

# CASCADING INFLUENCES:

## Long-Term Impacts of Informal STEM Experiences for Girls



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# PREFACE



## WHY WE UNDERTOOK THIS PROJECT

Starting in the 1980s in the United States, funders including the U.S. National Science Foundation (NSF) began supporting informal science education programs for girls. The hope was that, as a result of heightened interest and engagement in science, technology, engineering or mathematics (STEM), young women would choose to pursue STEM courses or academic degrees as a strategy for addressing their underrepresentation. The ultimate goal was to inspire more women to pursue careers in STEM disciplines.

From early on, both of us were actively engaged in the blossoming of informal STEM programs for girls, as program developers, evaluators, and researchers. We know from our work, and that of others, that well-designed and implemented programs offer rich and engaging experiences that often inspire girls and women in STEM in the short term. However, we wondered about their long-term impacts. Fortunately, we have had an opportunity to pursue this inquiry through the NSF-funded *The Impact of Informal Science on Girls' Interest, Engagement, and Participation in Science Communities, Hobbies and Careers: A Research and Dissemination Project* (award # 0452419). Our goal was straightforward: to investigate whether girls-only, informal STEM experiences have potential long-term influences on young women's lives, both in terms of STEM but also more generally. We would accomplish this by documenting young women's perceptions of their program experiences and the ways in which they influenced their future choices in education, careers, leisure pursuits, and ways of thinking about what science is and who does it.

## What This Research Was and Was Not

This was not an experimental or quasi-experimental study. Appropriate to the participation and engagement goals of many informal STEM programs for girls, we used a sociocultural lens to frame the study and approached most of our data collection from a qualitative perspective; even the development of a web-based questionnaire benefited from this approach.

Since this was a retrospective study to explore possible impacts of informal STEM experiences for girls, this is a study of *girls who were most likely to have been influenced*. We were systematic in our selection of programs from which to draw young women to be in the study. Those who elected to participate had participated in one of six girls-only programs that we (and the field) had identified as exemplary. What ties the programs together is that each one represents a shared commitment to inspiring girls in science, an informal context in which activities and experiences were developed and implemented, and a group of people—peers as well as adults—who were involved in an ongoing way. Together, they allowed for the development of a meaningful community over time.

As girls, many of the young women in our sample were involved in their programs for at least a year, often more. In some cases, girls even played teaching and leadership roles in their programs as they moved into early adolescence and adolescence. Thus, this is not a random sample, but rather a group potentially skewed towards a positive experience history. While this was a select group, their participation varied in intensity, age of involvement, experience, and focus.

## Rationale for Our Research Approach

We took this research approach with specific goals in mind. First, since the study was designed in part to explore the *potential* long-term impacts of informal STEM programs, we chose to start by looking at women who were likely to be influenced. Our thinking was that if we were unable to discern appreciable influence among these women, we were unlikely to do so in a large-scale study.

We also wanted to explore a broad variety of impacts. We were interested not only in the important yet fairly typical STEM education and career outcomes, but also in changes in participants' interest, engagement, and participation in science-related leisure pursuits, hobbies, and ways of thinking about what science is and who does it. We wanted to consider how, and to what degree, women's participation in informal STEM communities influenced their self-identity, including science, gender, cultural identity, and their ultimate relationship to sustained interest, engagement, and participation with STEM.

There were also logistical issues that favored this approach: we wanted to study women who had participated in programs 5-25+ years ago, and we anticipated challenges related to locating, contacting, and engaging this group of women. We worked with representatives of the six programs, and they assisted us in locating and recruiting former participants with whom they had contact. Some of these women had kept in touch with the program through alumnae groups associated with the program or by continuing to serve as mentors. Others were tracked down through mailings to postal and email addresses found in older databases, or through networking with known facilitators, participants, and their parents. Young women were told during the recruitment and consent process that they need not have stayed in the program, pursued science as a career, or even enjoyed the program to participate in the study.

Appreciating that learning is an ongoing and cumulative experience, making it extremely difficult to identify and attribute the direct impact of any specific experience in isolation from others, we wanted to see if there was evidence that these programs had *contributed* to women's lives in any discernible ways and if so, how these experiences had connected with and been influenced by other activities in the girl's life. This perspective suggests that, at its most basic, learning is the process and product of a series of cascading influences. Ideally,

informal STEM learning experiences for girls, along with experiences they have at home, school, university, and the work place, build upon one another, as well as connect to and reinforce the countless other experiences in a woman's lifetime. This study offers a highly personal view of what informal STEM programs mean to girls, both at the time they are participating, and years after, when they reflect back upon the experience. As this book will reveal, informal STEM programs can give rise to memorable experiences that cascade over time, influencing—at least these women—in myriad ways.

