Twenty First Century Women Prefer Summer Science Kamp

Matthew S. Sanders and Robert M. McAllister
Kettering University
Flint, MI 48504

Abstract

Although culture of science has contributed to the lack of women in engineering, the cultural diversity of our society offers an opportunity to seek future engineers in groups other than the traditional "white male" engineer. Women receive the majority of all bachelor's degrees, however fewer than 20% of those degrees are in engineering. This discrepancy increases at the graduate level. Furthermore, 63% of all doctoral degrees are awarded to international students. As the demand for engineers outnumbers the supply, we must recognize and take advantage of the enormous potential for future engineers that exist among women.

Although access to higher education is improving, few women have chosen engineering programs. Engineering differs from most other professions in that vocational decisions are ideal if they are made at the junior high level. To attract more women to engineering, Kettering University in cooperation with the Genesee Area Math and Science Technology Program sponsor two summer enrichment programs with year round activities. These are Engineering and Science for the 21st Century Woman and Kamp Kettering – An Adventure in Science, Math, and Engineering. They began in 1993 and 1995 and are designed for girls entering 9th – 12th and 7th – 8th grades, respectively. Each program is unique and at a different level, but they share a central theme – to show that science, engineering, and mathematics can be exciting, fun, challenging, and rewarding; provide high-quality education, motivate, and prepare them to pursue studies in technical fields.

Programs have been successful in terms of student satisfaction and goal achievement. This paper discusses program initiation and objectives, recruiting and processing applicants, and various hands-on activities. To improve the programs, data on observations and suggestions as well as identification of problems are collected yearly. This article describes the effectiveness of these programs based on statistical analysis of the collected data and sums it up with participants' comments.

Introduction

International competition is seriously affecting a broad spectrum of industries in the United States. To compete in the highly technological-oriented global marketplace, well-educated engineers and

scientists are needed to become professionals capable of designing, developing, producing, and marketing goods and services. Many higher educational institutions recognize the importance of this need by taking various actions in order to provide trained individuals who would create and master technologies for the betterment of humankind.

Although access to higher education is improving, few women enter postsecondary engineering programs. The culture of science has contributed to the lack of women in engineering, however the cultural diversity of our society offers an opportunity to seek future engineers in groups other than the traditional "white male" engineer. According to the U.S. Department of Education[1,2], women receive a majority of all bachelor's degrees, however fewer than 20 percent of those degrees are in engineering. The discrepancy increases at the master's and doctoral levels, where less than 10 percent of all engineering degrees are awarded to women[3,4]. Another alarming fact is that 63 percent of all doctoral degrees from U.S. universities are awarded to international students[4]. Since science, math, and engineering education for domestic students has been declining and the demand for engineers outnumbers the supply, we must recognize and utilize the great variety of human resources and take advantage of the enormous potential for future engineers that exist among women.

Actions Taken

Kettering University has recognized the realities of attracting women to the field of engineering and science as challenges that need to be met and has begun programs with the goal of providing a high-quality education for young students. In this regard, the Office of Student Affairs – Women's Resource Center in cooperation with the Genesee Area Math and Science Technology Program sponsors and operates two annual summer enrichment programs with year round activities for girls mainly residing in the Flint area. The first of these programs, Engineering and Science for the 21st Century Woman began in early 1993 while the second one, Kamp Kettering – An Adventure in Science, Math, and Engineering, began in 1995. The rational for offering these two programs to young females is that engineering differs from most other professions in that vocational decisions are ideal if they are made at a junior high level to keep open the option to become an engineer. For this reason, at the time they enter college many inner-city youth, particularly females, have not taken the high school courses required by most engineering departments. In addition, these adolescents do not have any understanding of the careers that are possible with an engineering degree.

Program Descriptions

Each program is unique and at a different level, but they share a central theme – to show that science, engineering, and mathematics can be exciting, fun, challenging, and rewarding as well as to provide high-quality education, motivate, and prepare them to pursue studies in technical fields. They help build the self-esteem needed to ensure college success. The programs also encourage and excite these highly gifted female students presenting non-traditional opportunities in pursuing careers in science, engineering, mathematics, and technology. Applicants must complete and submit the application form, two letters of recommendation, and a personal essay by a certain deadline. In writing the personal essay, applicants express the reasons for participation as well as

what they expect to gain from the program. In addition, the personal essay also shows applicants' interests in science as well as their career interests and goals. This one page essay is a vital part of the selection process.

