AC 2007-1106: LONG-TERM EFFECTS OF A MIDDLE SCHOOL ENGINEERING OUTREACH PROGRAM FOR GIRLS: A CONTROLLED STUDY

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Long Term Effects of a Middle School Engineering Outreach Program for Girls: A Controlled Study

Abstract

This study compares the high school choices and choice of college major of two groups: young women who participated in the two-week Camp Reach engineering program as rising sixth graders, and those who applied to the program but were not chosen in the random lottery (control group). Results indicate that, in comparison to the control group, Camp Reach participants were significantly more likely to attend a public high school specializing in mathematics and science and also more likely to enroll in elective math and science courses in high school. While a higher fraction of the Camp Reach group chose engineering majors upon college entry, the difference did not reach statistical significance. Grouping all STEM-related majors together, choices of the Camp Reach and control groups were not significantly different. Furthermore, there were no significant differences in the engineering self-efficacy and other measures of efficacy between the Camp Reach and control groups.

Introduction and Background

The crisis of under-representation of women in engineering continues unabated and in fact is projected to be worsening.[1,2] Enrollment statistics compiled by the American Society for Engineering Education (ASEE) for the period 1999-2005 show only a small increase in the number of B.S. engineering degrees awarded to women, insufficient to meet workforce demands. Furthermore, the number of women enrolling in engineering programs decreased in the 2004-05 academic year.[2] Among a variety of strategies being employed by universities, summer outreach programs for girls and/or other minorities, also referred to as pipeline or intervention programs, are relatively common. In their study of the impact of the National Science Foundation's Program for Women and Girls,[3] Darke, Clewell, and Sevo found evidence that summer camps were "successful in achieving positive change" for girls in science, technology, engineering, and mathematics (STEM). Still, however, there are key gaps in evaluation of these programs that limit the extent to which their value and cost/benefit proposition can be judged or compared to those of other strategies.

One limitation of existing summative program evaluation is that typically only short-term impacts are measured, comparing pre-program and post-program data on participants' attitudes about and knowledge of engineering. While widening the pipeline is the fundamental mission of most programs, there is very little knowledge of the extent to which short-term positive effects are sustained and realized over the long term. One conclusion of the review by Darke, Clewell, and Sevo was a call for longitudinal studies[2]:

> There is a need for innovative methods to encourage the assessment of longitudinal outcomes. Many programs are unable to assess the long-term outcomes of their efforts because of the difficulty and expense of collecting outcome data on participants over a period of several years…. The development

> of innovative approaches to facilitate the collection of longitudinal data would make a significant contribution to program evaluation. (p. 300)

This challenge of longitudinal evaluation is exacerbated for middle school programs. Many researchers have argued that early interventions, prior to high school, are critical,[1,4,5] yet there is such a long lag time between the intervention and the point of college entry that longitudinal evaluation is especially challenging.

Another limitation of prior research on the effects of STEM intervention programs that is rarely acknowledged has been the inability to eliminate or control for the self-selection factor. In other words, it is possible or probable that girls who choose to participate in an engineering outreach program, even in middle school, are those who would be inclined to choose a STEM major and career even without participation in the program. Appropriate control or comparison groups can be difficult or impossible to identify and engage.

This study closes both of these gaps in prior evaluation of pipeline programs for girls. In this paper we report the initial findings of an ongoing longitudinal evaluation of Camp Reach, a summer engineering camp for girls entering the 7th grade. The Camp Reach admissions process was specifically designed to enable a control group, so that self-selection could be eliminated as an explanation for any long-term impacts. After ten years in operation there are now four camper cohorts and associated control groups that have graduated from high school. From them we have collected information about their high school experience, knowledge of engineering, self-efficacy beliefs, and initial choice of college major. To the best of our knowledge, this study is the first longitudinal evaluation of a middle school intervention program that has used this type of controlled research design.