## People Who Contributed

As with any project of this size and complexity, there are many people to whom we owe gratitude and thanks. First we want to thank individuals in the Advancing Informal STEM Learning program (previously Informal Science Education) at the National Science Foundation for providing funding and support throughout the project. We have had a number of supportive colleagues there. In particular, we would like to thank Julie Johnson, Ph.D., Sylvia James, Ed.D., and Valentine Kass.

This project could not have been completed without the hard work and expertise of staff at the Institute for Learning Innovation and The Franklin Institute. At the Institute for Learning Innovation, Jessica Luke, Ph.D. and Kara Hershorin were critical partners in analyzing and interpreting the data from Investigation 2 and in planning Investigation 3. Judith Koke and Angie Ong provided invaluable support helping to design and launch Investigation 1 and were involved with supervising the development and launching of the web-based questionnaire.

At The Franklin Institute, Julia Skolnik helped to expand the sample of women in the study and supported our early work in data analysis. Sharon Kiefer provided critical support in contacting and increasing the sample of women, in organizing the logistics of the Research Advisory Council meetings and our final convening, and in many behind-the-scenes logistical details. Additionally, Steve Fifield, Ph.D., Amelia Wiggins, and Anna Padget were critical readers, and Jeanne Maier spearheaded the design and production of this book.

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- o Kevin Crowley, Ph.D., Director, UPCLOSE, Associate Professor, Education and Psychology, University of Pittsburgh;
- o Margaret Eisenhart, Ph.D., Professor of Educational Anthropology and Research Methodology in the School of Education, University of Colorado, Boulder;
- o Kathleen Fadigan, Ed.D., Assistant Professor of Science Education, Pennsylvania State University, Abington;
- o Angela Ginorio, Ph.D., Associate Professor of Women Studies, University of Washington;
- o Linda Kekelis, Ph.D., Executive Director of Techbridge, Oakland, CA;
- o Betsy Payne, B.S., Manager, Women In Natural Sciences (WINS) program, The Academy of Natural Sciences of Drexel University, Philadelphia, PA;
- o Ellen Wahl, M.A., Director of Youth Development and Entrepreneurship, New York Hall of Science, New York, NY;
- o Faedra Weiss, Senior Research Associate, Girls Inc.®, National Resource Center.

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- o Research participants from the following programs: 2 WINS participants, 2 Girls, Inc. Operation SMART participants, 1 Girls, Inc. Eureka participant, 2 Techbridge participants and 1 Girl Scouts/National Science Partnership participant.

**And most importantly and deeply, we thank the 174 women who shared their STEM stories and experiences with us. We greatly appreciate their time and candor.**

# STUDY BACKGROUND AND THEORY

*Despite significant investment, the field knows very little about the possible long-term impacts and contributions informal STEM programs can make in young women’s lives, both generally, and in the area of STEM specifically.*

Over the past decade, hundreds of STEM programs for girls have been funded, undertaken, and evaluated. There is short-term evidence that effective informal STEM programs can offer influential experiences that allow girls and women to engage with STEM in everyday contexts and build capacity and confidence in science (Afterschool Alliance, 2011; Modi, Schoenberg & Salmond, 2012). But with few exceptions, evaluation began and ended during the funding period with no opportunity to re-establish connections with girls as they grew to adulthood to determine whether and to what degree their program experiences influenced their personal and/or professional life choices. In addition, because outcomes in these evaluation studies were conceptualized and measured differently from project to project, these findings are often like apples and oranges—not easily, or in some cases even appropriately, compared. As a result, despite significant investment, the field knows very little about the possible long-term impacts and contributions such programs can make in young women’s lives, both generally, and in the area of STEM specifically. This study begins to address this gap.

The overarching question addressed by the study was, “What possible influences do informal science experiences play in girls’ interest, engagement, and participation in science communities, hobbies, and careers?” We were also interested in more specific questions:

- o Does participation in such experiences facilitate and lead to additional engagement?

- o What role if any do significant adults and peers play?
- o How do girls describe their relationship to science and their sense of themselves (identities) as science-interested learners and advocates?

