Kettering University's Bioengineering Summer Program for High School Women

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Abstract

It has been documented that young women are more likely to pursue a career that they perceive as contributing to the common good of society. Also, the number of young women that obtain degrees in science, technology, engineering, and math (STEM) is steadily decreasing or remaining stagnant. To address these two issues, Kettering University has developed a summer program that introduces high school women to bioengineering and the applications for Biomechanics, Ergonomics, Biochemistry, and Automotive Crash Safety.

There are very few residential bioengineering summer programs nationwide. Kettering's Lives Improve Through Engineering, or LITE, is a two week, residential, summer program for young women entering their senior year of high school. Approximately 36 students, recruited from throughout the United States and Canada, attend the fully funded camp each year. University female students receive a stipend to mentor the high school students. The student to mentor ratio is kept low, 3 to 1.

Four different professors, one for each bioengineering subject, are dedicated to presenting the curriculum. Hands-on laboratory experiences are integral to the learning process. In some areas, students present project posters at the end of the two-week period. Overall, the students participate in an interactive curriculum that shows them firsthand how they can apply bioengineering to societal concerns.

Benefits to the high school students are both perceived and measured. The students have a chance to interact with female professors who are balancing family and work, therefore showing first hand that women can achieve professional and personal aspirations. The undergraduates who serve as LITE mentors demonstrate collegiate success. Both faculty and coeds are positive role models for the high school women. A post-program assessment of the LITE participants indicates that after attending the two-week program, they are more likely to pursue degrees in STEM subjects. Data also indicates that the mentors, after participating in the program, are more confident of their mentoring skills and are more likely to seek out mentoring opportunities in the future.

Introduction

Increasing the diversity of young people entering STEM related disciplines is as important as increasing their numbers. The National Science Foundation recognized this in its publication "Women and Science; Celebrating Achievements, Charting Challenges," when it wrote that increasing this diversity would, "add new ideas, perspectives, and ways of thinking to science and its applications."

Kettering University recognizes the importance of diversity as well. Located in Flint, MI, Kettering University is rich in automotive history. Originally designated for training engineers and managers, General Motors Institute (as it was once called) was well known for integrating job experience at GM with classroom theory. Kettering University remains one of very few undergraduate institutions that encourage cooperative education beginning in the freshman year**.** The Mechanical Engineering program at Kettering allows students to select "specialties" on which to focus their elective courses. One of these specialties is Bioengineering Applications. Over the past several years, more and more students have selected this specialty, especially women. Two of the five faculty teachings in the Bioengineering specialty are women, providing these female students with important and necessary role models.

In 2001, Dr. Laura Sullivan, then Associate Dean of Students at Kettering University, began to develop a summer residential program for high school girls with high potential for science and engineering. Drawing from her experience in female student recruitment and retention, Dr. Sullivan developed a pilot program called Lives Improve Through Engineering (LITE). The program included three features essential to attracting young women to science and engineering. The first of these features is based upon the philosophy that young women are more likely to become interested (and remain interested) in science and engineering if they have a clear sense of ways in which these disciplines can improve the lives of others. The attractiveness of Environmental Chemistry and Bioengineering is clear when one observes the higher percentages of women in these fields, as compared to other science and engineering programs. A second philosophy used to develop the pilot LITE pilot program is that young women are concerned about what lies beyond the undergraduate degree. What will they do when they finish, and how easy will it be to combine this future with other aspects of their lives, particularly with family? The third component of the LITE program is the inclusion of mentoring by female undergraduates, because female role models and mentors positively influence women. J. D. Lee conducted a study that supports this philosophy. She evaluated 300 high school junior and senior women who had already expressed interest in STEM careers. These young women participated in STEM enrichment programs at one of nine universities across the United States in the summer of 1995. Lee found that persistence and achievement in STEM was most affected by the relationships that these young women established during the program[1]. Authors such as Pierce and Kite suggest that mentoring can occur electronically before and after a program, and that mentors can be key in assisting with program assessment[2].