Program Description

Founded in 1997 at Worcester Polytechnic Institute (WPI) in central Massachusetts, Camp Reach is a two-week summer residential program offered annually to 30 girls entering seventh grade who are interested in learning about engineering and technology. Initial funding was provided by a grant from the National Science Foundation, Model Projects for Women and Girls. Since 1999, WPI has raised approximately $35,000 to $40,000 annually from corporations, foundations, and individuals to mitigate program tuition and to provide close to full financial aid to families with need. In 2003, Camp Reach received the Women in Engineering Program Award from the Women in Engineering Programs and Advocates Network (WEPAN). This section provides an overview of program goals and strategies and summarizes previous summative evaluation of Camp Reach.

Goals and Strategies

The stated goals of Camp Reach are to generate and sustain adolescent girls' interest in engineering and technology, their motivation toward education, and their self-confidence. The program also seeks to enhance the understanding of engineering among the parents of participants and among the middle school math and science teachers and high school women

who are part of the program staff. The evaluation presented in this paper addresses only the goals specific to the middle school "camper" participants.

The program design of Camp Reach encompasses research-based best practices for engineering outreach programs for girls.[3,6,7] The following strategies and messages underpin the program:

- *Real-world problem solving:* The central feature of the camp experience is a service-learning design project in which teams of campers address a problem or need of a non-profit organization in the Worcester community using teamwork, creativity, and the engineering design process. Each team of 10 engineers is coached by a middle school teacher and two or three high school women, and they work on the project for at least three hours each day of the program. The client organization implements at least some aspects of the girls' recommendations in the year following the program.

- *Collaboration, teamwork, and communication:* Girls experience engineering as a social, collaborative "people profession" that benefits from excellent written, oral, and interpersonal communication skills.

- *Prevalence of role models:* The camp staff is selected in such a way as to expose girls to a broad spectrum of female role models: high school students who are alumnae of the program; undergraduate and graduate engineering and science majors; STEM faculty; and practicing women engineers at Bose Corporation.

- *Hands-on learning:* Campers participate in a variety of Discovery Workshops that are active, interactive, and exploratory, with topics that are likely to be relevant and fun for 12-year old girls.

- *Breadth of opportunities:* Discovery Workshop topics are selected to provide exposure to a wide array of engineering and science disciplines and careers.

- *Engineering as a helping profession:* Wherever possible, workshop topics show how engineers make a difference and make the world a better place. Examples include rehabilitation engineering, fire protection engineering, biomedical engineering, and forensics. In addition, design project sponsors are non-profits serving people with needs (e.g., homeless shelters, homes for families with childhood cancer, day care centers.)

- *Building self-efficacy:* Research has shown that self-efficacy beliefs are a stronger predictor of entry into engineering majors than measures of achievement.[5,8] Toward this end, the Camp Reach program seeks to develop a variety of self-efficacies by challenging the girls and providing sufficient encouragement and support so that performance accomplishment is achieved. These performance accomplishments range from staying in a college residence hall with an initial stranger for two weeks away from their families with only one phone call home, to making an oral presentation in front of an audience of more than 100 people.

- *Staying in contact:* Camp Reach is not just a single two-week intervention. Several strategies are used to promote long-term effects of the camp experience through the high school years.

In the year following the program, the design teams come back together at least once to participate in or celebrate the implementation of their recommendations. Two reunions are held each year for the entire alumnae community, and a bi-annual newsletter includes alumnae news, engineering and science topics and opportunities, and personal development information. In addition, alumnae who have completed their sophomore year of high school are invited to apply to be a Camp Reach staff member. Typically between four to six alumnae from each cohort of 30 campers have come back to the program as staff members.