To frame this study, we looked at issues raised by research into girls’ underrepresentation in STEM-related activities, interests, and careers. We drew from two fields of study: 1) the documented impacts of informal learning environments, and 2) the study of communities of practice.

## Girls’ Underrepresentation as Participants in STEM-Oriented Communities of Practice

Although there has been progress in areas of inequity since this research study began, the underrepresentation of females and minority groups in particular STEM fields remain a troubling issue. *Why So Few? Women in Science, Technology, Engineering, and Mathematics* (2010), a report by the American Association of University Women (2010), summarizes findings from eight major gender equity studies of the past decade, highlighting the progress that has been made as well as the challenges that remain. Statistics from the National Science Foundation, too, suggest that while academic achievement is up, the number of women earning bachelor’s degrees in math, engineering, computer science and physics is still low (National Science Foundation, 2011 ). In the table that follows, the percentage of women who received bachelor’s degrees in STEM disciplines over the last four decades provides an indicator of these issues.

**TABLE 1.** Women as a percentage of all bachelor’s recipients, by major field groups: 1966-2008

### Science and engineering fields (S&E)

Academic year ending	All fields*	Total	Biological and agricultural sciences	Earth, atmospheric, and ocean sciences	Mathematics and computer sciences	Physical sciences	Psychology	Social sciences	Engineering	Non-S&E fields
1970	43.2	28.0	24.1	10.2	36.1	14.5	43.6	36.6	0.8	51.5
1980	49.2	37.2	39.1	23.8	36.4	24.0	63.3	44.8	10.1	54.9
1990	53.3	42.5	48.2	27.9	35.8	32.2	71.5	46.3	15.4	58.1
2000	57.3	50.5	55.5	40.0	32.8	41.1	76.5	54.5	20.5	60.4
2008	57.4	50.3	58.3	40.7	25.3	41.3	77.1	53.3	18.5	60.6

\*Total excludes cases where field of study was not reported.

Source: Tabulated by National Science Foundation/Division of Science Resources Statistics; data from Department of Education/National Center for Education Statistics: Integrated Postsecondary Education Data System Completions Survey.



Consistent findings across studies suggest that girls and women are also underrepresented in science classes, clubs, events, careers, and leisure pursuits (Calabrese Barton & Brickhouse, 2006; Breakwell & Beardsell, 2007; National Girls Collaborative Project, <http://www.ngcproject.org/>; Bell, Lewenstein, Shouse, & Feder, 2009). Evidence also suggests that girls' experiences with science are gender-linked, through experiences in or out of school or home, in ways that influence their perceptions of and active participation in science (Modi & Salmond, 2012). Inequitable opportunities for girls to participate in science have been documented in schools, in programs outside of school, and even in the differential treatment by a parent or guardian at home. Examples of gender inequity are abundant in school texts and children's books and movies, classroom experiences, exposure to science toys, and other science-related experiences.

Gendered differences are not fully understood, and they are further complicated by the fact that although girls may be succeeding on standard measures of success in STEM, they are not necessarily identifying with science (Calabrese Barton & Brickhouse, 2006). If girls are capable and engaged with science, but don't feel a sense of connection to scientific learning and study, what can be done to bridge the gap? According to The Institute of Education Sciences (Halpern, Aronson, Reimer, Simpkins, Star, & Wentzel, 2007), there are three well-identified factors that suggest potential opportunities for improvement: (1) girls' beliefs about their abilities to participate in and contribute to science, (2) girls' beliefs that science careers are less significant than other careers, and (3) girls' access to support in pursuing STEM interests once a spark of interest is ignited.

## How Informal STEM Experiences Support Both Learning and Participation

Informal STEM experiences are useful to children and youth, as they provide unique opportunities to engage with and connect with science in an inquiry-based manner without the academic requirements of memorization and standardized testing. Such experiences are increasingly important:

- o Children's positive attitudes toward science by age 10 have been shown to significantly decline by age 14 (Archer, Dewitt, Osborne, Dillon, Willis, & Wong, 2010). Tai, Liu, Maltese, and Fan (2006) agree that early life experiences in elementary school should not be overlooked as an important contributor to future career decisions; yet elementary schools are spending less and less time on science, if any at all.
- o The recent report on learning science in informal environments by the National Research Council (Bell, et al., 2009) showed that these out-of-school-time science learning experiences can trigger children's enduring interest in science and provide opportunities for them to become comfortable with, interested in, knowledgeable about, and, in some cases, active contributors to science.
- o These experiences seem to be particularly critical (and unfortunately sometimes lacking) for youth from communities underrepresented in STEM. Offering opportunities for such youth to learn science and be exposed to STEM careers during out-of-school time, especially at young ages, has been recommended as a potential approach to improving representation of these populations in STEM at all levels (Bell, et al., 2009; Falk & Dierking, 2010; Peterson, 2013). According to *STEM Learning in Afterschool: An Analysis of Impact and Outcomes*, conducted by the Afterschool Alliance (2013), both boys and girls involved with such programs experienced: 1) improved attitudes toward STEM fields and careers, 2) increased STEM knowledge and skills, and 3) higher likelihood of graduating and pursuing STEM careers.
- o *STEM Out-of-School (OST) Time Programs for Girls*, a 2011 report from the Harvard Family Research Project (Chun & Harris, 2011), supports similar findings relative to gender specific programs. In the report, authors reviewed program evaluation studies and found that, "The STEM programs for girls profiled in the OST database typically contained evaluation findings related to academic/school outcomes. The most common outcomes included increased confidence in math skills, improved attitudes toward and engagement in math, and increased plans to attend or enroll in college."

The message from these and other studies is clear: girls are successfully participating in summer, after-school, and short and long-term programs. We know that such programs can have profound impacts on girls at the time when they are involved, and that these impacts relate directly to their confidence, attitudes, and future plans. The question remains, however, whether these programs fulfill their long-term potential.

### Looking Retrospectively: Studying Learning and Participation through Memories and Reflections

The collection and analysis of long-term memories, called retrospective studies, provide a window into the impact of experiences. Memories can reflect the enjoyment felt, the kinds of things participants recall learning, or the degree to which they developed understanding of or appreciation



for the ideas, values, and norms communicated. Because this was a retrospective study, we knew that a key component of the study would focus on young women's long-term memories of their participation in such programs.

Retrospective studies are well-documented research approaches in the field of free-choice learning (Anderson, Storksdieck & Spock, 2007; Falk, 2007) and also are used in other social sciences such as sociology and anthropology. They are particularly useful in the fields of nursing, teaching, criminology, and cultural studies (Harrison, 2009). In the case of museum learning research, retrospective studies have focused primarily on visitors' long-term memories of exhibitions.

There was another reason why we took a retrospective approach. Earlier museum studies show that the nature and quality of learning and enjoyment from an experience can shift dramatically over time. Some even suggest that the "true" impact of an experience may not be understood by a person at the time of the experience, but only afterwards, through subsequent opportunities that reinforce and support it (Falk, Scott, Dierking, Rennie, & Cohen Jones, 2004). If our findings showed that program experiences were exceedingly memorable and long-lasting, this would be an indicator of potential learning and evidence for the cascading influence of these experiences.

## Communities of Practice Framework

The theoretical framework guiding this study is Community of Practice (CoP) (Lave and Wenger, 1991). In this framework, three elements distinguish a community that fosters engagement and the potential for continued participation:

- o The domain of knowledge (in this case, the missions of the organizations and a clear and explicit set of goals);
- o The network of people engaged in its practice (i.e., girl and adult participants, as well as professional and amateur scientists), offering opportunities for personal connections and interactions that are created and facilitated within a rich and supportive community;
- o The shared activities in which they are involved (e.g., hands-on science activities, kits, museum experiences, and authentic contexts in which to engage in and enhance specific practices and skills in STEM, as well as potentially in other life skill areas).

This framework showed promise as a useful paradigm when trying to document the broad, strategic impact of a particular field of practice on participants (McCreeedy, 2003). We know from the literature that if girls are to engage in STEM actively throughout their lives, either through careers or leisure pursuits, they need to believe that they are full participants in STEM communities and organizations, traditional and non-traditional. Without this engagement in a meaningful and supportive community, they may take part in STEM-related activities or "feel good" about their informal STEM experiences, but they are unlikely to continue their involvement in a committed and focused way (Anderson-Butcher, Newsome & Ferrari, 2003).

When CoP analysis is applied to our present research, we see that girls might participate in an informal program and stay interested and active for an extended time period because of one or all of the CoP elements described earlier. In other words, a strong CoP may add value to a program by ensuring that it is more robust and all-encompassing than a simple series of STEM activities. We very explicitly set out to explore the three CoP elements in this study, considering the ways in which each of the six programs from which we drew women created its own CoP. We used the framework to design, collect, and analyze data in the study, and it served as a touchstone for the findings and implications we will share.

