A Proactive Strategy for Attracting Women into Engineering

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Abstract

In 1991, the Women in Engineering (WIE) Committee at Ryerson Polytechnic University initiated the Discover Engineering Summer Camp. The objectives of the program were to educate young women about the challenges and rewards of engineering, to show that engineering is a viable profession to consider, and to motivate women to choose engineering. Eighty-three percent of the 1996 camp participants said that they found the camp experience to be very beneficial, while 76% said that it had made a big difference to their awareness of what engineering was all about. Follow-up surveys from previous camp sessions found that approximately 60% of the young women who attended the Discover Engineering camp went on to pursue engineering and cited the camp as a key factor in their decision.

Résumé

En 1991, le *Women in Engineering Committee* [Comité des ingénieures] de la *Ryerson Polytechnic University* a créé un camp d'été en vue de favoriser la découverte de l'ingénierie (*Discover Engineering Summer Camp*). Ce programme visait particulièrement à informer les jeunes étudiantes des défis et des avantages associés à une carrière dans l'ingénierie. Le camp avait également pour but de leur montrer qu'être ingénieur était une profession d'avenir et ainsi de les motiver à s'engager dans cette voie. 83 % des participantes au camp de l'été 1996 ont répondu que leur séjour avait été très utile et 76 % ont déclaré avoir été sensibilisées à l'ingénierie. Des enquêtes de suivi portant sur des camps antérieurs ont conclu qu'approximativement 60 % des jeunes participantes avaient fait des études universitaires d'ingénierie et que le camp avait influencé fortement leur décision.

The economic well-being of Canada and the development of its technological base depends to a great extent on the effective employment of engineers. Along with the predicted shortage of engineers by the year 2000, employers cannot be satisfied with anything less than the very best engineers available, regardless of their gender (Frize, 1992). Although women represent 55% of all undergraduate students in universities, only 21% are enrolled in applied science and engineering programs (Frize, 1992). The participation of women in engineering has increased every year since 1974 (when the first statistics were recorded) when only 2.9% of full-time engineering students were women. However, the engineering profession has not been successful in attracting women in large numbers unlike other male dominated fields such as Law and Medicine (Women in Science and Technology, 1991). In 1991, women represented less than

4% of registered professional engineers in Canada (Frize, 1992). Currently, underrepresentation of women persists despite the fact that there are no differences in academic ability between men and women and that men and women initially pursue engineering for similar reasons (Bates & Stublen, 1993).

In 1992, the Canadian Committee on Women in Engineering released its recommendations to attract and retain women in engineering (Frize, 1992). One of the crucial factors to change the attitude toward women in engineering was identified as cooperation from educators. In particular, the Committee recommended that universities "commit, in principle and in practice, to the recruitment and retention of women faculty and students, especially in faculties of engineering" (Frize, 1992 p.33), and that "faculties and schools of engineering develop programs to attract women into undergraduate engineering programs to increase the pool of well-qualified, talented engineers" (Frize, 1992 p.40). To meet these objectives the committee recommended elementary and high school visits by engineering students and faculty, mentoring programs, information sessions for guidance counsellors, and implementation of part-time undergraduate programs to attract mature students.

Workshops and summer camps have often been used as educational tools to increase recruitment into university programs. For example, in Canada, Queen's University hosts Science Quest, a non-profit and student-run organization that introduces science and engineering to pre-high school students at summer day camps (Canadian Committee on Women in Engineering (CCWE), 1995). The University of Toronto's Science Outreach Program targets grade 5-10 students for its summer camp sessions. Although this program is not restricted exclusively to girls, one of the stated primary objectives is to encourage more girls to become interested in science and engineering and, depending on the demand, an 'all girls' session is organized (CCWE, 1995). Girls Exploring Technology is a one-week program offered by Fanshawe College to help girls in grades 6-8 choose secondary school programs that maximize future career options (CCWE, 1995).

At Ryerson Polytechnic University, the Women in Engineering Committee initiated the Discover Engineering summer camp in 1991 to increase the number of women entering university engineering programs. This program is unique in the Toronto area. It promotes engineering to senior level female high school students, an older age group than do other programs, and is presented in a week-long summer camp format which allows more time to introduce the many aspects of engineering.