The LITE pilot program was implemented at Kettering University in August 2002. The program was continued in 2003, and is planned for July 2004. This twelve-day program brings

approximately 36 young women who have just completed their junior year in high school to campus. Participants are recruited nationally through direct mail targeted to young women who have expressed an interest in Kettering, engineering, or both. A committee (composed of a Kettering University faculty member, an alumna, and the Director of Women Student Affairs) selects participants whom we believe are most likely to benefit from the program. Applicants are selected based upon their grades (we require a minimum 3.0 GPA), two letters of recommendation from high school teachers or counselors, and an essay describing one's interest in STEM, as well as college and career aspirati*ons*

Curriculum

Participants attend nine days of classes and laboratories during the program. Program faculty teach in 1 ½ hour sessions. The goal of classroom sessions, in addition to expanding knowledge about the topic at hand, is to build individual relationships between participants and faculty. Laboratory modules are also delivered in 1 ½ hour sessions. These modules are designed to integrate the ideas and information presented during lecture sessions.

LITE Faculty members teach the following topics:

Automotive Crash Safety

- Newton's Laws of Motion, Principle Direction of Force, Drag Factor, and Case Studies
- Occupant Kinematics
- Occupant Protection in Motor Vehicles
    - Injury Prevention Criteria used in Restraint System Design
    - Techniques used to Extend Injury Values for an Average Male to Protect Women and Children
- Recent changes to improve Occupant Protection and Areas for Improvement
- Data Collection and Analysis Techniques using NASS-CDS database

Ergonomics

- Introduction to Ergonomics - Definitions, Errors in Design, and Normality
- Anthropometry - Definitions, Averages, and Design Options
- Strength and Energy - Work Design, Heart Rate Guidelines, and Low Back Compressive Forces

Biomechanics

- Biomechanics of Hip and Knee, Total Hip & Total Knee Replacements
- Bone Repair and Healing
- Muscles, Ligaments, and Tendons

Biochemistry

- Basic Organic Chemistry
- Basic Biochemistry - Carbohydrates, Lipids, Proteins, and Nucleic Acids
- Cellular and Molecular Biology

Besides lectures and labs, the students take several educational field trips. Prior trips have included visits to a university medical center, hospital laboratories, science museums, an automaker's crashworthiness lab, and a salvage yard.

Since the LITE program is a residential program, the students are housed in our residence hall. Nightly entertainment and weekend activities are provided. Due to the scheduling at Kettering University, regular classes are in session when the participants are on-campus. The LITE students, therefore, are able to participate in active campus life.

Funding for the program comes from corporate and alumni support, as well as a from the nominal registration fee paid by participants (which is waived in cases of financial need). Faculty receives compensation for teaching and preparation, as well as funding for laboratory materials and essential equipment. Student mentors, who take unpaid leaves of absence from their co-op jobs, also receive compensation. Table 1 illustrates the costs for the LITE program.

	LITE Programming Costs				
	Faculty, Student Mentors	Housing and Meals	Laboratory Materials & Equipment	Speakers and Field Trips	Entertainment
	$26,000	$25,000	$14,400	$8300	$5800

Table 1. LITE Programming Costs for 2003 (based on 36 participants).

ASSESSMENT

Twenty-five participants who completed the 2002 pilot LITE program responded to a survey measuring their interest in STEM related undergraduate programs and careers. A web-based survey was created using www.freeonlinesurveys.com, and the response rate was 80%. When asked how likely they were to pursue the following STEM degree programs, prior to attending the pilot LITE program, they responded as shown in Table 2. Following the pilot LITE program, the respondents were much more likely to pursue these STEM programs, as reported in Table 3.

