

6-24-2017

Ten Years Later: Where are They Now?

Janet Callahan
Boise State University

Donna C. Llewellyn
Boise State University

Vicki Stieha
Boise State University

Ann E. Delaney
Boise State University

Ten Years Later: Where are they Now?

Dr. Janet Callahan, Boise State University

Janet Callahan is Chair and Professor of Materials Science and Engineering. Dr. Callahan received her Ph.D. in Materials Science, M.S. in Metallurgy, and B.S. in Chemical Engineering from the University of Connecticut. Her educational research interests include leadership, institutional change, engineering and STEM recruitment and retention, and engineering, materials science and engineering, and mathematics education.

Dr. Donna C. Llewellyn, Boise State University

Donna Crystal Llewellyn received her BA (major in Mathematics and minor in Economics) with High Honors from Swarthmore College in 1980. She went on to earn an MS in Operations Research from Stanford University in 1981 and a Ph.D. in Operations Research from Cornell University in 1984. After 30 years at Georgia Tech in a variety of roles, Donna became the Executive Director of the new Institute for STEM and Diversity Initiatives at Boise State University in January 2015. Donna's current interests center around education issues in general, and in particular on increasing access and success of those traditionally under-represented and/or under-served in STEM higher education.

Dr. Vicki Stieha, Boise State University

Vicki Stieha, Ph.D. is a faculty member at Boise State University in Organizational Performance and Workplace Learning. She earned her doctoral degree in Educational Studies from the University of Cincinnati. Her current work and research focuses on pedagogical and curricular reform in higher education with special attention to increasing the success of underrepresented students in STEM.

Ms. Ann E. Delaney, Boise State University

Ann Delaney graduated in 2016 with her Masters in Materials Science & Engineering with an interdisciplinary emphasis in Public Policy and Administration from Boise State University. Her thesis was entitled, "Nanomanufacturing Outside of the Lab: An Academic-Industry Partnership Case Study." She also received her B.S. in Materials Science & Engineering from Boise State in 2014. In the Spring of 2016, Ann was recognized as part of the first cohort of University Innovation Fellows at Boise State, and has worked as a Fellow to collect and incorporate student feedback into future plans for makerspaces on the Boise State campus. As an undergraduate and graduate student, she has been involved with the Society of Women Engineers, and also taught a materials science laboratory course as a graduate teaching assistant. She has volunteered at numerous STEM outreach activities on and off of the Boise State campus throughout her time as a student and is passionate about increasing diversity in STEM and helping girls and women to recognize that STEM is a path that is open to them if they want to take it.

Ten Years Later – Where Are They Now?

Abstract

This paper explores the educational and career trajectories of the alumnae of an outreach activity for girls. The outreach activity was originally developed using an integrated marketing approach to attract girls into engineering programs.¹ The program, a two day, overnight experience for rising 9th, 10th and 11th grade girls, focuses on showcasing engineering as an exciting, creative activity, including activities developed from that perspective. Started in 2005 and held annually since then, a total of over 500 girls have participated, with approximately 85% of them coming from Boise State University's immediate metropolitan area. Facilitated by the College of Engineering, and largely staffed by volunteering women engineers from the region, the outreach event takes place in Boise, Idaho - small metropolitan city in the United States. When it originated, e-Girls was the only science and engineering outreach or camp activity focused on girls and young women in this area. The college-going rate in Idaho is very low, so there is interest in any programming that increases that rate – especially for girls in engineering. The specific topic of this paper is an investigation into what has transpired in the girls' lives relative to their educational and career plans since participating in the program. We are interested capturing and analyzing narratives about their pathways so that we may better understand and enhance the impact of this and similar programs. These narratives will enable us to tell the story about how one program can influence such plans.

Our participants are drawn from a population of 418 alumni of the program who are currently at least 18 years of age and for whom we have a verified email address. Surveys were sent to 175 past participants focusing on what other STEM related extracurricular programs they participated in, their post-secondary activities (education and career), and what impacted those choices. Additional data was gathered from two focus groups of alumnae drawn from current students at Boise State University (n = 5). The qualitative methods used contribute to an evaluative analysis of paths taken and not taken by the program's alumni. Implications for program design and follow up activities are discussed.

Introduction

In response to an overwhelming need in the region, baccalaureate level engineering education began formally at Boise State University in 1997. By 2004, the College of Engineering was stepping strongly into the role of not only being a supplier of high quality undergraduate education (with various master's degrees also being offered by then), but also into a role of providing outreach engineering education in the state. During the early years of the baccalaureate degree offerings, enrollment in engineering by women was extremely low with only 12% female undergraduate engineering majors. Responding to this gender disparity, the first "e-Girls" camp was held in 2005 with 41 girls attending. Initially funded by a grant from a corporate foundation to a local teacher, e-Girls were recruited using a deliberate marketing approach and deploying

themes that would interest the young women of the region.¹ Since then, a total of over 500 girls have participated, with approximately 85% of them coming from the university's immediate metropolitan area.

E-Girls has been described elsewhere.^{1,2} From the start, the camp emphasized community. It deployed women staff at all levels, from near-peers to graduate students to adults who worked in engineering at the university and in the local area as engineers. Peers slept in the residence halls, ate, and participated in activities with the girls in four teams of about ten each. In all, generally about 25 staff and volunteers (75% of them women) have helped in some way, each year. Across eleven years, the total volunteer base has grown to more than 200 individuals who have supported the program in some way, including students, community members, and members of the regional workforce. The camp is offered over a two-day period, with an overnight experience. Activities span a spectrum of topics, designed to engage participants in projects that require them to “think like an engineer” such as:

- The Prosthetic Hand problem – using only given materials, design a 3-finger prosthetic hand that can pick up a wad of paper; or
- Design a filtration system that produces the cleanest water in the shortest time

These engaging problem-based activities connect e-Girls with one another and with their near-peer mentors and volunteers as they experience engineering.