The short-term objectives of the Discover Engineering program are to educate young women about the challenges and rewards of engineering through interesting, hands-on projects and discussions led by women

engineers, scientists and students, and to increase their awareness of engineering as a viable career option. A longer term objective is to motivate these women to choose engineering as their university program.

It is crucial that the success of a program aimed at attracting girls into science and engineering is evaluated. In the United States less than 50% of federally funded intervention programs have been evaluated (Davis & Rosser, 1996). In the report of the working conference on Model Programs to Attract Young Minority Women to Engineering and Science, follow-up is cited as the most important characteristic of an exemplary program, regardless of program design or setting (Heller, Martin, & Thomas, 1996; Heller & Martin, 1995). The lack of evaluation data impedes the ability to build programmatic interventions. To evaluate the success of the Discover Engineering program, the participants were asked to participate in two surveys, one immediately following the camp and one several years later. The surveys asked the participants about their camp experience, their attitudes about engineering, and their career decisions. This paper reports on the findings of these surveys. These data can be used to measure the success of the camp experience and to track the number of participants who go on to choose engineering as their university major.

METHOD

Description of the Discover Engineering Camp Program

For the past seven years, the Women in Engineering (WIE) Committee at Ryerson Polytechnic University has hosted the Discover Engineering summer camp. Currently, the program consists of five one-week day camps each with 30 registrants. Each week is divided into 10 sessions of three hours each. The participants undertake projects in different areas of engineering and work with women professors and engineering students. Female students who have completed grades 10-12 are the target, but girls who have completed grades 9 or 13 can also attend. Unlike some other science and engineering programs, Discover Engineering is delivered exclusively to women. Although there is conflicting evidence about single-sex education, there is a general perception that girls fare better in math and science in single sex environments (Kahle, 1996). The overall goal of the program is to increase the awareness of these women about careers in non-traditional areas of applied science at a time when decisions about post-secondary education is in the forefront of their minds.

The camp program has been modified over the years to cover a range of interesting and fun activities. Each discipline has at least one three-hour session so that there is ample opportunity for the students to explore each area and ask questions. For example, in the summer of

1996, the camp schedule included the following ten sessions: Introduction to Engineering, an Egg Drop Contest, Aerospace, Chemical, Civil and Mechanical Engineering projects, Holography, off-campus Tours, a Panel Discussion, and a Career Game. The introductory session serves as an ice-breaker, allowing participants to get to know each other and their camp counsellors. There is ample opportunity to discuss the myths and realities of engineering and to address any questions they may have before the camp starts.

Since the camp audience is senior level high school students, it has allowed the material presented to be technically challenging, but not overwhelming. For instance, in the Electrical Engineering session, the students are given a manual describing the basics of electricity, diodes and simple circuits and then go on to design, and build a battery-powered light emitting diode (LED) ornament of their own. The Civil Engineering session also involves a short lecture on structures and construction followed by a hands-on activity. Teams of four are given a simple building material such as straws or pasta and an adhesive (glue or tape) and scissors and are asked to build the tallest or strongest structure possible. The structures are then tested for their stability and strength. All teams are awarded humorous certificates for their achievements.

Since one focus of the camp is to have the students participate in as many hands-on activities as possible, many of the sessions include take home projects. For example, in the Chemical Engineering session the participants learn about the chemical basis of odours and textures and then produce their own "slime." In the Holography session they make individual holographic images. They are able to take both of these products home.

The last sessions of the week are the panel discussion and the career game. The panelists are female professional engineers from a wide variety of industries. They share details of their own academic history and career paths, describe their current jobs and highlight aspects of their profession that make it a viable and rewarding career for them. The students are encouraged to ask questions. The career game, Wammo (Women Aware, Motivated and Moving On), is a floor game which provides an entertaining and educational format for discussing women's issues in the camp agenda. Players are divided into two teams and collaborate to determine the team's responses to questions about Women in the Paid Labour Force, Women in Engineering and Science, Women and Education, Women and Family Life, and Stereotypes and Other Images. This promotes interaction and cooperative problem solving and is a fun way to finish off the week.