Program	**Very Likely**	**Likely**	Neutral	Unlikely	Very Unlikely
	%	**%**	%	%	%
Biology	**25**	**30**	25	10	10
Chemistry	**0**	**20**	20	50	10
Engineering	**15**	**30**	25	10	20
Mathematics	**15**	**40**	25	10	10
Physics	**0**	**30**	40	10	15

Table 2. LITE participant responses prior to program.

Program	**Very Likely**	**Likely**	Neutral	Unlikely	Very Unlikely
	%	**%**	%	%	%
Biology	**40**	**20**	15	15	10
Chemistry	**10**	**20**	30	35	5
Engineering	**65**	**25**	5	5	0
Mathematics	**25**	**35**	20	15	5
Physics	**20**	**45**	15	20	0

Table 3. LITE participant responses following the program.

It is clear that the participants far more likely to pursue programs such as engineering and physics after attending LITE (probably due to the heavy attention paid to these disciplines during the program). Of equal importance is the fact the interest in the other STEM disciplines did not decrease. In fact, 31% of the 2002 participates enrolled at Kettering University this year with declared majors in STEM programs and currently 25% of 2003 participants are registered for 2004.

A web-based survey was also sent to the undergraduate female engineering students who served as mentors in the LITE program. The mentors were asked to evaluate any increased interest in science, engineering, and mathematics among participants as a result of the program. Eleven of the twelve mentors responded to this survey (92%) All eleven mentors reported that the LITE participants that they mentored were either much more likely (6/10) or likely (5/10) to choose to major in science, engineering and/or mathematics after they had attended LITE.

The mentor survey was also used to evaluate benefits of the LITE program to the mentors themselves. The results of these survey questions are given in Table 4. Almost all of the mentors reported knowing more about the opportunities available to them in STEM related fields than they had before mentoring in the LITE program. Most reported that they were giving more consideration to graduate school in STEM disciplines, and some of the LITE mentors also reported they had become more interested in medicine or engineering career options. The vast majority of mentors reported feeling more confident about their value to the engineering profession (a perception we regard as critical to women student retention). Serving as a mentor improved their mentoring skills and increased their interest in mentoring others in the future.

Survey statement: As a result of participating in LITE…	Mentors responding "yes" (out of 11)
I know more about the opportunities available to me as a female in science, engineering, and mathematics	10
I am giving more consideration to graduate school for an advanced degree in science, engineering, or mathematics	9
I am giving more consideration to going to medical school	2
I have more ideas about the engineering career I might enjoy	5
I'm more confident about my value to the engineering profession	9
I enjoy mentoring more than I did before	8
I'm likely to seek out people to mentor in the future	9
My mentoring skills improved	10
I'm likely to continue to correspond with the women I mentored	6

Table 4. Mentor Survey Responses.

References:

1. Lee, J. D. (2002). "More than ability: Gender and personal relationships influence science and technology involvement." Sociology of Education 75(4): 349-373.

2. Pierce, R. L. and Kite, M. E. (1999). "Creating Expectations in Adolescent Girls," In S. N. Davis, M. Crawford, and J. Sebrechts (eds.), *Coming Into Her Own; Educational Success in Girls and Women*, Jossey-Bass, Inc., San Francisco, CA. pp. 187-191.

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BETSY HOMSHER is Director of Women Student Affairs. She received her B.A. and M.A. from San Francisco State University and has trained extensively in Gender Studies. She directs the LITE Program, as well as a number

of other programs designed to enrich the experience of current women undergraduates and to increase substantially the number of women students recruited to the university.

LAURA SULLIVAN is an Associate Professor of Mechanical Engineering at Kettering University in Flint, Michigan. She received her B.S. from Arizona State University, and her M.S. and Ph.D. from the University of Texas at Arlington. A former Division Chair in the Materials Division, Dr. Sullivan is now actively involved in the Women in Engineering Division and much of her research focuses on factors which contribute to the recruitment and retention of female students in engineering. Her other research interest is in orthopedic biomaterials.