting involved in the club activities. Few areas where they can contribute are assembling the library, writing a parent's perspective column for the monthly newsletter, helping with organizing the lectures and most importantly by ensuring that their children are not exposed to anything at home that may lead them to build negative stereotypes thereby resulting in self-doubt.

### *Pillar 6: Building Societal Support and Appreciation*

Community support is required for this program to be successful. The stereotypes that led to these gender equity issues in math and science, developed with time in society. If changes have to be made in the existing pattern, a gradual but sure social reform has to take place. Hence, it is of extreme importance that full utilization of community resources be made and community support be solicited.

One good way of utilizing the resources of the community is by organizing trips to science museums, national parks, zoological gardens, laboratories at near by colleges, etc. It would also be a good idea for all the members of the club to be involved in the community at an individual level. They can do so by tutoring younger kids at the elementary schools, volunteering their time at the museum, national park, local zoo, etc. depending on their interest. To assist them in this process, the mentors and parents can play an important role by networking with the right organizations so as to allow the kids to gain enriching experience. This should be accomplished by making allies out of all the local businesses, churches, schools and other organizations in the area. This will not only help create opportunities for the children but may provide a way of getting additional

resources for the club, like books for the library, guest lecturers, etc.

### *Pillar 7: Future Prospects*

Once girls graduate from middle school into high school, it is important that our support group still exists for these young girls about to make important decisions in life. Their mentors will hence still be available to them. The role of these mentors will now be to guide them where needed and help them with preparation for college. Since, this will be work outside the immediate club, we should either graduate mentors along with their students or give them additional incentive, like a small stipend to enable them to help these young girls. This will also help in assessing the success of our program in getting girls in math and science fields at a college level.

## **Reform Initiative Assessment**

Any good proposal for a reform movement should include a way of appraising its success towards meeting its goals. The methods that I am considering for assessing this initiative are longitudinal research, surveys, resource assessment/audit.

### ***Longitudinal Research***

To evaluate how successful the program is in increasing the enrollment of girls in high school math and science classes, a comparative statistical study can be conducted. The

study will compare voluntary enrollment of girls, that is, enrollment in non-required math and science classes in high school before and after the implementation of this program.

People graduating in math or science fields from undergraduate schools have a very high probability of pursuing the field further, specially if all the decisions were made out of choice. In order to judge the program's success in getting more women in fields of math and science, we will follow the participants of the program only to undergraduate schools and compare the numbers majoring in math and science fields before and after the implementation of the program. This will give a good variable to measure the program's overall success.

### ***Survey-Summative Assessment***

To evaluate the program at the level of the participants in terms of how it is affecting their motivation, interest and persistence, we will have them fill out a survey when they enter the program and then when they graduate from middle school. The kind of questions on this survey would be, "On a scale of 1 through 4, with 1 being 'extremely' and 4 being 'not at all,' would you say you enjoy math and science?" "Would you say you do well in it?" "Would you be interested in pursuing it in the future?" "Are your parents supportive of this interest of yours?" "Do you feel that you belong to the math and science community on a larger scale?" Then there will be a few subjective questions like, "Please share any one experience from your middle school science or math classes that you remember?" "What are you expecting from this program in future?" This will give a good idea of the effects that the program had on them and also their expectations from it.

### ***Survey-Formative Evaluation***

To be able to ensure that the participants do not have a bad experience in our club, we will have evaluative surveys directed towards assessing each of our pillars. These surveys will be filled out by all our participants, including the mentors and parents to help direct our resources in the best possible manner. These will include questions based on each of our pillars and how they think we are progressing in terms of providing all those to our students. Then in the end I would like to have them answer, “Which one of the pillars do you think we need to work on the most?” This kind of survey should guide us adequately towards providing our participants an enriching experience.

### ***Resource Audit***

It is crucial for the success of our program that our resources be up to date and plentiful for the use of our participants. We will have to set goals for each six month period for getting more relevant books for the library and building networks in the community. The success will then be assessed at the end of each six month period in terms of how close have we come to meeting our goals. This audit will be carried out by the head of the club with help from mentors and students and will ensure that adequate opportunities are always available for our participants.



But, thanks to my will  
That pushed me to try and strive  
Success is mine!!

## **Annotated Bibliography**

- Gender Working Group, United Nations Commission on Science and Technology for Development, *Missing Links*. USA: UNIFEM, 1995.

This book concentrates on issues of gender equity in science and technology, especially referring to women in the developing countries of the world. It also talks about how such an absence from important positions in fields of sciences, affects their lives. It is accurately titled *Missing Links*, as it does try to give a complete description of the missing links in the role of women in science.

