

Maximizing Industry and Academia Efforts to Attract Females into Science, Engineering & Technology (SET) Careers

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Abstract

Over the last couple of years the enrollments in Electrical Engineering and Computer Science have been declining at South Dakota State University (SDSU). In 2003 there were 175 students enrolled in Electrical Engineering, of which 17 were females (9.7%). In 2001, there were 164 students in Computer Science, of which 24 were female (14.6%). In 2005, there are 142 students majoring in Electrical Engineering, of which 12 are female (8.5%) and 83 students majoring in Computer Science, of which 6 are female (7.2%). This trend of decreasing enrollments of females in engineering mirrors the national downward trend, however the number of women enrolling in Engineering at SDSU was below the national average (SDSU Advisory Board Meeting 2005).

The proposed solution was to host one day workshops to show female students how interesting engineering, math and science can be, and, if possible, to continue to encourage them through an ongoing mentoring activity. The primary target of the first workshop called GEMS (March 2006) were 8th grade students within an hour drive of the SDSU campus at Brookings SD, the exception were the 9th grade students from the local Indian school. The primary targets of the second workshop called Ready SET Go! (October 2006) were High School students from primarily a one hour drive of Brookings SD. Other targets of both workshops were the teachers, parents and guardians of these 8th grade and High School students. Subsequent workshops were held in March (GEMS) and November (Ready SET Go!) in 2007. There were three objectives of this project:

- To encourage girls to consider a career in STEM-related careers (Science, Technology, Engineering, Math).

- To attract female students to SDSU.

- To convince teachers and parents to support females choosing careers in engineering, math, science and technology.

In the past, industry and academia have separately tried to accomplish the objectives listed above. This practice oriented paper will address how government, academia and industry can work together to influence the enrollment of females in STEMs related majors. It will show how

the program was set up, the actual results of the workshops, lessons learned and recommendations.

Introduction

Women are under represented in careers in science and technology. An article published by Northwest Regional Educational Laboratory (NWREL 2005) stated: “While women make up 45 percent of the U.S. workforce, they hold just 12 percent of the science and engineering jobs in business and industry” (NWREL 2005). But it is not just a case of a low percentage of women in the IT industry, it is the fact that the number of women going into these jobs is declining. “Women accounted for 16.6 percent of all network and computer systems administrator positions in 2006, down from 23.4 percent in 2000” (Nobel 2007, 34). The outlook is discouraging, especially in engineering, as there has been a decline in the number of women pursuing engineering degrees. According to an article in Engineering Trends (2004) a “comparison of the enrollments of women to total engineering enrollments (relative enrollment fractions) indicates that the interest of women in engineering academic programs has been declining for almost ten years”.

At South Dakota State University (SDSU) the number of women enrolled in the College of Engineering was already below the national average, especially in Computer Science where nationwide around 17% of the Computer Science students are female. SDSU is also experiencing the same national trend of downward women enrollments in engineering. Over the last couple of years the enrollments in Electrical Engineering and Computer Science have been declining at SDSU. According to the enrollment numbers presented at the December 16, 2005 SDSU EE Advisory Council (SDSU 2005), in 2003 there were 175 students enrolled in Electrical Engineering, of which 17 were females (9.7%). In 2001, there were 164 students in Computer Science, of which 24 were female (14.6%). Today there are 142 students majoring in Electrical Engineering, of which 12 are female (8.5%) and 83 students majoring in Computer Science, of which 6 are female (7.2%). In 2005, an estimate of the total number of female freshman in the College of Engineering in 2005 was 13 out of an incoming class of 300 (4.3 %).

This paper summarizes research and literature related to what is known about the reasons behind the lack of participation of women in science, technology, engineering, and mathematics fields. It will document the recommendations as well as outline the problem that is created if this problem is not solved. Lastly, this paper will document a program being conducted at SDSU to help encourage girls consider enrolling in engineering related majors. The documentation will include:

- Program initiation
- Goals of the program
- Program funding
- Program activities
- Results of the program
- Lessons Learned
- Recommendation for future

Background

What are the reasons for the declining enrollment?