The programs catch students at an age when they should be beginning to make career decisions. We do not believe that any child truly dislikes these subjects; rather we see the fault lying in the approach used to teach these subjects. A "hands-on" teaching approach can often improve both student attitude and performance in math and science, preparing them for a comfortable learning experience of engineering fundamentals. This way both programs involve young women in classroom activities, hands-on experimentation in the laboratory, and problem solving with computers. In laboratories close attention is placed on proper laboratory and research technique. This will prepare the students for both group and independent work. The hands-on laboratory component of the programs is meant to attract and retain the interest of the young women. For example, students were taught to use a Thermoformer Machine to produce a plastic product using the Visual Basic Program that they wrote in order to produce a Mickey Mouse image. In addition, the programs expose participants to an enormous variety of careers in science, mathematics, and engineering through laboratory projects as well as field trips to technology centers and career panels, using women engineers and scientists as role models. They also offer the students an opportunity to interact with all types of engineers including Ph.D. level faculty/researchers, retired engineers, and scientists with years of experience, recent graduates in their first year on the job, and undergraduate students. These programs cost $100 per week, which includes instructional fees, supplies, equipment, field trips, meals, and final banquet. Since the career exploration is an important part of the programs, field trips are scheduled to help students learn more about engineering and science opportunities, interact with industry professionals, and become familiar with a real, functional and ongoing engineering and science environment with the intention of promoting knowledge, understanding, and appreciation for engineering and science. Students have had the opportunity to explore Detroit African Museum, Detroit Science Museum, Toledo Cosi Museum, and Kellogg's Cereal City. During the following school year, students reconvene for follow-up activities, which provide exposure to a variety of campus faculty and staff. In addition, social activities provide time to discuss various topics informally.

The programs seek to provide a positive college experience. A variety of social and cultural activities also are included. These include group conferences, career guidance, and daily activities that allow them to air bothersome issues, develop some priorities, become better acquainted with each other, gain some feeling about themselves and each other, and set some personal objectives for themselves. Upon completion of the programs, students receive an appropriate program certificate suitable for framing and a student-designed program T-shirt.

Kamp Kettering – An Adventure in Science, Math, and Engineering – is a one week summer enrichment program with year round activities. The program is currently offered in two sessions during the summer in order to accommodate 48 girls entering 7^{th} – 8^{th} grades. One of the goals of this program is for participants to become so engrossed in and enthralled by science and engineering that they are eager to attend the Engineering and Science for the 21^{st} Century Woman program when they enter 9^{th} grade. Kamp Kettering features a number of professors who present academically challenging engineering and science topics in the area of their expertise with the

intention of promoting knowledge, understanding, and appreciation of engineering and science in the life of each participant. Some of these topics give students the opportunity to learn research and design fundamentals and gain first-hand experiences. These include computer-aided design, computer networking, internet challenge, fuel cells, science of making music, mouse trap racing, and water quality. Additional topics such as body language and public speaking are also part of this program.

Engineering and Science for the 21st Century Woman is a two-week summer enrichment program with year round activities. The program is designed for girls entering 9th – 12th grades. Students are presented with "hands-on" experiments and projects in engineering, chemistry, biochemistry, physics, and computer application. Some of the topics that these projects cover are statistics, Internet explosion, engineering animation, waste minimization, and postage stamp circuit programming. Students use engineering and science related software explicitly. For example, in the summer of 2002, students used Visio Technical to design their Dream House. The design and creation of a Dream House provided them with an intellectually challenging experience and helped them build confidence in their ability. The program is interdisciplinary and uses teamwork to create a cooperative learning environment. In addition, students are provided with school and career guidance, resumes and interview skills, and time management. A crucial element is career guidance – students are given the opportunity to explore their vocational interests with a career counselor. Close cooperation between admission and program administrators is necessary because most of the 21st Century Woman attendees are ready to enter a university the following year.

Recent Experience

Both programs have excited participants about learning and proven to them that they have unlimited potential. The community, in particular the public school system, benefited from improved students grades and behaviors due to increased ability to meet the fundamental requirements of their particular grade levels. Parent (guardian) participation has been one of the strong points of these programs, and past programs have had excellent parent participation. Dividing students into groups to perform various activities, not only increases competition but also helps to develop competencies in communication, human relations and social abilities, and builds a cooperative attitude among attendees.