More detailed information about program elements can be found in annual reports on the program website.[9]

Previous Assessment and Evaluation

Extensive formative and summative evaluation has been conducted since the program's inception in 1997. Adjustments to the program are made each year based on feedback from campers, staff members, and parents. Summative evaluation has provided information on the short-term impact of the program. Pre and post questionnaires are administered, and the quantitative data are analyzed using paired sample t-tests to compare pre-program data with post-program data from both campers and parents. Qualitative data from open-ended questions have added depth to those findings. Complete formative and summative evaluation results can be found on the program website.[10] The following short-term impacts of the program have been demonstrated:

- *Enhanced interest in and knowledge of engineering:* Campers' interest in engineering at the end of the program is significantly higher than their initial interest. In addition, participants' self-reported understanding of engineering improves as a result of the program. Moreover, their descriptions of engineering are more likely to include elements that the program emphasizes: engineering as a helping profession and engineers as problem solvers.

- *Enhanced motivation toward education:* After the program, Camp Reach participants typically report a significantly greater interest in their upcoming math and science courses. (This result has been seen in most but not all years of the program.) Parents' comments several months after the program often refer to improved motivation in school.

- *Enhanced confidence and self-efficacy:* At the end of the program, participants respond significantly more positively to the statement, "I could be an engineer if I wanted to." Self-ratings of skills relevant to an engineering career also increase over the course of the two-week program, and a measure of self-image and self-esteem increases significantly as well. Parents frequently cite improved confidence when describing effects of the program on their daughters.

A key question is *"To what extent, if any, are these positive effects sustained through high school and to the point of college entry?"* While short-term summative evaluation results have been sufficiently powerful to sustain personal, professional, and financial commitments to this ambitious program, to this point we have had only anecdotal evidence of some long-term effects of the program. Moreover, for the "success stories" among program alumnae, it is possible that much can be explained by the initial interest they showed in applying to the Camp Reach

program as a sixth grader. Therefore, a longitudinal evaluation with a controlled research design was undertaken to address these questions.

Method

Evaluation Objectives

Post-hoc evaluations were conducted in the summers of 2004 and 2006. Girls who attended Camp Reach or applied to Camp Reach from 1997 through 2000 were contacted six or seven years after their participation. The evaluations sought to identify possible long-term effects of the girls' summer and post-camp activities. Summative components of the evaluations addressed possible effects of Camp Reach on young women's high school experience and motivation (choice of high school, courses and activities, choice of college major), self-confidence (self-efficacy and self-perception), and knowledge about engineering. Formative aspects of the evaluations explored factors that influence educational/career path, long-term memories of Camp Reach, and participation in post-Camp Reach activities.

Sample

Girls who attended Camp Reach and girls who applied to Camp Reach but did not attend during the summers of 1997, 1998, 1999 and 2000 comprised the study sample. Because applicants typically outnumber available camper slots, a lottery system was established. Applicants write a short essay about a time in their life when they had to work hard at something. All essays that meet minimal standards are entered into a random lottery for the 30 available positions in the program. Adjustments are made as necessary so that the camper population is representative of the racial profile of middle school students in Worcester County. This lottery system allowed for a control group of girls with similar pre-existing interest and self-selection attributes as the Camp Reach group of girls.

We started with a potential study group of 178 girls; 111 (62.4%) who attended Camp Reach and 67 (37.6%) who applied, but did not attend. Successful contact was made with 129 young women; 88 (68.2%) who attended Camp Reach and 41 (31.8%) who did not. Thus, the overall response rate was 72.5%. (See Appendix Table A-1 for a breakdown by year.) The primary reason for lack of contact was outdated telephone numbers. Only three girls declined to participate, two from the 2004 interview group and one from the 2006 interview group.

Data Collection

Data for the study came from telephone interviews conducted by an assessment specialist in 2004 and by a professional interviewer with experience interviewing college-aged students in 2006. Prior to a telephone call, campers and controls were sent a letter informing them of the project and a $25 participation incentive. Letters were sent in four batches between early July and mid August. If not connected on the first try, at least four, and as many as 11, attempts were made to reach each girl by telephone.

The telephone interviewers followed and completed an interview protocol that included structured and open-ended questions. Detailed notes and quotes were written for the open-ended questions. Data from the 2004 and 2006 interviews were coded and entered into SPSS™ by the same person.