The following have been posited for the decline in females in engineering related careers.

First there is a misconception of job projects in engineering fields. In discussions, parents and students have expressed concern that after years of education students will engineers will either lose their job in another dotcom bust or to an offshore action. “The declining number of American kids enrolling in and graduating in the so-called STEM (science, technology, engineering, and math) disciplines coincided with the dotcom bust of 2000-2001” (Vanden Plas 2007). “Vondra said he is aware of the off shoring and outsourcing of IT jobs, particularly the call center variety, and he said a lot of his friends that considered a technology career were talked out of it due to parental concern over IT job losses” (Vanden Plas 2007).

Second, there is a lack of knowledge of engineering fields. “The Harris Poll survey revealed that 45 percent of Americans feel that they are ‘not very well informed about engineering and engineers’ while another 16 percent stated that they are ‘not at all well informed about engineering and engineers’. Among women, however, the percentages increased to 55 percent and 23 percent, respectively.” (National Academy of Engineering 1998)

Third, there is a misconception on the value of engineering careers. “Based on the latest EWC enrollment figures and this polling data, it seems that many Americans, especially women and minorities, don't consider engineering as a field where they can achieve to their maximum potential while utilizing their talents to serve society in the areas they most care about today - the environment, public health and safety, a better quality of life. We must do better at conveying that message if we're going to maintain the qualified engineering workforce we need for our future prosperity.” (National Academy of Engineering 1998)

Fourth, there has been a lack of role models and thus the perception of being an engineer has taken on negative connotations. In an article on information technology workforce development, Joe Vanden Plas interviews Sarah McGinn, a student at Marquette who “acknowledged that IT majors haven't exactly been among the “in-crowd” on college campuses” and stated ... “We're not just people with thick glasses hacking away in a corner. That's an idea that has to be revised.” (Vanden Plas 2007). Many people are worried about a lack of role models including Stanford University president John Hennessy who said: “We have [TV] shows about doctors, lawyers, politicians. Where are our role models of scientific innovation?” Hennessy continues: “We need Eddie the Engineer or Sam the Scientist.” (Winters Keegan 2006, 26) Both the lack of females and positive role models seem to cause girls to avoid IT careers, Margaret Ashida, director of talent for IBM's software group has an solution: “There's the perception that if you don't see a lot of women in the field, it must not be a very good field for women... You have to talk about how technology is making a difference to people to get them excited and engaged.” (Nobel 2007, 36)

Fifth, girls have had less experience with and or education in science and engineering. In a paper by Cheri Fancsali, entitled *What We Know about Girls, STEM, and Afterschool Programs* she quotes the following literature, “Girls have fewer out-of-school science experiences than boys (Farenga, 1995; Kahle, et al., 1993)” and “Farenga found to be related to girls' reduced participation in school science courses (1995)” and “While girls comprised a small majority

(54%) of the advanced placement test-takers in 2001, they were underrepresented in the areas of mathematics and science (College Board, 2001) (Fancsali n.d.).” (Fancsali n.d., 1) Carol Noble stated in an article entitled Back to School: Getting Girls Into IT agrees “Despite the success of various education initiatives in the past several years, there’s little doubt that the shortage of women in technology begins on the playground an early age” (2007, 36).

Lastly, we are losing girls because first they are losing interest in math and second because they feel they need to be straight “A” student to be an engineer. Sandy Carter, vice president of SOA and WebSphere strategy at IBM supports this “Young girls have been deselecting math for a while... They do very well in math and science for a while, and then seem to lose interest” (Nobel 2007, 36). Many females in personal discussion with the author have stated they thought you had to be a straight-A student to go into engineering.

Is a solution needed?