Twelve years since its inception, we look back on our e-Girls participants to conduct a developmental evaluation³ of the university's effort to increase the number of women in engineering and STEM. Two questions are central to this inquiry:

1. What paths have the e-Girls alumni taken?
2. What do alumni see as the impactful events leading to those paths?

The results of this inquiry provide details about their educational patterns, career pathways, and the recommendations offered to others young women. We are interested in using the pathway narratives from this evaluation to better understand the impact the program may be having as well as to better tell the story about how one program can influence such plans. Finally, from their stories we can better understand what e-Girls and other programs at Boise State University can do to increase the percentage of girls who complete STEM and other college degrees before and during their matriculation.

Literature Review

Interest in programs for middle and high school girls, such as e-Girls, stems from research showing a loss of interest in STEM exhibited by many girls in middle school.⁴⁻⁷ There have been relatively few longitudinal studies of these types of outreach programs focused on girls, relative to impact that the programs may be having. The studies that do exist are almost entirely focused on metrics such as number of math classes taken in high school and number of alumnae pursuing STEM majors.

Virinoche and Eschenbach⁸ reported on the longitudinal evaluation of an “Expanding Your Horizons” (EYH) conference aimed at impacting girls’ future decisions regarding math and science, especially by encouraging girls to take more math and science classes in high school. This study was based on interview data conducted in 2005 and 2006 from 22 high school girls who participated in an EYH conference at Humboldt State University in 2001 and 2003. Interviewees described feeling empowered by being surrounded by other girls/women who were interested in science and math, as well as highlighting the importance of talking to EYH about their professional journeys and careers. Some girls became interested in fields that they had little prior knowledge of prior to interactions with volunteers at EYH. However, it seemed that the level of interest in math and science had decreased for many girls in the intervening years since they had attended the conference, especially due to their subsequent experiences in high school. In some cases, the authors noted that the interviews done for the study may have gone some way towards reigniting these lost interests, with one girl stating by the end of her interview that she would “give science another try” when she got to college.

Virinoche and Eschenbach also cited three other previous longitudinal studies (in 1985, 1990, and 2002)⁸⁻¹⁰ of EYH conferences and their effects on girls. While each of the previous studies had some limitations, together with the data collected by Virinoche and Eschenbach, they provide a picture of the effects of this particular EYH conference approach. The first of the cited studies, conducted by Davis and Humphreys⁹, examined outcomes of students in grades 7-12 who attended six EYH conferences in the San Francisco Bay Area in 1981. Pre- and post-conference data was collected from girls at the conference and a stratified random sample was taken six months later with a follow-up survey (n=389, 67% response rate). Upon analyzing the data, Davis and Humphreys found that interest in taking math classes increased during the conference and, following the conference, participants reported taking more mathematics courses than anticipated. Conference attendance also increased interest in “nontraditional careers,” which some girls took even further by talking with their parents, doing research at the library, and working in science-related jobs. Qualitative data from this study suggested that the environment of the conference helped fortify girls against social pressures that might push them away from STEM, especially by eliminating stereotypes through the presence of role models.

The second cited study was conducted in 1990¹⁰, and surveyed three groups of girls who had attended the conference eight years before when they were in junior high school. One group was not interested in participating, another group was interested in attending but unable due to a snowstorm, and the third group attended the conference. The girls who attended the conference took more years of math classes in high school than those who did not intend to attend EYH. However, in terms of the number of science classes taken, there was not a significant difference between those who attended and the snowstorm group, making a statistically significant causal relationship between EYH attendance and the number of upper-level science courses taken difficult to establish. At the time of the 1990 survey, the EYH participants were the most likely of the three groups to still be intending to pursue a professional or doctoral degree. However, all

three groups showed a decrease in plans for earning an advanced degree. Five years after the conference, all three groups exhibited similar levels of interest in math and science, leading researchers to conclude that a singular interaction with an EYH conference was not sufficient to sustain this interest over the long term.

Virnoche and Eschenbach⁸ provide six suggestions for more effective EYH conferences that include:

- 1) Partner with engaged teachers and counselors of students with less college savvy parents to help these girls attend.
- 2) Workshop leaders must understand that workshops need to be hands-on and not “just like school”
- 3) If possible, provide girls opportunities to identify with women that “have it all” (beauty, popularity, intelligence, and accomplishment).
- 4) Workshop leaders should be sure to explain their career paths, as girls are only exposed to the career paths they find in popular media.
- 5) Workshop leaders need to show multiple perspectives and solutions to problems and experimental design, as some girls find math and science unattractive because they think those types of problems only have one solution.
- 6) It is important to have multiple interventions over a girls’ teenage years as the positive impact of the EYH fades over time.
- 7) Role models and parents have lots of influence. Those schools need to hire female math and science instructors and teachers and parents need workshops to help them envision a broader future for their girls.