Analysis

There were three groups in the analysis. Because it was posited that continued involvement with the Reach program after the conclusion of the two-week camp might be associated with long-term effects, the Camp Reach group was split into two groups. The first group consisted of campers whose only participation was Camp Reach (Camp Reach Only). The second group consisted of campers who participated in at least one Camp Reach follow-up activity such as a reunion (Camp Reach Plus). The control girls comprised the third analysis group (Control). There were 19 (14.7%) Camp Reach Only campers, 69 (53.5%) Camp Reach Plus campers, and 41 (31.8%) controls, for a total of 129 in the analysis. In some cases, the Camp Reach Only and Camp Reach Plus groups were combined together for analysis purposes (Camp Reach Combined). Due to the small number of women in the Camp Reach Only group and lack of contact information for 1997 control girls, analysis by year of participation was not conducted. See Appendix Table A-2 for details.

Quantitative interview question responses were entered into SPSS. Qualitative responses were entered into Microsoft Word. Standard statistical analyses ('*t*'-tests, contingency tables, analysis of variance, and related non-parametric approaches) were employed. Content analysis approaches were used for qualitative responses.

Determination of types of engineering: Lists of engineering majors at seven large, well-known institutions[11] were gathered to verify respondents' depiction of types of engineering and intended or declared majors. A summary list was created against which respondents' descriptions of declared and undeclared college majors and different types of engineering were checked.

Description of engineering: Three categories were developed for description of engineering. These categories matched program objectives for girls to be able to understand engineering by applying knowledge in areas of math and science and experiencing how the engineering design process can be used to find creative solutions for the problems of individuals, organizations, communities, and societies. In addition, dictionary *(Merriam Webster)* and encyclopedia *(Britannica)* definitions of engineering confirmed the three categories. Finally, two doctoral level electrical engineers verified the broad definition and partial descriptions.

"*Uses math and science to create things and/or to solve problems"* was chosen as a complete answer. Responses that included either *solves problems/creates things* or had a reference to the *use of math and science* were considered as a partial answer. The third category covered "*no idea"* and similar responses.

High school courses: While Massachusetts does not have statewide graduation requirements, most school districts require at least three years of mathematics and science.[12] Biology, Earth Science, Chemistry, and Algebra are typically required. These courses were not included in the

analysis. We did ask students if they took physics, calculus, computer science, and other science or engineering courses.

Results

Findings for differences between Camp Reach girls and control girls were mixed, with the strongest findings related to high school. First, we discuss high school influences. Next, the girls' knowledge of engineering is addressed. Effects on self-confidence and self-efficacy follow. The section concludes with the Camp's influence on choice of college major.

High School Experience

Camp Reach had an influence on girls' choices in high school and on the types of courses they took. In particular, it was felt that the Camp Reach experience would encourage the girls to apply to a select 11th and 12th grade public, academy high school for 100 academically accelerated youths. A collaborative effort among the Commonwealth of Massachusetts, Worcester Polytechnic Institute, and the high schools of Massachusetts, the Massachusetts Academy of Mathematics and Science emphasizes math and science and includes enrollment in college courses during the students' senior year. Seven girls did graduate from the Academy, and all seven were in the Camp Reach Plus group ($X^2 = .218$, $p < .05$).

In addition, it was posited that participation in Camp Reach would result in more Camp Reach than control girls enrolling in high school calculus, physics, computer science, and other science and engineering courses that are relevant to engineering preparation. More Camp Reach girls than control girls were enrolled in computer science and other science/engineering courses. Although more control than Camp Reach girls enrolled in Physics, the difference was not statistically significant. Table 1 depicts the number and percentage of girls enrolled in STEM-related courses.

