

# **AC 2008-1861: IMPACT OF PRE-COLLEGE PROGRAM ON HIGH SCHOOL GIRLS' INTEREST IN ENGINEERING**

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# **Impact of Pre-College Program on High School Girls' Interest in Engineering**

## **Abstract**

Lives Improve Through Engineering (LITE), introduces the field of engineering and its particular perspective for women during a two-week residential program held each summer at Kettering University. Since 2002, more than 150 11<sup>th</sup> graders have completed the program. Through classes, labs, hands-on activities, career seminars, and other program features, these rising seniors learn what engineers do and how engineering improves people's lives. Pre- and post-program surveys indicate participant interest in engineering as a field of study and career choice builds substantially as a result of the program: 64% of the participants report increased interest in the field. LITE's impact on high school girls is significant, to be sure. We have also found that the LITE Program benefits everyone involved in the program: mentors, faculty, and the University. Student mentors report renewed commitment to engineering. All of them describe their mentoring experience as personally "rewarding" and "fulfilling." Faculty report increased satisfaction with teaching. And, the University enrolls 36% of all LITE participants, the majority of whom become exceptional students as well as contribute to the University's diversity. LITE Program benefits extend even further. In one course, "Vehicle Collision Analysis and Occupant Protection", LITE Program participants study real-world collisions and learn how safety systems save lives. Data collected indicates that seat belt usage, among participants and their passengers increased 72% following LITE Program participation. Clearly, teaching crash safety can save lives. This knowledge assumes particular significance as the death rate of teenagers in automobile collisions rises across the United States. LITE, it turns out, improves the lives of everyone involved, and many others, too.

## **Introduction**

Lives Improve Through Engineering (LITE), introduces the field of engineering and its particular perspective for women during a two-week residential program held each summer at Kettering University. Since 2002, more than 150 11<sup>th</sup> graders have completed the program. Through classes, labs, hands-on activities, career seminars, and other program features, these rising seniors learn what engineers do and how engineering improves people's lives.<sup>1</sup>

## **Curriculum**

The LITE Program curriculum was developed in response to a growing body of evidence that indicates young women are drawn to engineering when they see its potential for improving people's lives. Through classes, labs, and career seminars, we link engineering and social values that young women care about; making important and unique contributions to the lives of individuals, as well as to American society.

The LITE curriculum consists of three tracks: academic, professional, and personal development. Faculty carry out intellectually rigorous classes and labs in subjects that capitalize on our professors' expertise, as well as marketplace needs for engineers and scientists.

Participants also explore why women's contributions to engineering are unique, significant, and in demand in a seminar entitled "Designing Women." Participants observe engineers at work—in labs, on manufacturing floors, and in offices at regional businesses. Alumnae and other working professionals conduct career seminars which emphasize work-life balance and a variety of gender-specific topics. Faculty, mentors, and program staff encourage participants to cultivate their talents and make active, positive choices that will lead to personal and professional fulfillment.

The academic curriculum includes courses in Biomechanics, Vehicle Collision Analysis and Occupant Protection, Biochemistry, and Engineering for a Sustainable Society.<sup>2</sup> Each topic links engineering and science to solving people's problems, a connection most young women with aptitude for science and math do not make.<sup>3</sup> For example, Engineering for a Sustainable Society is an interdisciplinary course that draws on the expertise of an industrial (or mechanical) engineer, a management specialist, and an ethicist. Participants learn how to design a drinking water filtration system, why "going green" makes good business sense, and the social and cultural implications of sustainable environmentalism. The course resonates with young women because it allows them to "combine [their] love of engineering with wanting to help people."

The Vehicle Collision Analysis and Occupant Protection course utilizes Newton's Laws of Motion to understand the physics of vehicle collisions. Besides being exposed to the theory of crash analysis, participants conduct crash tests with anthropomorphic test devices, install child seats into vehicles, tear-down seatbelts, deploy airbags, and study the structural design associated with crash safety. A survey of the participants showed a 64% increase in interest to pursue the study of physics. And, as an added bonus, the young women reported a 72% increase in seatbelt use for themselves as well as for their passengers. This increase was reported three months after program participation, so the information that they are exposed to stays with them. And, since teen car crashes are the single greatest cause of teen deaths and permanent injuries in North America<sup>4,5</sup>, increasing seat belt use can save lives.