Demetry and Sontgerath¹¹ reported on the long-lasting effects on perceptions of engineering and engineering self-efficacy for a two-week summer camp held at Worcester Polytechnic Institute for rising seventh-grade girls. They found that girls who attended the camp and who sustained their contact with the program (e.g. returning to the program as a staff member) had more positive and accurate perceptions of engineering. Multiple interventions were important – girls who participated in multiple STEM programs or events had stronger long-term outcomes. Participants in the camp did show a statistically significant positive long-term effect on participants’ perceptions of engineering. Overall, the study showed the benefits of using numerous role-models in the program (such as graduate students and faculty in STEM fields, and high school girls with STEM interests), reinforcing what many other programs have shown.

Ivey and Palazolo¹² conducted a study of an engineering outreach program that began in 2004, in Memphis. This program, a one-week session with an emphasis on girls from minority groups traditionally underrepresented in STEM, was to increase the number of girls pursuing careers in STEM fields. While only 10% of participants responded to the survey, results showed that 73% of the respondents changed their middle/high school course loads to include more math and science classes following the program and 73% reported greater confidence in their math/science abilities. Again, the influence of mentors was highlighted--more than 95% of respondents

indicated that the mentors and speakers were “positive role models that were important to the program, and 85% reported that they influenced them to consider an engineering career.”

McCormick et al.¹³ surveyed attendees of the POWER (Preparing Outstanding Women for Engineering Roles) program, a week-long residential camp put on by the Purdue School of Engineering & Technology (PSET) at Indiana University Purdue University Indianapolis (IUPUI). This program aimed to introduce high school girls to engineering and recruit these girls to study engineering at PSET. Through a survey of all past POWER participants that had graduated from high school (with a 37% response rate), researchers noted that survey participants attended IUPUI more than other universities and that significantly more respondents majored in engineering than in other disciplines.

Added to the literature discussed above, This State University has contributed two publications. The first¹ discusses the integrated marketing approach used to study and then design the e-Girls program. Based on the data collected for that study, four guiding themes were developed e-Girls, “1) Engineers help the world. 2) Engineers think creatively. 3) Engineers enjoy working with others. 4) Engineers earn a good living.” A second paper² sought to understand the motivations that people had for volunteering for e-Girls. This survey research collected feedback from 67 individuals, 55% of whom were students. One finding from the survey was that former e-Girls themselves volunteered because “they really enjoyed it the first time.”

Through examination of this selection of the literature, we see that several different groups have examined the effects of engineering or STEM outreach camps for teenage girls (see summary in Table 1). Overall, the results have been positive, with at least some impact observed on girls’ views of STEM and/or a notable impact on their course or major choices after their experiences. While these studies provide metrics to quantify the programs’ effects, relatively few provide narratives from former attendees expressing outcomes in their own words. This paper addresses that gap while simultaneously contributing to our own evaluative purposes.

Table 1| Summary and Comparison of Prior Research

Program Name and Institution	Authors Referenced	Years in Existence	Program Characteristics	Research Strategy	Findings
Expand Your Horizons conferences in the San Francisco Bay area (EYH) conferences take place across the	Virinoche & Eschenbach	43 years	<ul style="list-style-type: none"> • One day conference for middle school girls • Aims to encourage girls to take more math in high school through hands-on STEM activities • Emphasizes women role-models 	<ul style="list-style-type: none"> • Interviews with girls 2-5 years after conference 	<ul style="list-style-type: none"> • Empowerment through interaction with other girls/women in STEM • Interest in fields not previously known about • Level of interest decreased after conference • Interviews may have revived interest
	Davis & Humphreys			<ul style="list-style-type: none"> • Pre- and post-conference data collection • Follow-up survey 6 	<ul style="list-style-type: none"> • Increased interest in taking math and “nontraditional careers” • Conference environment

country)				months later	fortified girls against social pressures against STEM by eliminating stereotypes through role models
	Tomhave			<ul style="list-style-type: none"> • Surveys comparing attendees, interested, and not interested 	<ul style="list-style-type: none"> • No significant link shown between conference attendance and taking more math • Highest intent to pursue advanced degree in attendee group
Camp Reach at Worcester Polytechnic Institute	Demetry & Sontgerathi	20 years	<ul style="list-style-type: none"> • Two-week residential summer camp • Rising seventh-grade girls • Social context of engineering • Program follow up during high school years 	<ul style="list-style-type: none"> • Interviews 6-10 years after attendance 	<ul style="list-style-type: none"> • Attending camp and sustained contact with the program resulted in more positive and accurate views of engineering
Girls Experiencing Engineering (GEE) at University of Memphis	Ivey & Palazolo	13 years	<ul style="list-style-type: none"> • One-week camp for middle and high school girls • Goal to increase girls' awareness and interest in STEM • Leadership training and experience 	<ul style="list-style-type: none"> • Pre and post surveys • Daily journal entries during the camp • Focus groups • Online surveys • Social networking 	<ul style="list-style-type: none"> • More interactions girls had with the program, yielded stronger long-term outcomes • Link content with real-world problems • Parents tend to influence students' major choices
POWER at Indiana University Purdue University Indianapolis	McCormick et al.	10 years	<ul style="list-style-type: none"> • High School aged girls • Week-long residential summer camp • Focus: introduction to engineering 	<ul style="list-style-type: none"> • Cross-sectional follow up survey of participants from 2006-2012 	<ul style="list-style-type: none"> • Significant numbers of those surveyed were majoring in engineering and had started college in engineering
e-Girls Boise State University	Blind, for review	12 years	<ul style="list-style-type: none"> • Rising 9th grade girls • Increasing STEM interest • Connection with female STEM professionals 	<ul style="list-style-type: none"> • Survey of student and staff volunteers 	<ul style="list-style-type: none"> • Established 4 evidence-based themes for programming • Mutually beneficial impact of female role models as volunteers on the volunteers and e-Girls participants

Our Motivation

As discussed above, the e-Girls program has been continuously evaluated and, as part of those efforts, there is a reliable database of former e-Girls including information on institutions they are or have attended and their intended degrees. What we have not been able to ascertain prior to this point is their perceptions of the paths they have taken. Understanding those perceptions and gathering their sense of how programs like e-Girls can support young women contributes to our developmental evaluation³ of the program.