A more detailed description of all sessions and the program in general is available to any one interested by contacting the authors.

Camp Implementation

Posters, information, and applications for registration into the program are sent to the heads of the science departments, the guidance counsellors or individual science teachers of more than 500 high schools in the greater Metropolitan Toronto area. Once applications are returned, places are filled on a first-come first-serve basis. Because of the demand, the camp has been expanded twice, from the initial 60 places offered in 1991, to the 150 places that have been filled for the 1997 summer camp, with over 100 applicants on a waiting list. Each week hosts 30 participants who are divided into two groups, each with a camp counsellor who is usually a female undergraduate engineering student. The counsellors help to guide the participants around campus as they proceed from one session to another throughout the week. Sessions are taught by female professors with help from the counsellors. Thanks to support from the Dean of the Faculty of Engineering and Applied Science at Ryerson, the WIE Committee employs a part-time Coordinator responsible for administration of the camp and recruiting industrial sponsorship. The WIE Web Site (http://www.ee.ryerson.ca:8080/~womeng/) has also served as an effective tool to disseminate information about the camp over the last two years.

Assessment of the Camp Experience

In order to assess whether the camp was effective as an informative and fun educational tool, participants were asked to complete a survey once their camp experience was completed. Questions 1-7 of the survey were aimed at gathering information on the general influences and attitudes of the students attending the camp. Questions 8-12 dealt with gathering information strictly about the Discover Engineering camp experience. To evaluate whether the camp had any effect on the long-term career decisions of the participants, telephone surveys were conducted with participants who had attended the camp several years previously. This follow-up survey asked what the women were doing now and what influence the camp had had on their career direction.

RESULTS

Camp Survey Findings

One hundred and nine women who attended the 1996 summer camp completed the camp survey. Not all respondents answered every question in the survey so percentages reported on each item are based only on the respondents who answered. Ninety-nine percent (99%) of the camp participants indicated that they were planning on attending university. When asked what discipline they were likely to apply to, 44% checked engineering, 15% checked science, 3% checked math, none

(0%) checked business and 4% checked other. Notably, 26% chose the undecided option. Some respondents (9%) selected more than one option but generally Engineering was included in that mix of items. These data seem to suggest that most of the women who attended the camp had already decided to pursue an undergraduate degree although they were not necessarily interested in engineering.

The camp attendees were then asked "Of the choices listed below, which ones provide the most impact on your decision regarding school?" The options were: teachers, family, projects, guidance counsellors, friends, outside programs, and others. Family members (48%) and teachers (43%) appear to have the greatest impact on decisions regarding school while Guidance Counsellors was only checked by 18%. Although it is assumed that there is considerable peer pressure in the teen age years only 13% indicated that friends influenced their decisions about school. Twenty-nine percent indicated that outside programs (programs outside of their school programs) had helped to influence their decisions while 23% checked "other." They were not asked to give examples of "other."

The camp attendees were also asked "Of the options listed below, which ones provide the most important impact on your decision regarding career?" The same options as the above question were given. Approximately one third of the respondents selected family (37%) and teachers (32%) as having an impact on their career decision while guidance counsellors (16%) and friends(10%) were the lowest in percentage.

To determine if someone important to them had ever made a comment about girls' abilities to perform well in math or science, eight statements were listed and the participants were asked to check all that applied. Of those that checked at least one of the options, 50% checked "girls should find a partner (husband/boyfriend)." In descending order, 19% said they had been exposed to the comment "math and science are too difficult for girls," 18% percent checked "girls are not logical enough," 16% checked "girls can not combine family and science careers," 15% checked "social studies and business are for girls to study," 14% checked "computers are for men to understand," 9% checked "girls do not have to study math and science," and 6% checked "math and science are not important for girls." Thirteen percent checked the "other" option but were not asked to elaborate.