## Participants

Kettering University recruits nationally for LITE Program participants who, over the years, have come from 22 different states. The majority of participants (72%) reside in Michigan, although a number have come from locations 1000+ miles away. Admission to the program requires a 3.0 overall grade point average, a demonstrated strong interest in science and math, and a letter of recommendation from a science or math teacher indicating the applicant's suitability (academically and maturationally) for a pre-college program. A group of LITE faculty and staff review applications at least three months prior to the LITE session and select participants through a fair selection process. Typically, the number of applications exceeds the capacity of the session. The upper limit is of participants is set at 40 and driven by optimal class size and availability of rooms in the residence hall. The number of LITE students chosen per session has ranged from 28 to 36.

Participants find out about the LITE application process through a variety of communication channels. Applications are sent to high school counselors in the fall and winter prior to the LITE session. They are also distributed at National Science Fairs and through

professional networks of recruiting. Word-of-mouth communication has also increased the number of applicants. A letter of recommendation from a science teacher is a requirement of the application process so blank applications are sent to known high school science teachers as a means of recruitment.

## Assessment

Assessment is considered to be an essential component of the Kettering University LITE Program planning and implementation. Each year, we conduct a number of surveys that provide quantitative and qualitative data. We survey participants, faculty, and the undergraduates who serve as mentors. Participants complete pre- and post-program surveys to measure LITE's impact on their interest in engineering, as well as program expectations and satisfaction levels. We track participants into their college years, determining where they go to college, why they chose their particular institution, their majors and minors, and whenever possible, their post-baccalaureate plans. We track LITE matriculants closely once they enter Kettering, following their academic performance, as well as their co-curricular activities. We measure faculty satisfaction. Also, we survey mentors for information about their LITE experiences. The knowledge gained from our assessment tools (which have grown in number and content over the past six years) allows us to maintain a dynamic climate for participants, faculty, and student mentors. An overview of selected assessment highlights and their impact on all aspects of the program are listed in Table 1.

## Faculty

Seven tenured faculty teach all LITE Program courses and facilitate all labs. In addition to their program teaching responsibilities, the faculty develop personal relationships with participants by attending a variety of social events, including concerts, barbeques, and the like. The inclusion of faculty--and their family members—in social events allows participants to observe engineers, scientists, and other academic professionals as they balance challenging, demanding, and stimulating careers with rich family lives. This modeling resonates with young women who, in independent studies, often express fears that careers in STEM fields conflict with personal interests and values. LITE participants overwhelmingly agree their social interactions with faculty go a long way toward convincing them they can achieve all their aspirations, including marriage and family life, as well as professional careers.

Faculty relationships with LITE participants persist throughout the school year following the program as the high school girls apply for and select colleges and universities to attend. Some of these relationships are voluntary and informal, consisting primarily of email exchanges. Others are specially designed by program staff to maintain ties between the participants and the University so as to encourage the students to enroll here. Qualitative evidence gathered from former participants who enroll at Kettering University suggests that both types of exchanges contribute significantly toward choosing to attend, as well as enhancing the students' undergraduate experiences once they matriculate. Faculty report that these relationships contribute significantly toward their sense of satisfaction with the LITE Program, as well as with their teaching in general.

<u>Who is Surveyed</u>	<u>Type of survey</u>	<u>Measures</u>	<u>Significant Results</u>
LITE participants (156; 2002-2007)	Pre/Post <b>session</b> survey upon arrival and before departing campus	Interest in engineering	64% increased interest in engineering
	Post- <b>program</b> survey	Program expectations and satisfaction	>95% report LITE met or exceeded expectations; curricular and co-curricular offerings modified in response. Results consistent over 6 years of program.)
	Follow-up survey three years after completing LITE (2005 & 2007)	Academic choices	94% major in engineering
Undergraduate LITE matriculants (55; 2003-2008)	Informal relationships	Anecdotal	10/55 have become LITE mentors
LITE faculty (Seven total, 2002-2007. Five original, two added in 2006.)	Summative survey at session completion	Program expectations and satisfaction	Faculty has remained constant; course content changed. Faculty report high degree of satisfaction with LITE program
	Planning meetings	Curriculum	Class offerings modified to include sustainability
LITE mentors 46 students, some multiple years.	Summative survey at session completion	Program expectations and satisfaction	100% of mentors report their experience exceeded expectations.
	Formative survey during LITE session	Anecdotal	Program co-curricular content and logistics adjusted according to dynamic conditions.