Patton explains that a developmental evaluation “supports innovation *development* to guide adaptation to emergent and dynamic realities in complex environments (*italics in the original*).³

Our motivation is to conduct formative assessment about the program so that we can continue to improve upon the e-Girls Program results. We have not achieved parity—women remain underrepresented in engineering. Boise State University’s service region still has a very low college-going rate and an opportunity to positively impact future generations.

Thus, this study had three primary goals – to learn about what kinds of pathways these girls have traveled, to learn more about what programs and interventions (ours included) did have impact on those pathways (from the girls’ perspectives), and to hear a bit about where they see their future pathways going. These goals and the framework that developmental evaluation provides led us to select our methods.

Methods

Our review of the literature suggests that girls’ enrollment in extracurricular STEM or engineering-focused programs that are particularly developed for girls is positively correlated with pursuing STEM pathways. Based on the literature and our prior program evaluations, our interest was to gather data regarding the perceived importance of activities that might have influenced these participants’ professional direction. With this focus, the approach to the data was inductive; we worked up from the data toward concepts and themes.¹⁴ While we combined survey and focus group data, our core data was the qualitatively analyzed survey. As Morse suggests, clarity regarding core data when using mixed-methods is essential so that the results from all data sources can be integrated into a final analysis.¹⁵

The survey was intentionally brief to encourage its completion. The survey questions included stemming to allow for various stages of educational and career experiences; a synthesis of the questions is included in the Appendix. We made minor modifications to the survey between the first and second distribution, correcting a stemming error and adding a question about participants’ connections to others and advice for younger e-Girls based on input from our first focus group. We have combined all the survey results for the analysis.

We distributed the survey in two phases; the first survey was sent to participants from the 2005 – 2010 high school graduating classes (N = 48) anticipating that they were not currently enrolled in undergraduate programs. These older cohorts received the survey and responded in December 2016. The survey was deployed to the second set (N=127) of participants whose high school graduation was 2011 or later at the beginning of January, just as students were returning to college. Our overall survey response rate was 50% with 87 completed surveys returned out of 175 distributed.

Survey data were analyzed using descriptive statistics with an eye toward trends represented in the literature as well as any patterns that emerge from the narrative data collected from three open-ended questions:

1. What are you doing professionally now? For example, what steps are you taking to build your career such as internships, entry level positions, or continuing education.
2. What suggestions can you make to help participants remain on a STEM pathway after they complete e-Girls?
3. When you look ahead 3-5 years, what do you hope to be doing with your education?

While described numerically in the section to follow, primary analysis of the data was to consider the way the responses illustrated the various experiences e-Girl alumni shared as impactful. That is, the numerical data highlight subjective experiences connected to the narrative.¹⁶

A focus group invitation was sent to a purposeful sample¹⁷ of 45 former e-Girls currently attending Boise State University inviting them to share their “where are they now” stories with us and to reunite with other campus e-Girls alumni. The questions closely mirrored the open-ended questions in the survey. Our rationale for including the focus group was two-fold (1) to create an opportunity for former e-Girls to reconnect with others who had shared experiences, and (2) to provide an opportunity to probe narratives for complexities not easily surfaced through a survey. While 15 replied indicating they could attend, inclement weather forced one session’s cancellation and restricted travel for all but three participants for another scheduled session. Two participants attended a “make up” focus group a week later. The focus group facilitator (author x) was joined by author y and a note taker for the first focus group. The facilitator was alone during the second focus group. Although a small group, we gained valuable insights into our questions as the participants engaged in conversations with one another as well as the facilitator.

During each session, notes were taken including verbatim comments as well as the nature of the conversation. A voice recorder was used as back up and furnished the ability to transcribe highlighted sections of the focus group that corresponded to emergent themes from the survey for the analysis.¹⁸ These qualitative data were added to the open-ended responses on the survey and descriptively coded¹⁹ with the assistance of NVIVO software. Where we have excerpted quotes from the data, survey narratives (S) or focus group (F) are indicated for clarity. Summaries of the survey responses and narrative themes were shared with all of the researchers and reviewed collaboratively to verify our understandings and to increase the trustworthiness of our conclusions.²⁰

In this paper, we have excerpted descriptive data that inform our evaluation by including responses suggesting actions that Boise State University, or others, can take to improve the likelihood that future girls will select and remain on a STEM pathway. The participant demographic data in Table 2 provides a background to the narrative passages, which are shared anonymously to protect the confidentiality of our participants. Focus group participants indicated they responded to our survey and are assumed to be reflected in the demographics shared from that source.