Table 1. High School Course Selection, by Study Group

	Enrollment in High School Courses								
High School Course	Camp Reach Plus (n=69)		Camp Reach Only (n=19)		Control (n=41)		Total (n=129)		*p value*
	#	%	#	%	#	%	#	%	
Physics	43	*62.3*	9	*47.4*	29	*70.7*	81	*62.8*	*n.s.*
Calculus	31	*44.9*	6	*31.6*	21	*51.2*	58	*45.0*	*n.s.*
Computer Sci	23	*33.3*	4	*21.1*	4	*9.8*	31	*24.0*	*<.02*
Other Sci/Eng[a]	31	*44.9*	6	*31.6*	9	*22.0*	46	*35.7*	*<.05*

[a] Other science and engineering courses include: Anatomy and Physiology (58.7%), WPI courses taken by Massachusetts Academy students (15.2%), Environmental Science (13.0%), Engineering Design (4.3%), Forensics (4.3%), Anatomy and Environmental Science (2.2%), and unspecified (2.2%). It should be noted that Anatomy may have been required in some of the girls' school districts.

Other High School Activities

After two intensive weeks of exposure to engineering and science at Camp Reach, it was anticipated that the girls would take an interest in science, mathematics or engineering activities during their high school years. During the interviews, a list of mathematics, science, and engineering activities, such as summer programs and research were read to the girls. Girls were asked to indicate whether or not they had participated in any of them while in high school.

A higher percentage of Camp Reach girls than control group girls participated in competitions or contests, after school clubs, teaching, research, and paid work activities. A higher percentage of control group girls than campers participated in summer programs and volunteer work. However, none of the differences were statistically significant. The girls in the three groups reported similar levels of participation. About as many Camp Reach Only (52.6%, mean 1.26 activities), Camp Reach Plus (58.0%, mean 1.30), and Control (56.1%, mean 1.00) girls indicated that they had participated in at least one high school math, science, or engineering related activity.

Knowledge of Engineering

During Camp Reach, girls were introduced to various types of engineering fields and to what it means to be an engineer. Two questions addressed this aspect of the program. In the first, girls were asked to name as many types of engineering as they could. The most commonly mentioned fields were chemical, civil, computer, electrical, and mechanical. From zero to 11 different types were mentioned. Mean number of types of engineering were 3.52 (range 0 to 11) for Camp Reach Plus, 2.26 (range 0 to 5) for Camp Reach Only, and 2.88 (range 0 to 8) for the control group ($F = 2.353$, $p>.09$ n.s.) Post hoc comparisons indicated a statistically significant difference between Camp Reach Only and Camp Reach Plus girls' numbers of types of engineering. However, there were no statistically significant differences between the combined Camp Reach groups and the control group in numbers of types of engineering provided.

A second question addressed the girls' ability to define engineering. About as many Camp Reach as control girls gave a complete definition of the field of engineering. However, more campers than control girls were able to provide a partial answer ($X^2=.070$, p .053). These results are shown in Table 2.

The campers' responses to an open-ended question concerning what they remembered most about their summer supports their understanding of engineering. Even several years after the summer program, the women recalled one of the skills of engineering. The girls' memories of the activities at Camp Reach were filled with comments about working together in teams to solve problems and to create structures or products.

Self-Confidence and Self-Efficacy

The Camp Reach experiences were designed not only to expose the girls to engineering fields, but to increase their self-confidence and self-efficacy. The potential influences were measured

Table 2. Description of Engineering, by Study Group

Description of Engineering	***Number and Percent of Respondents***					
	Camp Reach Combined		Control		Total	
	#	%	#	%	#	%
Uses math and science to create things and/or solve problems	23	*26.1*	12	*29.3*	35	*27.1*
Either solve problems/create things OR uses math and science	55	*62.5*	19	*46.3*	74	*57.4*
No idea	10	*11.4*	10	*24.4*	20	*15.5*
Total	88	*100.0*	41	*100.0*	129	*100.0*

Table 3. Mean Self-Rating[a] on Abilities, by Study Group

Trait on which rated self compared to average person of same age	***Mean Self-Rating[b] on Trait***			
	Camp Reach Plus	Camp Reach Only	Control	Total
Computer skills	2.51	2.53	2.44	2.49
Mathematical ability	2.38	2.45	2.32	2.37
Science ability	2.30	2.58	2.45	2.39
Intellectual self-confidence	2.03	2.37	2.15	2.12
Social self-confidence	2.09	2.37	2.27	2.19