These programs have provided students with an opportunity to be involved in a pre-engineering curriculum in a university setting. Many of these female students are inspired to pursue higher education and enter engineering programs as undergraduates. Programs have addressed engineering, computer, and scientific educational deficiencies and placed students in an intellectually stimulating environment. It is easy to see that students identify their interest and potential for success and increase of self-esteem. It is also easy to see that many have not realized the breadth of educational opportunities available to them. What is equally important and much harder to quantify is the fact that students have learned more about themselves and their abilities, and what they can expect of life in college and life as science or engineering students.

Outcomes Analysis

The feedback from students, parents, and others who either have been involved in the program or know others who have been involved, indicates that the programs work well and have been tremendously successful, both in terms of student satisfaction and goal achievement. Goal achievement is evidenced by follow-up surveys showing that almost every single participant of these programs is in the process of completing her high school education or attending a college. Most of those who are attending college are majoring in technical fields. Available data from past participants indicate no one has dropped out of high school or been delayed in obtaining their high school diplomas. Students, school officials, parents, and others inquire about the programs, which is a good indication of the successfulness of both Kamp Kettering and 21st Century Woman. More than 90 percent of participants indicated that programs increased their interest in engineering and affected their plans for career in mathematics, science, or engineering. Above 88 percent of the participants of Kamp Kettering in the last four years have indicated that the primary source for program information was supplied by students, school officials, and parents. In the same period, over 92 percent of participants in the 21st Century Woman Program received the primary source for program information from the same group of people. It is worth mentioning that mathematics and science teachers were at the upper end and guidance counselors were at the lower end of school officials in providing program information to the participants.

To improve the programs, data on observations and suggestions as well as identification of problems are collected yearly. The effectiveness of these programs is measured by pre- and post-program evaluations and participants' comments. The following is a summary of these data over the last four years from about 300 participants.

The responses for the following question: "To what extent did factors A-H (described below) play in the attendees' decision to attend the programs?" are summarized in Table 1 on the following page.

Where A-H stands for:

A. Parents wanted me to attend
B. Wanted to lean about careers in engineering
C. Wanted to lean about careers in science
D. Wanted to be away from home for summer
E. Could not find a summer job
F. Wanted to meet new and interesting people
G. Wanted to prepare myself for college
H. Wanted to enhance my awareness of professional career opportunity available in engineering and science

Factors →		A	B	C	D	E	F	G	H
Very Much	Max	75.0%	73.0%	69.0%	18.0%	6.0%	50.0%	92.0%	86.0%
	Min	41.0%	40.0%	45.0%	0.0%	0.0%	41.0%	57.0%	50.0%
	Mean	59.2%	53.9%	58.0%	14.1%	2.0%	49.0%	81.3%	74.0%
	StDve	12.0	10.5	8.9	5.7	2.4	3.5	11.1	12.2
Mode-rately	Max	32.0%	52.0%	49.0%	41.0%	10.0%	41.0%	30.0%	30.0%
	Min	7.0%	18.0%	23.0%	7.0%	0.0%	12.0%	4.0%	0.0%
	Mean	22.8%	35.2%	31.8%	19.3%	4.0%	31.0%	11.9%	19.5%
	StDve	9.4	11.4	9.2	10.8	3.7	10.1	8.4	10.9
Some What	Max	27.0%	19.0%	15.0%	52.0%	26.0%	32.0%	14.0%	19.0%
	Min	4.0%	0.0%	0.0%	5.0%	3.0%	8.0%	0.0%	0.0%
	Mean	13.6%	10.3%	8.8%	28.3%	9.0%	17.2%	6.5%	5.5%
	StDve	7.0	6.4	5.1	14.4	7.4	8.6	4.7	6.3
Not at All	Max	11.0%	3.0%	5.0%	55.0%	95.0%	8.0%	2.0%	5.0%
	Min	0.0%	0.0%	0.0%	23.0%	70.0%	0.0%	0.0%	0.0%
	Mean	4.4%	0.6%	1.4%	38.3%	85.0%	2.8%	0.3%	1.0%
	StDve	4.5	1.2	2.2	11.0	8.1	3.0	0.7	2.0

Table 1. Factors played in participants' decisions.