Table 2| Summary of participant demographics

	N	%
Highest Educational Level Attained		
High School	6	7%
Some College	46	53%
Earned Bachelors	20	23%
Enrolled/Completed Graduate School	8	9%
No response	7	8%
2007-2012 high school graduates	38	43.6%
2012-2017 high school graduates	49	56.3%

Results

Degrees and Educational Levels

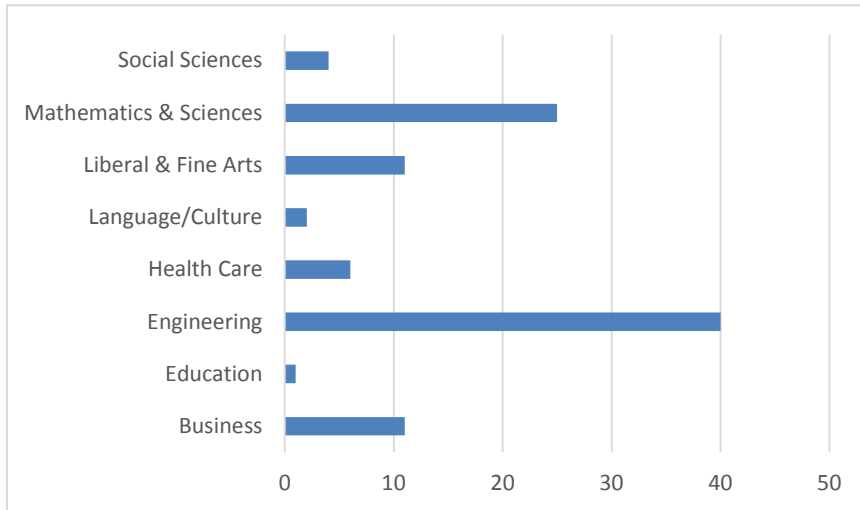
As described earlier, the college-bound rate for high school students in This State University's service area is quite low, which is one reason the e-Girls program was created. The college-bound rate, statewide, for 2014 was 47% versus a national average of 63%.²¹ We are very interested in the post-secondary educational pathways taken by our program alumni.

Survey responses sent to older cohorts indicate that many of them are continuing (or completing) advanced degrees. While it is possible that our alumni have pursued non-STEM related graduate degrees, many degrees specifically mentioned cluster in STEM fields (Marine Renewable Energy, PhD in Chemical Engineering, Ph.D Mechanical Engineering, medical school, veterinary school, Masters in Project and Construction Management). As indicated in Table 2, 28 of our respondents reported that they have completed an undergraduate degree and they are either enrolled in or have completed a graduate degree program. Of those young women, we find some exciting stories about the professional paths they have taken. For example, we heard from a regulatory affairs specialist working in the medical device industry, a digital marketing analyst, and an administrative coordinator for a software development coordinator. We also heard from a former global business management student who is in "mid management" at a small café while becoming a professional bass angler with corporate sponsorship (S). Another story comes from a Google software engineer who tells us, "It's my dream job and I'm so fortunate to have this opportunity. I plan to stay at Google for the foreseeable future and advance my career internally" (S). The array of pathways reinforces the sentiment shared by several of our focus group and survey respondents that e-Girls, and programs like it, should continue emphasizing the preparation that a STEM pathway provides.

As is often the case, the degree earned does not always correlate directly to the field in which someone works, particularly early in her career. From our survey, we found that our students' first and second majors (when reported) fell heavily into engineering, mathematics, and sciences.

Business and Liberal Arts followed. Figure 1 illustrates the reported college majors reported by participants in our survey.

Figure 1| Reported First or Second Undergraduate Majors



Some of our former alumni report having completed some college, but are not currently enrolled in a post-secondary program. Of those respondents, completing a college degree remains part of the plan for several. For example, one former e-Girl reports, she is “still hoping to go back to school with interests in computer and network repair” (S). Others report pursuing a degree, attending on and off as they work full time or assume family responsibilities. For example, one shared being unable to go to college:

I hit a rough patch in life as we all may do. I became pregnant with my first child at 19, I started an online course to become a medical transcriptionist and finished after she was born. I haven't found a job in the field yet, but I worked hard to provide for her and became the assistant manager for a business and then became a stay at home mom and have a beautiful little boy for his sister. I am planning on going to school when the time permits, but not sure for what yet. Have looked heavy (sic) into radiology technology. (S)

While many universities are increasing proactive measures to support student persistence, contemporary enrollment in post-secondary education is characterized by swirling attendance patterns and stop-outs.²² We see our outreach to students who are not currently enrolled as a thread that may keep them connected to the university and prompt them to continue or return.

Another pattern in our data, Table 3, is the skew toward STEM degrees. Therefore, comparisons between the reported undergraduate degrees of our e-Girls cannot be compared to national averages. Yet, clearly former e-Girls pursue STEM degrees at a rate that far outpaces the national average. Nationally only 8% of bachelors' degrees awarded fall into engineering fields and 2% are classified as physical or natural sciences.²³

Table 3| e-Girls reported undergraduate degrees

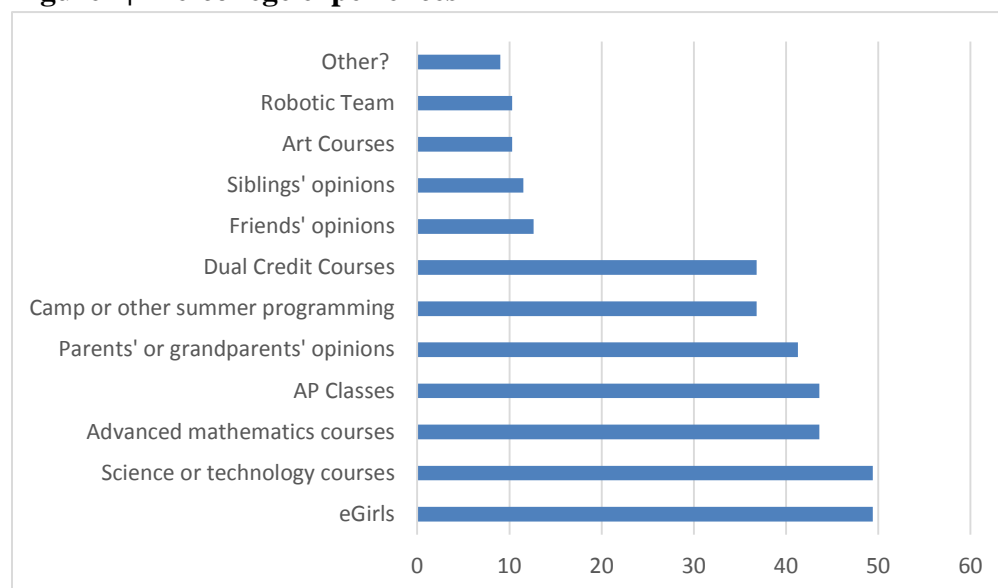
Undergraduate Degrees	Percentage of Graduates
Engineering	41%
Business	21%
Mathematics and Sciences	14%
Liberal and Fine Arts	14%
Health Care	10%

