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# Longitudinal Studies of an Outreach Program for Seventh Grade Girls: Evidence of Long-Term Impact

Grazia Todeschini  
College of Engineering  
Swansea University  
Swansea, UK  
grazia.todeschini@swansea.ac.uk

Prof. Chrysanthé Demetry  
Department of Mechanical Engineering  
Worcester Polytechnic Institute  
Worcester, MA, US  
cdemetry@wpi.edu

**Abstract**— Camp Reach is a two-week summer engineering enrichment program for seventh grade girls, with continuing mentoring, communications, and activities for participants as they advance from seventh grade through high school. Camp Reach was founded in 1997 and the selection of participants has been designed to allow for longitudinal studies to evaluate the long-term effects of the program. This paper will present the main features of Camp Reach, the methodology used to perform the longitudinal studies, relevant results and a summary of lessons learned.

**Keywords** — *engineering outreach; K-12 programs; longitudinal study; long-term impact; women in STEM*

## I. DEDICATION

This paper is dedicated to the memory of Prof. Denise Nicoletti, co-founder of the Camp Reach program. Prof. Nicoletti was Associate Professor of Electrical Engineering at Worcester Polytechnic Institute (WPI) when she died tragically in the summer of 2002 at the age of 39. Prof. Nicoletti was a Drexel University alumna and the first female faculty member to be awarded tenure in the Electrical and Computer Engineering Department at WPI. The memory of Prof. Nicoletti is still strong at WPI. She is remembered for being an outstanding faculty member, dedicated wife and mother, and for her kindness and attention to others in every aspect of her life. Camp Reach staff strongly believes that the best way to keep her memory alive is to dedicate themselves to the continuation of the programs she started and to their continuous improvement.

## II. INTRODUCTION

Worcester Polytechnic Institute (WPI) is a private doctoral university in Worcester, Massachusetts, focusing primarily on education and research in engineering, technical arts, applied sciences, and business. Women remain underrepresented at WPI, comprising 33% of the undergraduate and 29% of the graduate student populations, respectively, as of October 1, 2014. The representation of women among undergraduates remains below 20% in some STEM departments, including Computer Science, Electrical and Computer Engineering, Physics, and Robotics Engineering. Programs dedicated to the support of female students are offered in several departments and campus-wide. Other programs are offered to educate and

encourage female students at the middle-school and high-school levels to pursue STEM degrees.

This paper will focus on Camp Reach, which is a summer camp offered to female students entering the seventh grade. After describing the activities carried out during the two week program, two particular features of Camp Reach will be described: 1) follow-up activities intended to support and encourage female students beyond the single intervention, and 2) an ongoing longitudinal study of the long-term effects of the program.

## III. CAMP REACH PROGRAM OVERVIEW

Camp Reach was founded in 1997 by Chrysanthé Demetry and the late Denise Nicoletti, both professors at WPI. At that time, women comprised between 20-25% of the undergraduate student body at WPI, with less than 15% in some departments. Initial funding was provided by a grant from the National Science Foundation, Model Projects for Women and Girls [1]. After the first two years funded by the grant, the program has been sustained with donations from corporations, foundations, and individuals, combined with modest program tuition for those families with the ability to pay.

Camp Reach is a two-week summer engineering enrichment program offered annually to 30 rising seventh grade girls, with continuing mentoring, communications, and activities for participants as they advance from seventh grade through their high school years. The 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 [2].

The program is based on best practices for engineering outreach programs for middle school girls [3] such as: collaborative problem solving, engineering as a helping profession with a social context, hands-on learning, prevalence of role models, building self-efficacy, and sustained contact.

The program includes the following major elements and features [2]:

- A real-world service learning project for a local non-profit organization, utilizing the engineering design process (3 hours per day);
- Daily hands-on engineering design experiences in a variety of engineering disciplines (3.5 hours per day);
- A spectrum of female role models and mentors in STEM fields, ranging from high school and college women on the program staff, to faculty and practicing engineers;
- A two-week living experience in a college residence hall, with no cell phones allowed and only one phone call home during the program; and
- Sustained contact and additional opportunities in grades 7-12, through project follow-up activities, biannual reunions, newsletters, and the opportunity to be a staff member after completion of their sophomore year of high school.

#### A. Real World Projects

Design projects are a major focus of Camp Reach and a primary means by which the girls experience engineering as a collaborative process that makes the world a better place. The projects are conducted in teams of 10, and each team is coached by a middle school math or science teacher and three female high school counselors who are usually alumnae of the program.