### CoP Element 1: Engaging Girls in New Communities of Practice through *Mission*

The domain of knowledge or mission is the set of issues and goals that define the focus of a community. For our purposes in this study, we described this domain as the missions or purposes of the programs in which girls participated. All were girl-focused, and all incorporated science learning opportunities. Yet they varied in the specific ways in which they characterized their focus. Where one program included in its mission a desire "to build competence, confidence, and character," another included a focus on "promoting the recruitment, retention, and success of women in science," and a third states its mission as "inspire girls to be strong, smart, confident and bold." These missions are quite different from one another, both in scope and in intent.

In reflecting upon why we join a community or become a member of an organization, it is clear that the reasons are diverse and personal. However, there is a body of literature that conceptualizes learning as social participation and characterizes the construction of identities in relation to this participation (Lave & Wenger,

1998; Matusov & Rogoff, 1995). As one of the three elements of a CoP, the purpose, goal, or mission of an organization may be the factor that resonates for a girl, leading to engagement in that community.

### CoP Element 2: Engaging Girls in New Communities of Practice through a *Network of People*

Personal connections and interactions are an important element of any community; in this study we explored the role significant adults and peers played in girls' experiences and decisions. Children can have many adults involved in their daily lives, including their immediate family members, schoolteachers, and those adults other than family members with whom children spend their out-of-school time. While every child may not have support from within her family, the presence of a significant adult or mentor can make a tremendous difference. Cited in numerous studies is the fact that female scientists often reference family members, teachers, or contexts outside of schools as significant influences in their pursuit of science careers (Baker, 1992; Campbell, 1991; Fort, 1993). These influential adults in children's lives outside of school have the potential for offering educational experiences, even though they are often neither trained educators nor scientists. The youth group leader, after-school care provider, child-care worker, camp counselor, parent—all are important resources with potential to connect children and science.

Peers who are supportive and "like me" are also critically important to the community fostered in informal STEM programs. Finding a community of smart and science-interested girls with whom they identify is recognized as an important reason that some girls stay engaged in such programs. Research focused on boys and girls in museum-like settings specifically, and child development more generally, demonstrates how powerful these relationships can be, and how sought after and valued they are by children because they feel they learn more by interacting with peers (Azmitia, 1996; Jensen, 1994). Involvement in scientific extra-curricular activity and having "scientific peers" is highly correlated with positive science attitudes and interest for girls (Breakwell & Beardsell, 2007).

### CoP Element 3: Engaging Girls in New Communities of Practice through *STEM Skills and Practices*

Girls are attending computer clubs, digging for fossils, and orienteering. They are designing video games, building robots, and handling live animals. They are doing all this in many different settings, ranging from museums and zoos to after-school programs, outdoor classrooms, field-based sites, YWCAs, and clubs. Some of these programs last for an afternoon; others run intensively for years. While informal STEM programs may offer exposure to skills and practices, all vary not only in structure and intensity, but also in their connection to the larger STEM community. All programs do not necessarily establish a CoP. The distinction between participating in a science experience and an informal CoP is that the specific knowledge, skills, and practices are developed, shared, and maintained by the community through its mission, tools, language, and documents.

## Building on Theoretical Foundations

While research about women's long-term participation in science resulting from engagement in informal science programs is modest, there is evidence that informal STEM experiences can be beneficial in supporting and building capabilities, experiences, and confidence in science (Afterschool Alliance, 2011). We set out in this study to see if we could build on that evidence. Our tools, including retrospective and CoP analysis, are well-established and tested. They are also particularly appropriate for a study that explores long-term impacts of STEM programs for girls.

# RESEARCH QUESTIONS, PARTICIPANTS, AND INVESTIGATIONS



This study documents young women's perceptions of their program experiences and the ways in which participation in girls-only, informal STEM programs influenced their future choices in education, careers, leisure pursuits and ways of thinking about what science is and who does it. Additionally, it explores potential long-term influences on young women's lives more generally, beyond STEM.

The overarching question addressed by the study was, *"What possible influences do informal science experiences play in girls' interest, engagement, and participation in science communities, hobbies, and careers?"* We were also interested in more specific questions:

- o Does participation in such experiences facilitate and lead to additional engagement?
- o What role if any do significant adults and peers play?
- o How do girls describe their relationship to science and their sense of themselves (identities) as science-interested learners and advocates?