As has been described above, precollege programming that helps girls envision viable pathways in STEM is a crucial component to recruit them into the field. Our data supports an assertion that, at least for these pre-disposed young women, the e-Girls and other pre-college experiences is contributing to the pool women earning STEM undergraduate degrees.

Academic and Other Experiences

As we look at responses to the question reported as “academic or other experiences impacting academic/career plans,” we see a pattern that reflects known correlations with STEM pathways. Courses and experiences (including e-Girls), science and technology courses, advanced mathematics courses, advanced placement courses, parents’ opinions, other summer programs, and dual credit courses are all reported by over 37% of the respondents (see Figure 2).

Figure 2| Pre-college experiences



The young women we surveyed and interviewed stressed the importance of advanced mathematics courses. In one focus group for example, a current mechanical engineering student explained that she took calculus in high school, but was not able to take it for concurrent college credit because the school did not have a qualified faculty member. She stated that because of this, it was a year-long course rather than a rushed semester course which helped her learn the material. Her peers at that focus group all agreed when she suggested, “If you have an opportunity to take calculus in high school and then restart in college, then do so” (F). Rather

than seeing the repetition as a negative, they concurred that the repetition in college after getting an orientation to calculus in the lower stakes high school environment was supportive of their success. Even though four years of mathematics is not required in all schools, they all agreed, “Take the highest math you possibly can before [high school] graduation. Taking calculus in high school will help more than imaginable” (F). During that conversation, another student identified her struggles in trigonometry and calculus as the reason she did not remain in STEM despite her interests in engineering. Her family, she reported, lived in three different school districts during high school and she never completed trigonometry in high school. When it came time to take college level mathematics, she struggled, citing the method of teaching (“I like math, but I can’t learn it on the computer”) and difficulty getting to study sessions (held “during her other classes”) she concluded that she did not have the necessary preparation, which made remaining in her chosen engineering major impossible (F). This discussion about mathematics both reflects the pattern in the scholarly literature⁷⁻⁹ and helps us see that, given the student demographics at This State University, a pattern of simply enrolling in more math classes may not be sufficient to support student success.

Not surprisingly, participation in e-Girls and other STEM related camps or summer enrichment programming was cited as being a pre-college experience that was supportive of their academic and career pathways. Interestingly, it is not only the emphasis on STEM that the participants found beneficial during these “camp” opportunities. Comments from our participants stressed the idea that connections to others (whether near-peer volunteers, women who are already in the field, and/or faculty) were valued. In response to a question about what we could do to support other girls to pursue STEM pathways, respondents who were STEM majors offered valuable insights, particularly for girls who were initially unsure about whether they wanted to be an engineer:

- I stuck with STEM after e-Girls because it was emphasized how large a range of interest a degree in STEM can cover. (S)
- I would say that I really appreciated the [women] engineers that were [at e-Girls] because they made me realize that I wasn't them, that I wanted something else. I'm now a math/bio major looking at biostat (*sic*) grad program which I found after I realized engineering wasn't for me. (F)
- Find projects that interest you outside of school/work. I made [a project] out of a microwave and a pair of magnetic boots which helped keep my love of science and engineering! (S)

Recommendations for future e-Girls

Our survey and focus groups asked participants to offer suggestions to future e-Girls to help them remain on a STEM pathway. One theme that emerged from the responses was to offer reassurance to girls who are coming up through the curriculum. For example, “Math and science courses are always helpful. The courses might be tough, but if you're passionate about a STEM career, work hard and it'll pay off” (F). Another young woman stressed that challenging

mathematics and science courses were part of STEM, but not her favorite part, and offered a suggestion to engage students through various other interests:

What made the difference for me staying with a STEM career path was getting out there and realizing that I could incorporate my language interests into a STEM path. Whether by learning a language, or being an artist, or have an interest in English or History, you can make a unique impact on the STEM community no matter what. (S)

Program alumnae also offered recommendations for future e-Girls reflecting on the surprises they encountered. Not only are e-Girls alumnae pleasantly surprised that they can bring their varied academic interests in to STEM, others encouraged girls to engage in discovery, for example:

My greatest advice in pursuing further education in science and math is to take a broad scope of courses. Take courses in [STEM], and whatever other courses interests you. The hard part isn't finding a career that's obtainable, it's finding a career that really fuels your fire. Once you find that fire that makes you truly passionate about something, the hard work and studying comes easy. (F)

One of our focus group participants loves being able to go with other engineering friends to the maker space to “play” with the 3D printer. Keeping that “love of science” in the forefront of the mind is a dominant strand in the narratives that the students shared with us through surveys and in focus group conversations. These recommendations share the theme that we saw throughout our data, these former e-Girls recommend exploring “real career examples that are appealing and...are STEM related.”