Project topics are solicited from non-profit organizations in the Worcester community. At the start of the program, each team goes on a site visit to meet with their customer and learn about the problem or opportunity the customer would like the team to address. With the support of staff members, the team develops a solution using the engineering design process. They define the problem, develop specifications, gather information from expert sources, develop alternative solutions and evaluate them, test solutions, and redesign. At the end of the two week program, each team presents its proposed solution to the customer, in the form of a written report and oral presentation. In most cases, the customer implements at least some aspect of the proposed solution in the year following the program, and the girls are invited back to help implement the project or to see their solution at work.

Some example of design projects include: 1) designing a computer workstation for an adult day program, 2) recommending trail improvements for all-persons accessibility at a local wildlife sanctuary, 3) improving a children's outdoor play area at a homeless shelter, and 4) designing an irrigation system for a community garden.

#### B. Hands-on Design Experiences

The other portion of daytime activity during Camp Reach is spent on hands-on engineering design activities, led by a middle school teacher with the assistance of other program staff. Topics are chosen that are relevant to the girls' everyday lives or that clearly show engineering as a helping profession.

Recent topics have included Wacky Shoes (materials engineering), Environmental Detectives (environmental engineering), Dance Pad Mania (electrical engineering), and Rehabilitation Engineering / Assistive Technologies (mechanical engineering). All are conducted in a collaborative and non-competitive manner. During the two-week program, campers also visit engineers in industry and meet many others at a Career Explorations dinner on campus.

#### C. Follow-up and Broader Impact Activities

The directors of Camp Reach recognized that the program could have limited impact if it was a one-time intervention. A number of publications have highlighted the limited ability of out-of school interventions alone to address gender-equity issues in engineering because of the more pervasive effects of societal factors and/or formal schooling [4], [5]. A study performed by the American Association of University Women (AAUW) Educational Foundation [4] noted that the majority of efforts have focused on out-of-school activities "which have limited success in changing the regularities of schooling" (p. 20). The AAUW and many other advocates and scholars recommend the integration of STEM gender equity efforts into formal school curricula as one element of systemic change.

Based on this research evidence, middle school teachers are included among the staff of Camp Reach, with three different teachers participating each year. They leave with better knowledge of opportunities in engineering and ideas for incorporating engineering activities into math and science curricula. Thus, the impact of the program is extended beyond the 30 middle school girls who participate each year.

Several strategies are used to extend the experience beyond a one-time intervention and promote long-term effects 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. In addition, two reunions are held each year for the entire alumnae community, in order to sustain peer mentoring and to engage girls in additional STEM activities. For example, a recent reunion that attracted more than 35 alumnae was led by WPI's Women in Robotics Engineering organization and challenged pairs to build and program a robot. In the first decade of the program, the directors prepared and sent a semiannual newsletter that included alumnae news, engineering and science topics and opportunities, and personal development information. In recent years, that newsletter has been replaced by a Facebook group. Another opportunity to extend the impact of the program is the opportunity to return as a staff member. Alumnae who have completed their sophomore year of high school are invited to apply. Typically between 4 and 6, and as many as 9, alumnae from each cohort of 30 campers have come back to the program as staff members [6], serving as near-peer role models for the seventh graders.

#### IV. LONGITUDINAL STUDIES OF LONG-TERM PROGRAM EFFECTS

A distinctive element of Camp Reach is the ongoing quasi-experimental study of long-term program effects. The longitudinal study seek to fill the following gaps highlighted

by scholars regarding the evaluation of K-12 STEM outreach programs [6]:

- Evaluation of many programs is lacking [5], [7] and there is very little knowledge of the extent to which short-term positive effects are sustained and realized over the long term. Longitudinal studies are rare, likely due to the challenges associated with cost, logistics, and study design and interpretation. These challenges are exacerbated for middle school programs, where there is long time lag and many intervening factors between participation in the program and the point of college entry.
- When research on the effects of the programs is carried out, there is little recognition that the results are influenced by self-selection bias. In other words, it is possible 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.

#### A. Methodology of Longitudinal Studies

The longitudinal studies for Camp Reach are conducted with the intent to overcome the above challenges. The Camp Reach admissions process was specifically designed to enable a control group. Every year, applicants outnumber available camper slots, and a lottery system is used to select the 30 program participants. Girls who applied to and attended Camp Reach and girls who applied to Camp Reach but did *not* attend (thus, the Control group) comprise the study sample.