While the number of jobs in technology industries has been increasing the number of graduates to fill these jobs has not matched this increase in jobs. “[T]he enrollment numbers have yet to catch up with a growing number of jobs available in a technology sector that has made a solid comeback. According to [AeA's](#) 10th annual [Cyberstates](#) report, the nation's high-tech industry added nearly 150,000 net jobs in 2006, bringing the total number of technology jobs to 5.8 million” (Vanden Plas 2007). But “more than a matter of stemming the tide of the ongoing skills shortage, encouraging women to get involved in technology is fast becoming an imperative for establishing the kinds of adaptive, collaborative, and versatile enterprises that will thrive in a fast-paced global economy” (Nobel 2007, 34).

Martha Sloan, AAES Chair and professor of electrical engineering at Michigan Technological University stated (National Academy of Engineering 1998):

In an age when technology helps turn fantasy and fiction into reality, engineers have played a pivotal role in developing the technologies that maintain our nation's economic, environmental and national security. They revolutionized medicine with pacemakers and MRI scanners. They changed the world with the development of television and the transistor, computers and the Internet. They introduced new concepts in transportation, power, satellite communications, earthquake-resistant buildings, and strain-resistant crops by applying scientific discoveries to human needs. Despite these contributions to society, this 'stealth profession,' whose membership numbers more than two million in the United States alone, remains largely invisible when more than 60 percent of Americans state that they are not well informed about engineers and engineering.

Who are responsible for helping fix the problem?

According to Martha Sloan, AAES Chair and professor of electrical engineering at Michigan Technological University a combination of groups needs to work together to increase females into the STEMs pipeline.

As our nation's workforce continues to transition from one which is predominantly male and Caucasian to one which will be majority female and African-American, Asian, and Hispanic, the price we pay in our society for engineers having worked in such obscurity may not be known for another generation. But it is clear to me today that if we, as an engineering community, in

partnership with the media and our educational system, fail to act now to increase society's understanding of engineering, particularly among women and minorities, our nation's economic, environmental, and national security will be threatened.” (National Academy of Engineering 1998)

Carol Noble in an article entitled *Back to School: Getting Girls Into IT* (2007) suggests that industry must take the lead in bringing girls into technology fields, “Now more than ever, the onus is on IT to play an active role in ensuring that more women choose technology as a career path—and thrive in it”. (Nobel 2007, 34).

Industry is stepping up to take leadership role in this activity. Sandy Carter, IBM VP stated:

We started looking at these statistics and decided that at IBM we needed to start attracting young girls.” In 1999, IBM launched a pilot day camp for seventh- and eighth-grade girls, staffed by women volunteers with technical backgrounds. The program, dubbed EXITE (EXploring Interests in Technology and Engineering), has grown annually. In 2006, IBM hosted more than 50 week-long EXITE camps worldwide. “We’ve focused on showing these young girls women in technology who are supercool, and what it’s like to be a woman in technology” (Nobel 2007, 36).

Parents, especially mothers, as well as teachers also play a role. “Asked what they want to study, most girls in high school answer, ‘I don’t know.’ Asked who most influenced their career choices, they usually answer, ‘my parents’—and for girls, especially, ‘my mother.’ Intentionally or unintentionally, mothers influence their teenage daughters’ career paths, typically know very little about math and science, and tend to perpetuate stereotypes about math and science being men’s work, best avoided by women” (McNees 2003, 94).

Government, who see this decline in STEMs enrollments, must also take a role. Newt Gingrich citing the Hart-Rudman commission statement said: “The second greatest threat to the United States is the failure of math and science education. And we went on to say: It is a larger threat than any conceivable conventional war.” (Community Oncology Alliance 2005)

So the solution to this concern lies in the hands of parents, teachers, universities and industry as well as US, state and local governments.

GEMS & Ready SET Go Program

Recognizing the problem and taking action

Becky Schmieding, IBM Executive Project Manager and an alumna of SDSU, is a member of the SDSU Electrical Engineering Advisory Council as well as a Campus Recruiting Manager for IBM at SDSU. She was concerned with the lack of women pursuing careers in IT related fields at SDSU and felt that for IBM to be successful, a diverse employee population is needed. This diverse employee population requires a diverse population in the educational pipeline, and therefore something needed to be done at SDSU to help refill the technology pipeline with females. The solution to the problem of declining female enrollment was to find a way to excite and encourage girls to study math and science, and to ultimately pursue a degree in one of the engineering majors (e.g. Electrical Engineering, Mechanical Engineering, Civil Engineering, Computer Science, Software Engineering, etc.).