Table 1: Assessment Methods and Measures

### Mentors

Mentors play an essential role in the LITE Program. Kettering undergraduate women (selected by program staff through a competitive application process) serve as advisers, program guides and, perhaps most importantly, as role models. LITE mentors exemplify what the program is all about: smart and talented young women pursuing academic degrees; preparing for careers in engineering, science, and technology; and enjoying college life. They represent the very best of what STEM fields and Kettering have to offer, something which participants recognize. Year after year, participants rank their mentors as one of the most appealing aspects of LITE. Indeed, since 2002, participants have identified their mentors as the first or second best

feature of the program. For their part, mentors report significant benefits from their experiences, including increased confidence in their choice of engineering and their ability to have a positive impact on protégées. The best evidence for mentors' rewarding experiences lies in their desire to serve, year after year. Nearly 100% of all mentors serve more than one year; many have served every year since they enrolled at Kettering University. Of the 55 former LITE participants who have matriculated here, 10 have become LITE mentors for at least one year.

This program component evolved from studies which identify mentorship as a critical ingredient to selecting a STEM major, as well as persistence and success at the college level. In 2003, Goodman et al found that mentorship (and other forms of community building) served a number of important functions for high school girls considering engineering.<sup>6</sup> It provides role models to support and encourage smart and talented girls in pursuing their intellectual interests. It also counteracts the isolation girls experience in mostly-male STEM learning environments. We find it benefits participants and mentors in a myriad of ways.

### LITE Matriculants

Since 2003, 55/152 (36%) of LITE participants have matriculated at Kettering. They represent our best and brightest students. Their GPA's (expressed at Kettering by percentage points) exceed all students' by nearly three points. Nearly half of them have earned spots on our Dean's List every term of enrollment. Twenty-four (44%) have GPA's above 90%.

Eighty-three percent (83%) of LITE matriculants major in mechanical engineering; 75% of these students intend to complete a concentration in bioengineering, a primary focus of the LITE curriculum. Given the overall decline in interest in mechanical engineering across the nation, this figure demonstrates how exposure to the field's potential can impact interest and matriculation. We can further substantiate this claim with data from post-program surveys conducted among former participants who matriculate elsewhere. Nearly 65% of them major in mechanical engineering at other colleges and universities (92% major in various engineering fields).

Retention rates among LITE matriculants are significantly higher than those of other students, including women students. We have retained nearly 100% of all LITE matriculants, a highly favorable number by any standard. Only one student has left the University before completing her degree. Four (4) have graduated. Among them are two women who intend to complete Ph.D.'s in STEM disciplines. One attends graduate school; another will begin next fall.

### Conclusion

Attracting young women to engineering remains challenging, despite our success with LITE. Social and cultural obstacles are deeply entrenched and remarkably resistant, despite considerable efforts by many segments of American society to open up opportunities for young women. We believe that LITE and other pre-college programs contribute significantly to changing perceptions among young women about studying STEM subjects and choosing careers in STEM fields. LITE is a successful program that benefits the participants, their mentors,

Kettering University faculty, and the institution. We have shown that a dynamic, gender-specific curriculum can influence how high school girls choose majors and colleges/universities. We have also demonstrated how mentors' and faculty members' participation positively impacts self-perceptions about choices; academic, professional, and personal. We have established that participation in a pre-college program impacts the University's enrollment and retention rates. While we cannot necessarily connect participation and later academic performance, we can say that LITE matriculants out-perform their peers by almost any measure. We have also learned how far-reaching instruction can be, given changes in attitudes and behavior regarding seat belt usage. We intend, over time, to measure other attitudinal changes about a variety of topics, so that we may engage our students and ourselves in a continuous cycle of improvement.

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