Similarly, when asked "Are you discouraged from pursuing science or using a computer?," five statements were listed and the respondents were asked to check all that applied. Fifty percent checked "assistance is not available when you need it," 19% checked "you did poorly on a math or science exam," 18% checked "you are not given an opportunity to work on a computer," 16% checked "teachers are unable to answer your questions," and 15% checked "you do not like laboratories."

In question 6, four statements were listed and participants were asked to check all the ones they had experienced. The statements included "Do you experience nervousness in test taking?" Fifty percent checked this item. Twenty-nine percent reported experiencing "doubts about conducting experiments or working with machinery," 20% experienced "frustration in working with a computer or machinery" and 15% indicated "apprehension about choosing engineering because it is a male-dominated field."

In question 7, respondents were asked "Have you been able to overcome any of the obstacles you checked in the previous question? If yes, How?" The option, "self-determination," was chosen by 59% of the respondents and "working smarter, harder, and longer" was checked by 50%. Forty-seven percent circled "encouragement from someone close to you," 31% checked "teacher's encouragement," and 24% checked "seeking extra help or tutoring." The options "supportive groups" or "workshops" were only checked by 13%. Although family and teachers were seen as providing impact on school and career decisions, these respondents appeared to rely on themselves more than others in overcoming obstacles.

In the second half of the survey, participants were asked to rate the summer camp experience. Eighty-four percent rated it as "very beneficial" and 16% as "moderately beneficial." In terms of becoming more aware of engineering, 76% said it made "a big difference," 23% said "some difference." The participants were then asked to rate the components of the camp as either "not interesting," "somewhat interesting," or "very interesting." The Egg Drop (84%), the Holography (82%) and most of the hands-on activities generated the highest level of interest. Of the camp components, the two off-campus tours were rated the lowest in terms of interest.

The camp provided opportunities for participants to be with women engineering students and engineers. The women were asked if meeting women engineering students changed their ideas about women in engineering. Thirty-nine percent checked "somewhat" and another 39% checked "significantly." However, without a reference point for the respondents' ideas about women in engineering, it is difficult to interpret these findings (i.e. was the change in ideas positive or negative?). Similarly, when asked if the opportunity to meet with women professional engineers changed their ideas, 67% said "yes" but we don't know how their ideas changed.

Post Camp Telephone Survey Findings

Two follow-up surveys were conducted. One in the fall of 1993 surveyed students that had participated in either the 1991 or 1992 summer camp.

The second was conducted in the winter of 1996 and surveyed participants of the 1993 summer camp.

Seventy-four of the 160 participants from the 1991-1992 summer camps were interviewed by phone. Sixty-six percent were currently in university at that time, 57% of these were enrolled in engineering programs. An additional 35% were enrolled in other science-based programs. Seventy-five percent said that the summer camp experience greatly influenced their decision on which program to enroll in.

From the 1993 summer camp 51 of the 80 participants were interviewed by phone. It was found that 94% of them were currently enrolled in university, two of them at Ryerson. Of those attending university, 45% were enrolled in engineering programs and over two-thirds cited the Discover Engineering Camp experience as a great or moderate influence on their choice of field of study. Since 760 girls have attended the Discover Engineering camp program over the last eight years, it is estimated that approximately 400 of these women have enrolled in engineering programs. This means that approximately one in ten of the women engineering students currently in Ontario universities participated in the camp experience. Information collected from both of the surveys suggests that the camp experience helped students to decide whether or not to study engineering.

DISCUSSION

The climate for women in engineering has improved in recent years, however, misconceptions about engineering, lack of encouragement, peer pressure and other factors still act as barriers preventing more women to pursue a career in this non-traditional field. The Discover Engineering summer camp was meant to remove some of the misconceptions and allow girls with similar interests to come in contact with each other.