To begin to better understand the long-term significance of informal STEM programs for girls, this research study focused specifically on young women who had participated in girls-only STEM programs at least 5-25+ years before the study began. Our research would focus on girls' reflections on their engagement in informal science through such programs, and their long-term participation in science, as evidenced through further STEM course work, majors in college, careers, or science-based interests and hobbies.

## Programs Involved in This Study

As stated earlier, we were systematic in our selection of programs from which to draw young women for the study. While the focus was to be on individual girls rather than on programs, strong all-girl, informal programs were the source of research participants. Thus, we started our research process by selecting six STEM programs from which to draw our research participants based on defined criteria. Each program:

- o Offered informal, girl-focused efforts;
- o Were longstanding programs (established at least 5 years prior to study initiation) with documented effectiveness;
- o Had access to high-school-aged young women or older who participated 5 or more years ago;
- o Could provide staff willing to facilitate contact with young women and share existing evaluation and research efforts with us.

These programs had been evaluated and found to be highly successful informal science programs for girls, characterized by their social, free-choice, open-ended, voluntary, and non-competitive structure. In addition, these programs represented a broad range of qualities and communities of practice in that each program:

- o Differed in its opportunities, venues, and patterns of participation;
- o Involved different groups of significant adults (leaders, parents, and other relatives);

- o Held differing expectations and goals for participants;
- o Represented distinct geographic and demographic communities;
- o Incorporated youth development principles to varying degrees.

The programs selected were the National Science Partnership for Girl Scouts and Science Museums (NSP), Techbridge, Women In Natural Sciences (WINS), Girls Inc. Operation SMART®, Girls Inc. Eureka!®, and Rural Girls in Science.

NSP and the two Girls Inc® programs, Eureka!® and Operation SMART® offered STEM programs as a component of a broader set of program offerings. Embedded within girl-centered youth development organizations (Girl Scouts and Girls Inc., respectively), girls' STEM activities often were only one part of a multi-year association, which may have incorporated mentorship, field trips, and a wide range of other non-STEM programs intended to build character, civic engagement, and other qualities. Techbridge, WINS, and Rural Girls in Science were locally initiated programs having STEM learning as their primary focus. In-depth descriptions of each of the programs follow.

### Program Descriptions

*National Science Partnership (NSP) for Girl Scouts and Science Museums*  
*The Franklin Institute/Girl Scouts of the USA*  
*National*

**Girl Scout Mission:** Girl Scouts builds girls of courage, confidence, and character, who make the world a better place.

**NSP Mission:** The National Science Partnership for Girl Scouts and Science Museums (NSP), initiated in 1988, seeks to increase opportunities for girls, ages 6-12, to explore the knowledge and processes of science in a hands-on, exploratory, all-girl environment. NSP's goal is to build the confidence and self-esteem of young women through positive experiences with science and technology and promote their interest in science careers.

**What:** NSP offers seven activity guides, kits, and training workshops that directly correspond to Try-Its and badges for Brownie and Junior Girl Scouts. Workshops are offered to leaders, who then return to their troop where they implement the NSP program over the course of 5-7 weeks of troop meetings, or within the many other

contexts offered within Girl Scouting (science Saturdays, day and resident camps, homeless shelters, etc.). As girls advance to middle and high school, they have the opportunity to help facilitate the training of adult leaders or offer science activities to the younger girls for whom the kits were intended.

**Who:** NSP activities target girls, ages 6-12. This program, first implemented in the Philadelphia tri-state region, ultimately expanded to over 70 Girl Scout Council and Science Institution partnership sites nationwide. More than 11,800 adults were trained, reaching more than 138,000 girls across the USA.

**How:** Implementation of the program for girls was usually by a Girl Scout leader within a Girl Scout troop setting but could be part of science Saturday events or the core of a week- or day-long camp experience.

*Techbridge*  
*San Francisco Bay Area*

**Mission:** Techbridge inspires girls to discover a passion for technology, science, and engineering, empowering future female innovators and leaders. Through a variety of activities, Techbridge builds a strong network of support for girls to expand their career options, instill confidence, and diversify our future workforce.

**What:** Founded in 2000 by Chabot Space & Science Center, Techbridge is a year-round program that emphasizes skills development, career exploration, leadership development, and teamwork.

**Who:** Techbridge focuses on grades 5-12. Afterschool programs are hosted in elementary, middle and high schools in Oakland and other East Bay communities. The program has served over 4000 girls in grades 5-12.