For each longitudinal study, the participants were divided in four groups [2],[6]:

- 1) *Camp Reach Partial*: girls who attended the two-week summer program after sixth grade and were sent newsletters through high school, but they did not report attending a reunion or other WPI program.
- 2) *Camp Reach Full*: girls who attended Camp Reach and also participated in at least one other activity in the years following the program, such as attending a reunion, participating in another WPI program, or returning as a Camp Reach staff member.
- 3) *Control*: girls who applied to Camp Reach as sixth graders but were not selected in the lottery. They did not report attending another STEM-related program at WPI and did not appear in other program records.
- 4) *Control with WPI*: girls in the Control group who indicated participation in another STEM-related program at WPI as a middle school or high school student, or whose names appeared in those program records.

Applicants from 5 years of the program were interviewed by phone near the point of college entry. Information was gathered about their STEM-related high school experiences, perceptions of engineering, engineering self-efficacy, perceived abilities in STEM areas, and plans for college

major. A longitudinal study of the first five program cohorts (1997-2001) was published in 2009 [6]. In the summer of 2012, a second group of program cohorts (2002-2006) was contacted, and some results of that study were published in 2013 [2].

#### B. Results of Longitudinal Studies

The results of the two longitudinal studies are reported and analyzed in detail in [2] and [6]. Some relevant findings are summarized here:

- Almost 18 percent of the *Camp Reach Full* group—those who participated in at least one follow-up activity—intended on pursuing an engineering major in college, as compared with 2.9 percent in the *Control* group and a national average of 2.5 percent for women (Fig. 1).
- Six years after they attended or applied, the *Camp Reach Full* group had more positive perceptions of engineers compared to the *Camp Reach Partial* group and *Control* groups [2].
- Sixteen (15.8%) of the Camp Reach girls who were in college or about to attend college said that the program influenced their choice of major. Nine of the 16 stated that Camp Reach was the primary influence on their choice of major (5 engineering, 3 biological sciences, and 1 science-based professional).
- Regardless of education or career plans, participants cited Camp Reach as providing a sense of empowerment and self confidence [6].
- In a separate examination of admissions data, girls who attended Camp Reach as rising seventh graders later applied for college admission to WPI to a greater extent than girls who applied to the program but were not selected in the lottery. Twenty-one (8.5%) among the whole group ( $N = 248$ ) applied to WPI. Seventeen (12.1%) from the Camp Reach group applied, and four (3.7%) from the Control group applied; this difference is statistically significant. (To protect confidentiality, admissions data could not be associated with student names, and therefore we cannot further divide these data into *Camp Reach Full*, *Camp Reach Partial*, *Control*, and *Control with WPI* subgroups.)
- As high school students, all study groups (Camp Reach and Control) showed high self-ratings of computer skills, math abilities, and intellectual self-confidence compared to national averages for women [6]. In addition, all study groups reported high enrollments in calculus, physics, and STEM enrichment activities as high school students. These findings suggest that applicants to a middle school STEM outreach program are an important population to support.
- From the perspective of Camp Reach study participants, the program elements with the most

lasting positive impact include returning to the program as a staff member in high school, the access to role models, and the teamwork component of Camp Reach. Study participants who were pursuing engineering majors in college recalled role models as the most influential program element.

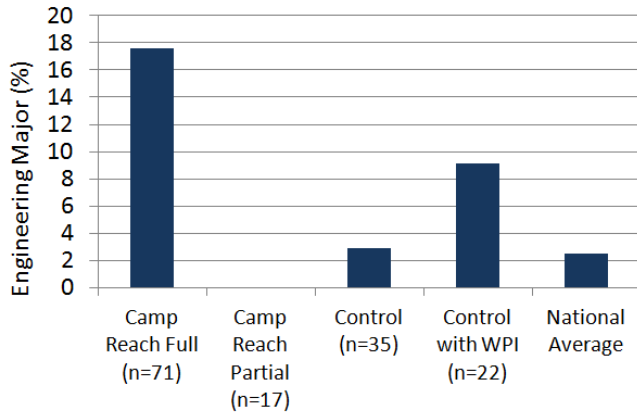


Figure 1: Evidence that a middle-school program has long term benefits [6,8]

## V. CONCLUSIONS AND RECOMMENDATIONS

The longitudinal studies suggest that Camp Reach has long-term positive effects on participants and that the program has an important role to play in supporting young women to persist in STEM fields. They also highlight the challenges of sustaining the impact of the program in the long term. The results of the longitudinal studies provide valuable information to highlight the merits and limitations of Camp Reach and to guide the program's future direction, and to serve as a model for other middle school outreach programs.

Based on findings to date, the following recommendations are offered to other educators who wish to strengthen outcomes of K-12 STEM enrichment programs:

- infusing programs with volunteer female role models with interests in STEM
- create a pipeline of opportunities and multiple interventions from middle school through high school
- using activities that involve collaboration.

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