Table 1 shows the average, maximum, and minimum percentages as well as the standard deviations of participants' responses with respect to the above factors. For example, the data in the cells of the intersection of column B and row Moderately indicate that in average 35.2% of participants stated that the factor they wanted to learn about careers in engineering (factor B, above) played a moderate role in their decision of attending the program. During those four years, a maximum of 52.0% and a minimum of 18.0% of attendees indicated the same reason for their participation. The standard deviation for this data was 11.4. As Table 1 shows, factors A, B, C, F, G, and H influence significantly in participants' decisions for attending the programs while factors D and E were very insignificant.

Data on the primary influence for career choice of participants were collected. Figure 1 on the following page shows the average percentages (Y-axis) of sources (X-axis) influence on participants' career choice. The "G.C." stands for Guidance Counselors, "Teachers" includes mathematics and science teachers, and "Others" covers relatives, grandparents, and program flyers. Sadly, again guidance counselors played relatively insignificant roles in having influence in participants' career choice as they were in providing program information to the participants.

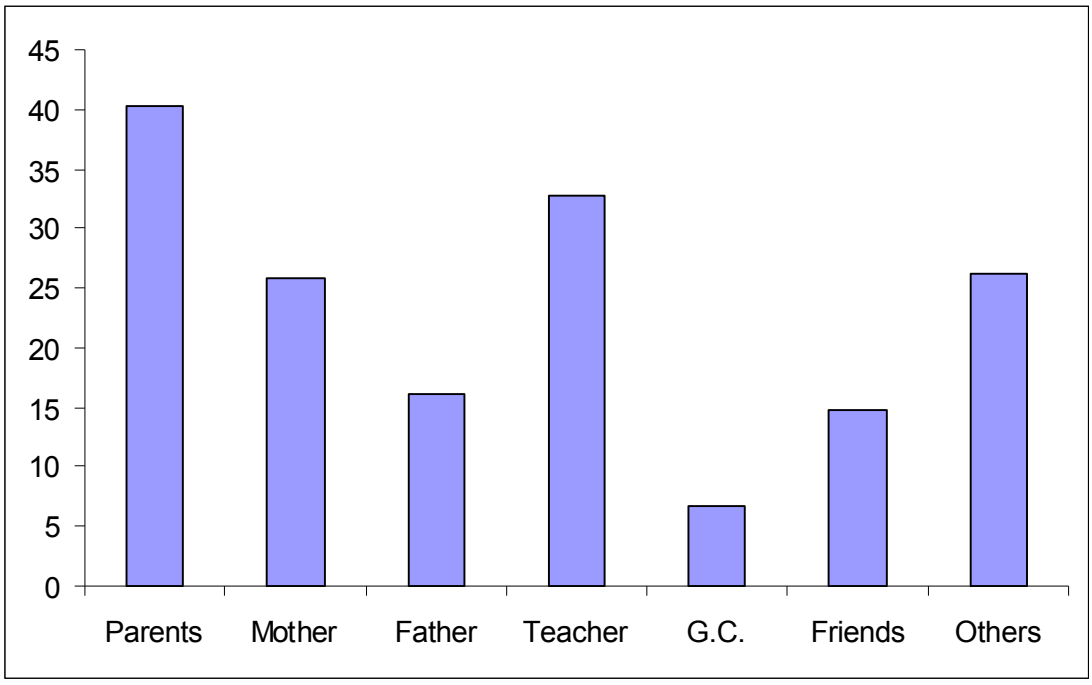

Figure 1. Influential sources for participants' career choice.

Attendees and their parents gave the programs positive evaluations. Annually, participants are asked if they would recommend the programs to their friends. Their responses are summarized in percentages as follows:

	Mean	Minimum	Maximum	Standard Deviation
Yes	73.6%	49.0%	86.0%	12.7
May be	23.9%	14.0%	43.0%	10.5
No	2.5%	0.0%	8.0%	3.1

Table 2. Participants' view on programs recommendations.

As Table 2 indicates, a significant percentage of participants recommend the programs to their friends. Written and verbal comments of the programs are overwhelming. A significant number of participants wished for a longer program and more woman programs in mathematics, science, and engineering. Perhaps nothing sums it up better than the words of a few participants:

"Girls can be engineers too!"

"I think science, math and engineering are fun and I want to have a career in an engineering field."