**How:** Techbridge once-a-week afterschool programs introduce girls to careers in science, engineering, and technology through hands-on projects, field trips, role models, career exploration opportunities, family outreach, teacher professional development, and academic and career guidance. Summer programs offer the opportunity for Techbridge girls to continue exploring their interest in science, technology, and engineering through fun hands-on projects and career exploration. Summer programs are only open to girls participating in Techbridge after-school programs and Techbridge alumnae.



*Women In Natural Sciences (WINS)*  
*The Academy of Natural Sciences of Drexel University/  
School District of Philadelphia*  
*Philadelphia, PA*

**Mission:** The WINS program at the Academy of Natural Sciences is designed to promote the recruitment, retention, and success of women at all levels throughout the Academy.

**What:** WINS, founded in 1982, is a science enrichment program conducted by The Academy of Natural Sciences of Drexel University in collaboration with the School District of Philadelphia. The WINS program strives to provide young women with the information, encouragement, and confidence they need to shape their futures. In addition to a strong emphasis on academics and science, WINS also provides a uniquely nurturing environment, a community of like-minded friends, and experiences not typically found in school.

**Who:** WINS provides young women who are rising high school freshmen with a yearlong summer and after-school science enrichment program. The program is designed for females whose households demonstrate restricted income with a special emphasis on young women who live in single-parent households. Most participants represent racial minorities. All participating students are from the Philadelphia Public School System. Twenty-five young women participate in WINS per year. To date, more than 700 young women have participated in the WINS program.

**How:** WINS participants engage in classroom lessons, science experiments, behind-the-scenes museum tours, and daylong, weekend, and weeklong field trips—all of which are designed to help them explore the intricate relationships between plants, animals, and our biological and physical environments.

Once young women have completed WINS I, they have the opportunity to pursue higher-level experiences in a second phase, called WINS II. Young women may act as “explainers” in museum exhibits, or as junior interns in scientific research areas of the Academy. Some also accept summer internships at university-based science programs nationwide. WINS staff help participants develop their study techniques, prepare for college entrance exams, and research and apply to colleges and universities.

*Girls Inc. Operation SMART®*  
*Girls Inc.*  
*United States and Canada*

**Mission:** Girls Inc. is a nonprofit youth organization dedicated to inspiring all girls to be “strong, smart and bold”® by providing them the opportunity to develop and achieve their full potential.

**What:** Girls Inc. developed Operation SMART in 1985 in response to the underrepresentation of women in science, mathematics, and technology. The program is now offered through some 70 member organizations and licensees in the United States and Canada. Within a supportive, experiential, all-girl environment, Operation SMART participants have an opportunity to satisfy their curiosity about the world and to develop the personal tools necessary to pursue education and careers in the sciences. The purpose of Operation SMART is to build the interest and confidence of girls in science, mathematics, and technology.

**Who:** Girls Inc. serves ethnically diverse students in urban and rural areas, many of whom live in poverty. Operation SMART serves girls ages 5-18, mostly in girls-only settings. Over two-thirds of the girls reached through Girls Inc. identify as girls of color, nearly 70% come from families earning \$30K or less, and 52% live with one parent. Nearly 600,000 girls in over 30 states (and, so far, one Canadian province) have been involved in Operation SMART.

**How:** Operation SMART models include informal activities, Operation SMART days, and intensive summer camps. Activities for younger girls focus on hands-on manipulation of materials and tools that promote scientific inquiry, demystification of mathematics and science, self-reliance and direction, and learning to think with (and like) scientists, mathematicians, or engineers. Programs for young women who are 15-18 years old focus on career awareness and often provide in-depth exploration of STEM careers. Many individual Girls Inc. affiliates design and implement local Operation SMART programs as well.

*Girls Inc. Eureka! ®*  
*Girls Inc.*  
*United States and Canada*

**Mission:** Girls Inc. is a nonprofit youth organization dedicated to inspiring all girls to be “strong, smart and bold”® by providing them the opportunity to develop and achieve their full potential.

**What:** In some Girls Inc affiliates Eureka! is a specific component of Operation SMART, but in others, it is a stand-alone program. For this study, young women were recruited specifically for Eureka! or Operation SMART, so we have separated the two programs for purposes of this report while also appreciating that, in many Girls Inc. affiliates, they are connected.

**Who:** Girls Inc. Eureka!® encourages girls ages 12-18 to explore career paths and post-secondary educational opportunities in STEM fields. The program begins by addressing girls in middle school who are at high risk of losing interest in STEM as they are beginning to set educational goals and identify future coursework.