As an IBM employee she was inspired by the week long EXITE camps to help encourage girls to go into STEMs related majors. However she saw a limitation with these camps. First the closest camp to SDSU was at the IBM Rochester MN facilities over 240 miles from the SDSU campus. A second limitation was that these camps were already oversubscribed, so sending girls to Rochester wasn't an option. Therefore the idea of holding a workshop at SDSU took shape.

By holding the workshop at SDSU the following could be accomplished

1. Hold workshop for larger number of students
2. Allow students to become familiar with SDSU
3. Allow SDSU to identify students who might be interested in attending SDSU College of Engineering and would allow SDSU to follow up with those students after the workshop.

Program initiation

This project was initiated by a meeting on September 28, 2005 between Becky Schmieding, IBM Executive Project Manager and Peggy Gordon-Miller, President of South Dakota State University. This was followed up by an e-mail on October 14, 2005 to the Dean of Engineering, Dr Lewis Brown, and the head of the Electrical Engineering and Computer Science Department, Dr Dennis Helder, at South Dakota State University. The meeting and e-mail expressed concerns over the decline in the percentage of the number of women in the above mentioned majors. In the e-mail, an offer was extended by Becky Schmieding to help SDSU conduct a one day workshop similar to EXITE camps run by IBM Women in Technology. SDSU was asked to host the workshop. The Dean of Engineering, Dr Lewis Brown, accepted the recommendation and assigned the Assistant Dean, Dr Rich Reid, to work with Becky Schmieding. Contact was also made with the IBM Rochester Coordinator for Women in Technology, Claudia Knowlton-Chike on October 10, 2005 to secure IBM Women in Technology support of the effort to provide materials and supplies.

Project planning occurred between November 22 and December 29, 2005. The formal execution of the project started on January 3, 2006. The project planning team consisted of a group of professors from SDSU. The team decided that there were two target groups with different goals and therefore decided to conduct two different workshops. The groups and the goal of the workshop for these girls were:

1. 8th grade girls—encourage them to select (not deselect) math and science as the move to high school
2. High School girls—encourage them to pursue STEMs major in college and if possible at SDSU.

A secondary target of this workshop were the teachers, parents and guardians of the students to provide them with the means to encourage their girls to pursue STEMs related coursework and majors as well as provide them with reasons to send their child to college at SDSU.

The group also decided that it would be better to hold the 8th grade workshop in the spring because that is when students have to decide on their classes for high school. A decision was made to hold the high school workshop in the fall as that is when high school students start to

think about their futures both in deciding which major and what school as they start the college application process. Because planning had begun in November, they decided to start with the 8th grade workshop. The first targets of this first workshop were the 8th grade students within an hour drive of the SDSU campus at Brookings SD. SDSU sent the information about the workshop directly to the math and science teachers in those schools. An invitation was also extended to the 9th grade students from the local Indian boarding school.

Program goals

The goals in conducting these workshops were:

1. To help both girls and their parents understand engineering and the careers available by providing a presentation on job opportunity and to introduce them to web pages like <http://www.engineeryourlife.org/>
2. To understand the value that projects in technology provide by providing them with examples of the types of jobs in which engineers make major contribute and to show through a session on great women the major contributions that women have made for society
3. To provide roles models through interaction with industry representatives, SDSU professors and female SDSU students from the College of Engineering as well as to spark the girls interest in math and science by demonstrating how interesting and fun engineering can be
4. To let both girls and parents know that it is not necessary to have a 4.0 grade point average to major in technology fields through interactions with existing engineers and engineering students
5. To provide girls with more experience in STEM's fields and to show the girls how exciting these fields can be through hands on experiences.