As we apply these recommendations to our developmental evaluation, we are mindful that the emphasis on active learning during e-Girls, following up with our alumni to encourage their participation in other STEM outreach programs including a NASA sponsored program and robotics, are supportive of girls' subsequent pursuit of an engineering or STEM pathway.

Connections: “You’ve got to have people”

When we thanked our focus group participants for responding to our call to talk to them, all immediately attributed their desire to support the program to a single professional staff member at the University. Indeed, since its inception, e-Girls has had one advisor who has kept track of former attendees through email messages and other mailings. The young women who spoke to us in the focus groups talked about the importance of the personal contacts they had in engineering following e-Girls as the reason they initially pursued engineering at the University. In addition to returning to volunteer for the program, the rate of response that we received tells us that there is a high regard for the e-Girls program among its former participants.

Because we know from the literature¹⁵ that connections to others are important for women, we were interested to see if this theme emerged in our data. While no clear pattern emerged in the survey data, several open-ended responses included actions the program could take or continue to help future e-Girls succeed. One adds to this saying, “Keep connections [with the University]

active, give online resources, present scholarship opportunities” (S). Another suggests that we could remain connected with e-Girls by creating a Facebook or other social media site (F).

Others recommend connection as a reciprocal commitment. For example, one respondent suggests that students themselves should seek “internships and committee chairs. Being involved in your university. Building connections” (S). They implore the program to, “continue to show the girls a broad range of engineering careers, and show them how many cool and interesting things you can do with a major in engineering” (S). Others suggest that we emphasize staying in engineering less and help future students see that engineering education is an excellent foundation for many post-college pathways. For example:

When I was in e-Girls there was a presenter that talked about how law schools love STEM (especially engineering) majors and that engineering is the number one most accepted major for medical schools. [...] I think if that was more heavily emphasized in e-Girls, girls would be less nervous about sticking with STEM because with a STEM major you can really do anything you are passionate about. (F)

In a similar vein, a rising senior preparing to go to pursue a dual PhD in medicine and material science shared that her engineering preparation helps her stand out in comparison to other applicants. Medical schools, she says, “don’t necessarily care about all of the calculus and differential equations that you know. But they really like how engineering majors, like how the major trains your brain on, like, how to think and how to work. They really like all of the problem-solving skills” (F).

Other respondents note the rigors of university learning and suggest that the program administrators can help future e-Girls by preparing “them for the differences between high school and college grading. An A in high school is average where in college, the averages are much lower. It has nothing to do with how smart people are; it is just a different environment” (S). Echoing this sentiment, another suggested, “don’t worry about grades and don’t worry about finish in four” (S). The focus group participants who were majoring in engineering wanted to dissuade others to focus on finishing college quickly. “Especially for engineering majors. Like it’s great if you can finish faster...its totally possible, but only if you have no extra classes. Like no minor, no extra classes. Then it’s great you’re finishing in 4 years, but you are not getting exposure to other things” (F). It is the “other things” like learning communities, “playing” in the maker’s space, undergraduate research that were stressed as the valuable experiences helping the participants retain the enthusiasm they needed to stay on the path toward their goal.

Bolstering resolve, because of the rigorous curriculum, is described as something that is best achieved with the support of others. Indeed, the need for community for engineering students was a very clear theme in our second focus group. The young women, one a first-year student and one in her fourth year, both emphasized “e-Girls, it’s kind of like a little community” (F) which resembles what girls will need later if they want to major in engineering. Continuing this theme later in the conversation, one participant says:

I'm only in my first year, but I've already figured out that you need to have people, right, to go with you through this. [...] You need to have someone because you can't do this alone. Maybe you can, you probably could if you tried, but it's a lot better if you have a support group, like people to study with, people to do homework with, people who want to do projects with. You need a community. (F)

Conclusions

We set out to learn more about the pathways that the e-Girls participants had taken after participating and what had impacted those pathways. We were struck by the variety of the different journeys and directions that these young women had taken – they remind us how engineering education is indeed excellent preparation for many career paths and that there were multiple benefits beyond the actual content expertise. We also learned about the obstacles that our own institution, unintentionally, creates for students who arrive lacking mathematics preparation and/or confidence. The participants in our study emphasized that taking calculus in college even after taking it in high school helped reinforce the important foundational mathematical knowledge, and that instructional methods matter – offering preparatory courses in multiple formats (rather than just on-line) would have helped them persevere. And, perhaps not surprisingly, human caring contact matters – it was critical both that the program delivered the message of how important it is to be part of a community and that the main organizer stayed in touch with the participants through the years, encouraging them to continue their educational (and STEM) journeys.

This advice is relevant to all universities who are performing middle and/or high school outreach to girls with the goals of increasing the number of women studying engineering and other STEM disciplines in the future. Emphasize the versatility of an engineering degree, advise that repeating foundational mathematics classes is an investment in future understanding, help the girls to create a community, and keep in contact long after the outreach program ends.

Acknowledgments

We gratefully acknowledge the financial support of the Society for Women Engineering Southwest Idaho section, the Micron Foundation, Idaho National Laboratory, the Hewlett Foundation, Keynetics, the Wittenberger Foundation, First-to-File, and Soroptimist International of Boise. We also wish to acknowledge Patricia Pyke for her role in the founding of the eGirls program and the present and past Deans of the College of Engineering for their tremendous support. And, finally, the eGirls program couldn't exist or thrive without the amazing work of Leandra Aburusa-lete.