[a]Rating choices were: 1 – highest 10%, 2 – above average, 3 – average, 4 – below average, and 5 – lowest 10%.
[b]There were no statistically significant differences between means for any of the competencies.

quantitatively and qualitatively. One approach was to ask the girls to rate themselves on computer skills, mathematical and science ability, intellectual self-confidence and social self-confidence. Except for science ability, all items come from the Cooperative Institutional Research Program (CIRP) Freshman Survey developed by the Higher Education Research Institute (HERI). While the Camp Reach girls generally rated themselves more highly than the control girls, as shown in Table 3, the differences were not statistically significant.

Except for mathematical ability, Camp Reach and control girls' CIRP ratings are higher than those of first year women at WPI who took the CIRP-HERI survey in 2005.[13] Ratings on all three variables are higher than CIRP women attending non-sectarian four-year institutions. These results are shown in Table 4.

Table 4. Comparison: 2005 CIRP Institutional Profile for First-time, Full-Time College Women

	Percentage of Women Selecting Above Average or Highest 10%				
CIRP Skill or Ability	WPI CIRP	4-year non-sectarian CIRP	Camp Reach Plus	Camp Reach Only	Control
Computer Skills	23.5%	20.5%	44.9%	52.6%	48.8%
Mathematical Ability	67.7%	45.9%	60.9%	47.4%	65.8%
Intellectual Self-Confidence	36.5%	44.9%	76.8%	63.2%	65.8%

Self-Confidence: Engineering Self-Efficacy

A second quantitative approach involved the girls' rating of their ability to become an engineer. The girls indicated their agreement (from 1 strongly disagree to 5 strongly agree) with the statement, *"I could be an engineer if I wanted to."* Mean ratings of agreement were 4.12 for Camp Reach Plus, 3.42 for Camp Reach Only, and 3.90 for Control girls ($F = 3.168$ $p < .05$). The greater the exposure to Camp Reach activities, the higher the mean rating: post hoc comparisons in an analysis of variance indicated a statistically significant difference between the two Camp Reach groups, but not between the control and combined Camp Reach groups.

Open-ended responses suggest that the program had a stronger influence on self-confidence than these data imply. Six to seven years later, most of the campers recalled specific activities in which they worked together as a team to solve problems. The activities, along with the camaraderie, made the summer program "fun" and "great" for the girls. In addition, Camp Reach gave the girls a sense of empowerment and a feeling of inspiration. Empowerment was expressed as a sense of accomplishment that the activities gave the girls (e.g., "very empowering…the fact that I could do it," "know that [I] did something with an impact") and the personal strengths they gained (e.g., "strengthens you as a girl," "sense of freedom," "got to learn about myself.") The Camp "inspired" girls and "broadened [their] horizons." As one camper said, "It opened up new areas that I wouldn't have considered." The girls told about how Camp Reach influenced them. For one girl it "encouraged me to keep going in math and science," while for another camper it "sparked my outlook on design…affected me and choices I made."

Choice of College Major

Almost all of the young women (97.6 % control , 90.9% Camp Reach X^2 *n.s.*) were enrolled in or about to attend college. Respondents indicated a variety of choices for a major while in college, with many choices (54.2 %) outside of science or engineering. A few girls (12.5%) had not declared a major.

While more Camp Reach girls than Control girls selected an engineering or science-based major, the differences were not statistically significant. More Control girls than Camp Reach girls indicated having a major in the biological sciences, but again the difference was not statistically significant. Table 5 lists the number and percentage of girls selecting a science or engineering major.