The Discovery Engineering program targeted female participants from grades 10 through 13 which would place their ages between 15 and 18. Most of these students already had taken some chemistry, biology, and higher mathematics. Almost all of the girls indicated that they would pursue university degrees and almost half expressed an interest in engineering. This data suggests that girls currently in high school in the Toronto area were more likely to choose non-traditional careers. We do not believe that this is so. They do not represent a random sample of the female population in this age group since the girls needed to be interested enough to want to apply to the camp. Furthermore, although camp literature was sent out uniformly to all schools in the Toronto area, certain schools and school boards were more pro-active about encouraging young women to investigate programs like Discover Engineering. For example, the most active schools often were those where the science

teacher was known to a member of the WIE at Ryerson (WIE, personal communication). Another interesting note was that single-sex girls schools have repetitively sent more students than did the co-educational schools (Hiscocks & Zywno, 1998).

The dogma that parents have a strong influence on children when it comes to decisions about university and careers was upheld in our study where almost half the participants said their parents had a great influence on their school decisions and one third said their parents also had an influence on their career decision. Teachers were also another strong influence probably because most of these girls had heard about our program through their teacher. Early socialization within the family has often been cited as a factor in young girls developing interests in non-traditional areas (Astin, 1984). In one study, it was noted that many women who choose engineering are likely to know an engineer or to have a parent or close relative who is an engineer (Baignee, 1990). Since the number of women pursuing engineering degrees is still very low, it is wondered how many women are being discouraged from pursuing such career by their parents and teachers.

Even more surprising was the low percentage of girls that were influenced by their guidance counsellors and peers. In fact, anecdotal evidence from the participants indicates that many guidance counsellors are still actively discouraging girls from non-traditional pursuits. Previous data collected by the authors during the early years of the camp indicated that most participants heard of the program through their teachers although the same promotional material had been sent to all the high school guidance counsellors as well.

While many of the participants in the Discover Engineering camp had already thought about pursuing a career in engineering or science when asked if they had been discouraged from such a career path many said they still experienced stereotypic attitudes. Half had been told by someone important to them at some point in their lives to "go and find a boyfriend/husband." Others had been exposed to many other discouraging comments. Surprisingly, although self-esteem in girls aged 14 and higher has often been attributed to girls' decisions not to pursue math and science (Kahle, 1996), our participants did not seem to lack self-confidence. Many cited their own self-determination as their way of overcoming such obstacles. Possibly such an attitude may explain why they choose to pursue such a career in the first place.

Girls have been found to attribute their success in math to effort and less likely to attribute it to ability than do boys (Mura, Kimball & Cloutier, 1987). This was found in our study where 50% of the girls indicated that they worked harder and longer to do well. They also relied on encouragement from people close to them and teachers.

The follow-up surveys of the participants of the camp program has indicated that approximately 50-60% go on to enroll in university engineering programs. Although these girls may have thought about engineering as a career, many still cite the camp as a great influence on their decision on which program to enroll in and the camp program has helped them to affirm their decision to pursue a non-traditional career.

SUMMARY AND CONCLUSIONS

As both the camp and follow-up surveys indicate, over the past seven years that the camp has been running, there has been a positive response to the camp activities and a high number of women who attend the camp go on to enroll in university engineering programs.

Current work involves the continuous evaluation of the camp sessions and the development of new ideas. In 1997, partly in response to survey results indicating levels of interest generated by different sessions and partly to introduce new aspects of engineering, several changes were made. The off-campus tours and the Autocad sessions were dropped and instead a multimedia session, a plane-building exercise, along with the updating of various other sessions were implemented into the program. All activities emphasized hands-on and team aspects.

In Ontario, female enrollment in engineering programs continues to climb, and over a five year period it has increased from 13% in 1992-93 to 18.5% in the 1996-97 school year. Enrollment at Ryerson has grown at an even faster rate, increasing from 8% in 1992-93 to 13.7% in 1996-97 school year (Hiscocks & Zywno, 1998). Although relatively few Discover Engineering alumni are included in these numbers, word of mouth and publicity generated by the camp has probably helped Ryerson's image for promoting women in engineering programs and may have indirectly contributed to increase in enrollment.

For Canada to be competitive in the world market, it needs a workforce educated in engineering, science, and technological trades and therefore the entire pool of talent needs to be tapped. To increase the number of women in engineering, among other things, they need to be exposed to engineering concepts and participate in hands-on activities. The Discover Engineering summer camp format continues to provide that venue.

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