"I didn't know that you could use simple science to figure out a lot of stuff."

"I did not know that math was tied into all types of engineering courses."

"I discovered … engineering isn't just about engines."

"There are lots of jobs to do with engineering that are open for women."

"Science and engineering are where the good jobs are…there are many doors opening up for women."

"Engineering is very interesting."

Conclusion

To regain our international leadership in technology, full integration of women into the engineering profession is a necessity. The common concept of "success in science" should not create an illusion that only "the best and the brightest" can do science. This attitude should not prevent anyone from a career in science and engineering. Outreach activities that encourage young females to pursue studies and careers in engineering and engineering technology play a major role in their preparation. Furthermore, the importance of outreach programs and their contributions are a well-known fact. The outreach programs have long-term benefits for both the universities and society. Basically, outreach programs not only benefit the University financially but also give visibility to and enhance the reputation of the University. It is worth mentioning that 16 graduates from these two women's outreach programs are presently pursuing their bachelor degrees, mainly in engineering, at Kettering University.

We must train the next generation of engineers and scientists now, if the United States is to keep its global competitive edge. The training can be initiated by offering programs that emphasize the importance of augmenting the young students' study of science and computers with practical engineering knowledge of various state-of-the-art instruments. This prepares them for a possible career in the field of applied engineering. It also helps students to develop new knowledge and skills, which as professionals, they will apply to improve productivity and cut costs within industries. Hands-on experience with laboratory and field experiments enable each student to experience the excitement of "doing science".

Finally, engineering offers its practitioners the opportunity for a fulfilling and lucrative career. According to many engineering professional societies, 90 percent of those receiving a bachelor's degree with an engineering major had jobs with career potential related to their major field only one year after graduation. Starting salaries for engineering is one of the highest paid professions. However, with all these facts, new and creative educational and corporate strategies are needed to attract women to engineering and science. These strategies may include the funding of conferences and scholarships, the recruitment of women interns and students, and/or educating and providing related information to the school officials particularly the guidance counselors. Based on our success at Kettering University, we strongly believe in a positive future for U.S. industry if other institutions choose to adopt programs similar to the Engineering and Science for the 21st Century Woman and Kamp Kettering – An Adventure in Science, Math, and Engineering.

Acknowledgement

The authors would like to acknowledge and extend their sincere gratitude to Associate Dean Edith Withey and her staff at the Office of Student Affairs – Women's Resource Center at Kettering University for their assistance and providing information and data for the programs.

References

1. U.S. Department of Education, National Center for Education Statistics, Digest of Education Statistics, 2001 – **http://nces.ed.gov/pubs2002/digest2001**.

2. U.S. department of Education, National Center for Education Statistics, 1999-2000 National Postsecondary Student Aid Study (NPSAS: 2000).

3. U.S. department of Education, National Center for Education Statistics, The Condition of Education 2000, NCES 2000-062, Washington, DC, U.S. Government Printing Office, 2000.

4. M. Sanders and M. Sanders, *"The Challenge of Lowering the Demographic Barriers of the Engineering Work Force,"* On Target, Recruiting and Enrollment Strategies for 2000 and Beyond, The College Board, Number 24, Fall 1996, pp. 18 – 21.

Biographies

MATTHEW S. SANDERS is an associate professor of Industrial and Manufacturing Engineering program at Kettering University. Since 1983 Dr. Sanders has been involved with outreach programs in various capacities. He established and directed a number of pre-engineering programs under auspices of National Science Foundation, Connecticut Department of Higher Education, and GET Foundation. Dr. Sanders' most recent involvement has been with the Office of Minority Student Affairs where he has assisted them with grant writing and taught in several minority outreach programs. Dr. Sanders received his Ph.D. from Texas Tech University and both Bachelor's and Masters' from Indiana State University.

ROBERT M. MCALLISTER is an associate professor and chair of the Chemistry program at Kettering University. Dr. McAllister is also the director of these two outreach programs described in this paper. In the last 15 years, Dr. McAllister has been also actively involved with other pre-college programs such as Detroit Area Pre-college Engineering Program (DAPCEP), Accelerate Students Potentially Interested in Research and Engineering (ASPIRE), National Science Foundation Young Scholars Program (YSP), and Academically Interested Minority Program (AIM). Dr. McAllister received his B.A. from Adams State College and Ph.D. from University of New Hampshire.