Table 5. Choice of Major, by Study Group[a]

Major	Camp Reach Plus		Camp Reach Only		Control		Total	
	#	%	#	%	#	%	#	%
Engineering	10	15.9	1	5.9	2	5.0	13	10.8
Biological Sciences	8	12.7	3	17.6	8	20.0	19	15.8
Science-based Professional	8	12.7	0	0.0	1	2.5	8	6.7
Other or Undeclared	37	58.7	13	76.5	29	72.5	80	66.7
Total	63	100.0	17	100.0	40	100.0	120	100.0

[a]The nine girls who were not attending college were not included in the analysis.

To put the data in Table 5 in perspective, national statistics reported by the National Science Foundation in 2004 showed only 2.9% of first year women enrolled in four-year colleges intended to major in engineering and 9% in biological/agricultural sciences.[14]

Influences on Choice of Major

Almost a fifth (18.4%) of Camp Reach girls who were in college or about to attend college said that the program influenced their choice of major. All but two of these girls had chosen STEM majors.

Interviewers asked the girls what things or people particularly influenced them to choose their area of work or major to study in college. The girls spoke of personal preference or interest (52.7%) most often. Parents (22.3%) and teachers (19.6%) were the next most frequently mentioned influences. There were no statistically significant differences between Camp Reach girls' and girls' in the control group on selection of influences.

Discussion

The controlled design of this study has revealed the strength of the self-selection factor, even in middle school, for applicants to this engineering outreach program. Both the Camp Reach group and the control group—girls who applied to Camp Reach as sixth graders but were not selected in the random lottery— at the time of their interview (close to college entry) rated several measures of academic self-efficacy as high or higher than women who had applied to and enrolled at WPI, a selective technological university. Moreover, the percentage of girls in both the Camp Reach and Control groups who intended to major in engineering or science in college far exceeds national norms. These results suggest that Camp Reach applicants as sixth graders already had some combination of internal, family-based, and/or external factors that led, encouraged, or enabled them to develop their abilities in STEM areas. Therefore, the program seems to be supporting girls who already have strong potential to pursue STEM education.

This is not to say that Camp Reach did not make a difference, however. The greatest impact of Camp Reach is seen during high school and among those campers who had sustained participation with the program. The fact that seven of the Camp Reach girls graduated from the Massachusetts Academy of Math and Science ("Mass Academy"), compared to none of the control girls, is impressive. Parents of Camp Reach participants learn about the Academy from the principal and current female students (typically Reach alumnae) on the closing day of the camp. Mass Academy students often serve as counselors for Camp Reach, and information about applying to the Academy is sent at the appropriate time of year to all alumnae who are high school sophomores. Thus, it seems that these focused efforts to inform parents and girls about the Academy have positive outcomes.

Sustained participation in the Reach program following the summer camp experience in middle school is also associated with stronger longitudinal outcomes. More Camp Reach Plus girls than other girls were enrolled in STEM-related courses in high school, and reported higher engineering self-efficacy at college entry. While no causality can be inferred—it's possible that sustained participation was an outcome of greater interest or self-efficacy at the time-- this result suggests that post-camp activities are important and may benefit from emphasis or expansion. Another implication is that engineering summer camps for middle school girls, in general, may hold little hope for differential longer-time impact if they are just one-time interventions.

Encouraging further participation in the Camp Reach program may have two benefits. First, more young women may enter science or engineering as a result of the program. Secondly, and pragmatically, we may be able to keep track of where they live and increase the sample size for future studies.

While our quantitative data show limited long-term influence, data from open-ended questions suggest that there may have been greater long-term influences than those specifically addressed in closed interview questions. The young women spoke of being "empowered" and "inspired" by the program. Although two young women talked about these influences in response to an open-ended question, they did not indicate Camp Reach as an influence on choice of major in a

closed question. This may be because open-ended questions came toward the end of the interview after the closed questions were asked.

The richness of qualitative data leads us to consider including more emphasis on them in future follow-up studies. Instead of simply asking, "What do you remember most about participating in the Camp Reach program at WPI," we may probe with questions about how they felt then and feel now about the program and their abilities and interests as engineers.

The closeness in results between campers and controls may be because the girls attended other events at WPI. We did not have registration information, nor did we ask the girls specifically if they had attended them. We did drop one girl from the control group who became a Camp Reach counselor.