To publicize this activity, letters were sent directly to both the school administrators and to the math and science teachers asking them to inform the girls of the workshop. In addition, multiple news articles were placed in local papers informing people of this workshop. Lastly, information was placed on the SDSU web pages about this workshop. At the workshop, the girls were given a gift bag which contained not only the workshop material but also information about SDSU and some trinkets from sponsoring corporations like IBM and Daktronics as well as a memory flash drive inscribed with the SDSU logo.

Program funding

Funding was requested from the industry representatives on the SDSU Electrical Engineering Advisory Board. Companies such as Daktronics, MidAmerican Power, Sencore, Eastern Electric Power and 3M combined to donate \$4200 in 2006 for the first workshops and most have continued to contribute on a yearly basis. In addition, the girls paid \$10 each to attend the workshop. The \$10 fees provided an incentive to not just register for the workshop but to attend the workshop as well.

Program results

As of January 2008, four workshops, two of each, have been conducted with positive results. The results of these workshops are summarized below. Planning is underway for the 3rd GEMS workshop to be held March 29, 2008.

On March 25, 2006, the first Girls: Engineering Math Science (GEMS) workshop was held for 54 girls and 20 parents/teachers. The workshop staff consisted of 12 female industry professionals, 10 SDSU professors/staff and 12 female SDSU students. After the workshop 44 of the 54 girls indicated they would continue their interest in math, engineering and science. The students really enjoyed the workshop. One student was overhead saying “I wish school was this fun”. The workshop also had the support of the parents and teachers that attended. “I would like to strongly suggest that you continue this opportunity.”

When asked “What was the most surprising thing you learned during the workshop?” The students answered:

“That there are so many different fields of science that have jobs available and that I actually am interested in some of them

“How many different famous women that there were that made a difference in the world.”

“That there are so many different fields of science that have jobs available and that I actually am interested in some of them.”

“The variety of jobs and things that engineers and scientists can do.”

“Learned more about successful women and how they really did impact our world.”

On March 24, 2007 the second GEMS workshop was held for 59 girls and 18 parents and teachers. The workshop staff consisted of 10 female industry professionals, 9 SDSU professors/staff and 13 female SDSU students. The students were very enthusiastic about the workshop. Here are some of the comments from their post-workshop survey:

“After this workshop, I learned that we can be anything we want to be; the sky really is the limit

[I learned] “women are just as capable as men in the math and sciences.”

“I never knew all the great things women have been in the past and present.”

[I learned] “Engineers have fun and don’t sit behind a desk all day; they do fun stuff.”

[I learned] “Women play a major role in math, science, and engineering.”

[I learned] “how much an engineering degree can make a difference.”

But what speaks louder is the impact of this workshop on the girls and it can be seen in the comparison of two questions that were asked in a post-workshop survey. Before this workshop were you considering a career in technology or engineering? After this workshop would you consider a career in technology or engineering? As can be seen from the bar chart to the right, this workshop had a significant impact on these young girls. In other words, this workshop increased the girls considering a career in technology from 39.2% to 90.2%.

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Figure 1: GEMS 2007 before and after workshop results

On October 21, 2006 the first Ready SET (Science, Engineering, and Technology) Go! workshop was held for twenty-four girls from different schools around eastern South Dakota and Iowa. The workshop staff consisted of 10 female industry professionals, 10 SDSU professors or staff, and 12 female SDSU students. The students were very enthusiastic about the workshop. Here are just a few of the comments they provided on their end of workshop survey:

“It was fun.”

“It was GREAT!”

“I loved it and hope to come again.”

“I enjoyed it a lot. It was educational and fun.”

“It was better than I expected. It was a very good opportunity. I would definitely recommend it.”

In addition to having fun, the students also felt that they were learning, as shown thru these comments:

“I learned a lot about the engineering field from the workshop. I think it broadened my perspective of what the field’s options for possible careers are (Lots of options)”

“I learned how easy it was to do computer programming”

“I learned how outnumbered women were in this field”

“I learned a lot”

The parents and teachers strongly supported and valued this workshop as evidenced by the following comment from a parent: “I thought it really helped them to see how engineering extends beyond what they might have thought”. The University and Industry representatives who devote extra hours and a Saturday deserve the credit for their efforts but even as they give, they receive. One of these women sent me a note afterwards which said “They [the workshops] help the young ladies feel their lives are full of possibilities. They also help me see the possibilities in mine!”