References

- 1 Pyke, P. *et al.* in *Annual Conference and Exposition*. Where the girls are: Applying an integrated marketing approach to attract girls into engineering programs. (Chicago, Illinois).
<https://peer.asee.org/667>
- 2 Llewellyn, D. C., Callahan, J., Moll, A. J. & Bates, C. R. in *2016 ASEE Annual Conference & Exposition*. The impact of volunteering at a girls outreach activity on community formation (New Orleans, Louisiana). <https://www.asee.org/public/conferences/64/papers/14812/view>
- 3 Patton, M. Q. *Developmental evaluation: Applying complexity concepts to enhance innovation and use*. (Guiford, 2011).
- 4 Gender gaps: Where schools still fail our children. Report No. 1-879922-17-7, (American Institutes for Research, Washington, DC, 1998).
- 5 Fennema, E. H. & Sherman, J. A. *Sex-related differences in mathematics achievement and related factors: A further study*. (Journal for Research in Mathematics Education, 1978).
- 6 James, R. K. & Smith, S. Alienation of Students from Science in Grades 4–12. *Science Education* **69**, 39-45 (1985).
- 7 White, P. E. & National Science Foundation, W. D. C. Women and Minorities in Science and Engineering: An Update. (1992).
- 8 Virnoche, M. & Eschenbach, E. in *2007 ASEE Annual Conference and Exposition* 12.707.701-712.707.724 (Honolulu, Hawaii, 2007).
- 9 Davis, B. G. & Humphreys, S. M. *Evaluating intervention programs : applications from women's programs in math and science*. (Teachers College, Columbia University, 1985).
- 10 Tomhave, J. A. *The effects of a short-term intervention program on future participation in math and science* (North Dakota State University, 1990).
- 11 Demetry, C. & Sontgerath, S. in *2013 ASEE Annual Conference and Exposition*. Does a middle school intervention for girls have long-lasting differential effects on their perceptions of and participation in engineering (research to practice) 23.441.441 - 423.441.413 (Atlanta, GA).
<https://peer.asee.org/19455>
- 12 Ivey, S. S. & Palazolo, P. J. in *American Society for Engineering Education*. Girls Experiencing Engineering: Evolution and Impact of a Single-Gender Outreach Program).
- 13 McCormick, J. R., Talbert-Hatch, T. L. & Felhaus, C. in *2014 ASEE Annual Conference & Exposition*. Increasing Female Participation in Engineering: Evaluating POWER Summer Camp 24.734.731 - 724.734.724 (Indianapolis, IN). <https://peer.asee.org/20626>
- 14 Patton, M. Q. *Qualitative research and evaluation methods*. 3rd edn, (Sage Publications, 2002).
- 15 Morse, J. M. Essentials of qualitatively-driven mixed-method designs. (2017).
- 16 Tappan, M. B. in *From subjects to subjectivities: A handbook of interpretive and participatory methods* (eds D. L. Tolman & M. Brydon-Miller) 45-56 (New York University Press, 2001).
- 17 Maxwell, J. A. *Qualitative research design: An interactive approach*. 3rd edn, (Sage, 2013).
- 18 Richards, L. *Handling qualitative data: A practical guide*. (SAGE, 2009).
- 19 Miles, M. B. & Huberman, M. A. *Qualitative data analysis*. (Sage, 1994).
- 20 Schwandt, T. A. Judging interpretations. *New Directions for Evaluation* **2007**, 11-13 (2007).
- 21 Maben, S. in *Spokesman-Reivew* (Spokane, WA, 2016).
- 22 Schulte, M. Stopout, swirl, double-dip, and dropout: Attempting to understand student enrollment patterns. *Journal of Continuing Higher Education* **63**, 133-135, doi:10.1080/07377363.2015.1043001 (2015).
- 23 Degrees conferred by postsecondary institutions, by control of institution, level of degree, and field of study: 2013-14. Report No. Table 318.50, (Integrated Postsecondary Education Data System (IPEDS), Washington, D.C., 2014).

Appendix: E-Girls Survey Summary of Questions

Questions asked of all respondents: E-Girls, “Where are They Now” received IRB approval to collect survey data and conduct focus groups with former participants over the age of 18. IRB# 935-SB16-193.

Focus group questions

- What do you remember about e-Girls
- Did you know/stay in touch with other girls attending the program?
- Changes you would suggest to support participants to go on to college and pursue STEM related careers?
- Academic or other experiences that impacted your academic/career plans since e-Girls (follow up: who influenced you?)
- Today: What is your field of interest (or major?) (Follow up: what attracts you about that field/major?)
- Looking ahead 3-5 years, what do you hope to be doing with your education?

Survey questions:

- What is/are your field(s) of interest? (Select from list and option for other.)
 - What is/was your major(s)
 - Did you know other girls who attended e-Girls? Did you remain in contact with other e-Girls after your camp?
 - When you participated in e-Girls did you know girls from your community?
 - Have you changed majors (if so what were former majors?)
 - Which academic or other experiences impacted your plans since e-Girls (select from list and option for other)?
 - What are you doing professionally now? For example, what steps are you taking to build your career such as internships, entry level positions, or continuing education.
 - What suggestions can you make to help participants remain on a STEM pathway after they complete e-Girls?
 - When you look ahead 3-5 years, what do you hope to be doing with your education?
 - Would you like to share your story with other e-Girls and the general public (yes/no) and if so please indicate your preferred name (short answer)?
-