Summary and Conclusions

In this study we contacted young women who had applied to Camp Reach as sixth graders and have now completed high school. Some had been drawn in a random lottery at the time of application and participated in the Camp Reach program. Those who were not drawn constitute the control group. For study purposes the Camp Reach group was divided into those who participated only in the two-week summer camp and those who also participated in at least one activity for alumnae.

Results indicate that, in comparison to the control group, Camp Reach participants were significantly more likely to attend a public high school specializing in mathematics and science and also more likely to enroll in computer science and other elective STEM courses in high school (not including Calculus and Physics). Close to college entry, the Camp Reach group expressed better knowledge of engineering than the control group. Furthermore, participation in activities for Camp Reach alumnae was associated with stronger longitudinal outcomes compared to girls who participated only in the two-week summer camp. While a higher fraction of the Camp Reach group chose engineering majors upon college entry, the difference did not reach statistical significance. Grouping all STEM-related majors together, choices of the Reach and control groups were not significantly different. Furthermore, there were no significant differences in the engineering self-efficacy and other measures of efficacy between the Reach and control groups.

This study has shown that the self-selection involved in applying to a particular engineering summer camp as a sixth grader is quite strong. Expanding the STEM pipeline more substantially may require approaches that include more follow-up activities, begin at an even earlier age, recruit students with a broader range of initial interest, or that are directed at parents and teachers.

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Not all of the authors had the privilege of knowing Dr. Denise Nicoletti, co-founder of the Camp Reach program, but those who did know Denise know that in spirit she is very much a co-author of this paper. Nicoletti, a tenured associate professor of electrical engineering at WPI and mother

of three, died tragically in the summer of 2002 at the age of 39, the victim of a head-on car collision. The financial support for this longitudinal evaluation project was provided by dozens of donors to the Denise Nicoletti/Camp Reach Memorial Fund, which was established at WPI following her death at the request of Denise's family. Denise was passionate about Camp Reach and cared deeply about assessment and evaluation, and we can't imagine a more fitting tribute than this paper. We are deeply grateful to the fund donors for enabling us to carry on Denise's passion for evaluation.

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Appendices

Table A-1. Number[a] and Percent of Girls in Potential Sample and in Interviewed Group

	Study Status							
	Potential Sample		Completed Interview		Unable to Contact		No Interest Refusal	
Campers	#	%	#	%	#	%	#	%
1997	30	100.0	21	70.0	8	26.7	1	3.3
1998	29	100.0	23	79.3	6	20.7	0	0
1999	24	100.0	20	83.3	4	16.4	0	0
2000	28	100.0	24	85.7	4	14.3	0	0
All Years	*111*	*100.0*	*88*	*79.3*	*22*	*19.8*	*1*	*0.9*
Controls	#	%	#	%	#	%	#	%
1997[b]	0	0	-	-	-	-	-	-
1998	13	100.0	9	69.2	3	23.1	1	7.7
1999	17	100.0	11	64.7	6	35.3	0	0
2000	37	100.0	21	56.8	15	40.5	1	2.7
All Years	*67*	*100.0*	*41*	*61.2*	*24*	*35.8*	*2*	*3.0*
Total[a]	178	100.0	129	72.5	46	25.8	3	1.7

[a] One 2000 control girl who worked as a Camp Reach counselor was dropped from the Potential Sample.
[b] Contact information for 1997 control girls was not available.

Table A-2. Study Groups for Statistical Analysis

	Study Group							
Camp Year	Camp Reach Plus		Camp Reach Only		Control		Total	
	#	%	#	%	#	%	#	%
1997	17	24.6	4	21.1	0	0	21	16.3
1998	20	29.0	3	15.8	9	22.0	32	24.8
1999	12	17.4	8	42.1	11	16.8	31	24.0
2000	20	29.0	4	21.1	21	51.2	45	34.9
All Years	69	100.0	19	100.0	41	100.0	129	100.0