On November 3, 2007, fifty girls from different schools around eastern South Dakota and Iowa meet at South Dakota State University for the second annual Ready SET GO! workshop. This was over double the number from last year. They were accompanied by parents and teachers. The workshop staff consisted of 14 female industry professionals, 10 SDSU professors/staff and 10 female SDSU students. The students were very enthusiastic about the workshop, the following are comments taken from their post-workshop survey.

“This was an awesome and fun experience. I learned a lot. The instructors were great.”

“The way you people make engineering sound it makes me want to be interested.”

“It was definitely worthy my time and the people assisting were all so kind, fun and helpful.”

“This experience helped me determine my future. I liked it thank you so much for your time and effort. Everyone involved was kind and helpful. Thank you, great job.”

“I was surprised at how much I enjoyed the programming part. Computers and I don’t usually get along but this activity was fun.”

“I didn’t know that making a computer program was so easy.”

Parents and teachers also found this workshop valuable. “As a teacher, I was very excited to see the opportunities available. Great workshop” and from a parent; “People speaking from real-life experiences made a huge difference. (It is) very affordable for anyone to attend.”

Challenges & Encouragements

The biggest challenge this program faces is in finding avenues to publicize the event for these girls. Even though the workshops drew a large number of students the largest school district in South Dakota (Sioux Falls) was not well represented (1-3 students per workshop). While attempts have been made to publicize this workshop to these students, parents repeatedly say that they and their girls are not hearing about these workshops from their schools. We continue to look for ways to reach the large school districts.

The biggest encouragement for this program occurred when the organizers were contacted by the South Dakota US Congressional Representative, Stephanie Herseth Sandlin who asked to be a speaker at the opening session of the first Ready SET GO workshop. She agreed to help them with future workshops and taped a message for the second GEMS workshop. Representative Herseth Sandlin talks were an inspiration not only to the girls but to all who attended. In her videotaped message she told the girls that “the transformation of the US economy into the knowledge based information age is well underway... making mathematics, science, engineering and technology even more critical to the future of American students, workers and employees. That transformation can’t be complete without the substantial and essential contributions of women. So what I am saying is your country needs you and you have an irreplaceable contribution to make... The choices you make in middle school and high school can offer a world of opportunities that weren’t available for women just 10 or 15 years ago. Let me say it again. The future of South Dakota and our nation depends on the contributions of people like you” (Herseth Sandlin 2007).

Lessons Learned

The following lessons were learned in conducting these workshops

1. Teenagers have a very full agenda of school activities therefore it is important to find the appropriate date. For the workshops at SDSU, this was the time period between the fall and winter sports and the winter and spring sports.
2. Getting a “name” opening speaker allows for additional media coverage and helps draw additional attendees.
3. Once the workshop has been done once it is easier to put on again.

Conclusion

It is still too early to tell whether or not the workshops have been successful in persuading girls to pursue engineering related majors as thus improve gender equity in the college classrooms and workplace. But as Jayshree Ullal, vice president of datacenter, switching, and security at Cisco

said: “I have a passionate belief that the crux of the problem isn’t something we can fix in five years. It’s going to take decades, but once you have that pipeline going, things will change for the better” (Noble 2007).

The innovative strategy of having industry, academia and government working together along with parents and teachers to reverse the troubling trend of fewer females in engineering related fields allows for a win-win-win scenario for universities, industry and government. It can be easily replicated. The group desires to continue these workshops at SDSU as well as to extend these workshops to other universities thus creating an increasing pipeline for engineers, especially female engineers to attend universities, get jobs in industry and help governments with technology related issues. In fact, talks are already underway with Iowa State University about conducting a GEMS workshop in 2008.

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