- Ginorio, Angela B. *Warming the Climate for Women in Academic Science*. Washington D.C.: Association of American Colleges and Universities, 1995.

This is a report/ paper on under representation of women in math and science mostly at the levels of undergraduate, graduate and working world. There are some disturbing statistics in this paper, that I found useful in my composition. I think it is a great eye opener. If you read this paper first without knowing anything about the issue, you are immediately intrigued enough to want to find out as much as possible about this issue.

- Pollina, Ann. "Gender Balance: Lessons from Girls in Science and Mathematics." *Education Leadership* September 1995: 30-33.

This is an article that was published in the *Education Leadership*. It talks about how it is time now that instead of blaming women for not being able to handle math and science, we should blame ourselves for not being able to handle teaching math and science to women. The article gives examples of successful women scientists who used their feminine traits of care and feeling to make wonderful contributions to the scientific world.

- Rosser, Sue V. *Re-Engineering Female Friendly Science*. New York: Teachers College Press, 1997.

This book supports talks about how females have different learning patterns as men and how traditionally science classes have been oriented towards teaching men. This book talks about various methods that could work better in attracting women to science, going from ways of introducing women to science to evaluating them in this field. I used this book directly to support the issue and indirectly as background for the initiative.

- Skolnick, Joan, Carol Langbort and Day, Lucille. *How to Encourage Girls in Math and Science*. New Jersey: Prentice Hall, 1982.

This is another wonderful book that first discusses why women are not choosing math and science fields these days and then goes on to talk about curriculum and instructional strategies that could encourage more women in these fields. It mentions specific strategies and gives examples of problems that can be used in classrooms for this purpose.

- Tolley, Kim. *The Science Education of American Girls*. New York: RoutledgeFalmer, 2003.

This is a very interesting book that talks about how women used to study science and math in ancient America, while men used to study classics. However, due to some historical upheavals the trend began to change and now has almost completely reversed.

- [http://www2.edc.org/GDI/engaging\\_girls.htm](http://www2.edc.org/GDI/engaging_girls.htm)

This website supports my argument tremendously about how girls start going away from math and science in middle school itself. Then it gives some suggestions for achieving gender equity in math and science classes.

- <http://www.expandingyourhorizons.org/>

This website I have not really used directly in my paper, but I got various excellent

ideas from it. This website is dedicated to nurturing girls' interest in math and science. This would be a great place to get ideas for this purpose.

- <http://www.sdsc.edu/~woodka/Chapter1.html>

This talks about gender equity issues, from the point of view of a woman who was very interested in math and science. She decided to stand against societal stereotypes and pursue these fields. She writes using her own experiences, which serve as excellent examples for supporting this issue.

- [http://www.nncc.org/Curriculum/sac52\\_math.science.girls.html](http://www.nncc.org/Curriculum/sac52_math.science.girls.html)

This is a brief and concise description of the gender gap in science and math. Then it gives quick tips on what parents and child care providers can do to make sure that their children are not being influenced by any stereotypes furthering this gender gap.

- <http://www2.edc.org/WomensEquity/resource/MST/Digest/mathdig.htm#Math>

This talks about various reasons and explanations that have been offered over the centuries of research and exploration of the curious and disturbing gender gap in math and science fields. The it offers suggestions on where to start, where to head and what challenges to expect as we combat this issue.

- <http://www.aip.org/history/curie/>

An interesting website on the great woman scientist Marie Curie, who worked with radioactivity and discovered radium.

- <http://www.awis.org/resource/statistics.html>

This gives a lot of statistics that support the given issue over the years. This has the most recent statistics that I could find for free.

Additional Resource:

- Parker, Marla Ed. *She Does Math! Real Life Problems from Women on the Job*. USA: The Mathematical Association of America, 1995.

I gave this book as an example of a book to have in the club library. This is an excellent and a very interesting book where various women write about the real life mathematical problems that they face and solve as part of their jobs, as mathematicians in some capacity or other.

## **Dissemination Plan**

The best way of making this initiative available to most people across the globe would be having it on the world wide web. However, for implementing it I would like to select a few middle schools, which are located in an urban setting, with high schools and colleges in the area, to introduce my initiative to. For instance, twin cities middle schools would be an excellent place to start with. The most effective way of getting schools to agree to implement this program would be to present it to the school board. I would gather a “task-force,” comprising of people supporting this issue and willing to work for it. My task-force would go to selected regions, present our case to the school board and have the program implemented. Even if the program is not implemented, the exposure provided will definitely be useful and it is my hope that the schools will adopt aspects of the plan if not the complete program itself.