**How:** Eureka! is an intensive three year (recently extended to five year) math, science, and sports program beginning with rising 7th or 8th grade-aged girls, many of whom continue their affiliation with Girls Inc. and disproportionately go on to STEM majors and careers. The program is offered afterschool, during the summer, and during school hours. A common model is structured sessions lasting 1-1.5 hours in length, offered once or twice a week over 8-12 weeks.

*Rural Girls in Science*  
*The Northwest Center for Research on Women,*  
*University of Washington*  
*Washington State*

**Mission:** Rural Girls in Science was designed to foster interest in science, engineering, and mathematics among rural high school girls in the state of Washington. The goal was to inspire girls’ commitment to science and to heighten their awareness of its usefulness in their communities.

**What:** The Northwest Center for Research on Women’s comprehensive program for rural girls in science developed a partnership with students, teachers, counselors, parents, and community members to create an environment that was conducive to rural girls’ science and math achievement.

**Who:** Seventy-three young women from 16 rural high schools and 35 high school math and science teachers along with 19 high school counselors and/or principals participated in the program.

**How:** This comprehensive program developed a partnership with students, teachers, counselors, parents, and community members to create an environment that was conducive to rural girls’ science and math achievement. The summer program consisted of science-related offerings that targeted specific audiences: high school girls, high school teachers, and high school counselors. In addition to the summer programs, each school-based group participated in ongoing activities during the school year that included a Long-Term Research Project (LTRP), an Internet science club, and two working meetings.

## The Research Process: A Three-Part Study Design

This research project was conceived as a multi-phased undertaking, involving the research team, a group of distinguished advisors, and past participants in six very different girls-only informal STEM programs. There were three separate investigations:

1. Investigation 1 - Personal Meaning Mapping (PMM)/ In-depth interviews
2. Investigation 2 - Web-based questionnaire
3. Investigation 3 - Life story development; review and vetting of findings

### **Investigation 1:** Personal Meaning Mapping/In-Depth Interviews

During Investigation 1 we explored the ways in which seven young women discussed their experiences with the program in which they participated. We did this in order to ground our study in women's own language and perspectives. These findings helped us better understand what outcomes might be possible and informed the development of a web-based questionnaire administered during Investigation 2.

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*Unlike some data collection techniques, creating a Personal Meaning Map does not feel like a "test," since the person is sharing their own ideas and perspectives. In fact, most participants enjoy creating and talking about their PMM.*

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Personal Meaning Mapping (PMM) is an approach designed specifically for use in free-choice/informal education settings (Falk, Moussouri and Coulson, 1998). This approach has several advantages that were essential to the personal focus of this study. First, it enabled us to understand relatively quickly and in a young woman's own words the range of possible outcomes that could result from participating in informal STEM programs. Second, unlike some data collection techniques, creating a PMM does not feel like a "test," since the person is sharing their own ideas and perspectives. In fact, most participants enjoy creating and talking about their PMM.

Each informal science program for girls identified two or three past participants with whom they had contact. They may, or may not, have continued to engage in science-related activities in their lives (college science

classes, science-related hobbies, clubs, or careers, etc.). We sought to interview a range of women, although in this phase of the project we were not concerned about whether the young women we interviewed constituted a representative sample.

Personal Meaning Mapping consisted of participants responding to a single-word prompt by writing down all the words, ideas, images, phrases, or thoughts the prompt brought to mind. The young women completed two separate Personal Meaning Maps, the first with the prompt, "me" and the second with a prompt naming the program in which they participated, such as "Women In Natural Sciences (WINS)" or "Rural Girls in Science."

Following the completion of each of the written maps, we conducted open-ended interviews at which time individuals were encouraged to explain why they wrote down what they did and to expand on their thoughts or ideas relative to the idea of "me." The discussion allowed individuals to elaborate on their perceptions and understandings, in their own words and from their own frame of reference. We did the same with the map about their program.

Finally, with the two PMMs side by side, we interviewed the young women about how the ideas they expressed on each of the maps overlapped or connected in their lives, if at all. These interviews were audiotaped. Seven young women participated in Investigation 1; two women had been in Eureka!, two in NSP, two in WINS, and one in the Rural Girls in Science program. We collected these data in a variety of places, wherever we could arrange to meet. The maps were complex and diverse and the interviews exceedingly rich, as seen in the two examples we share.



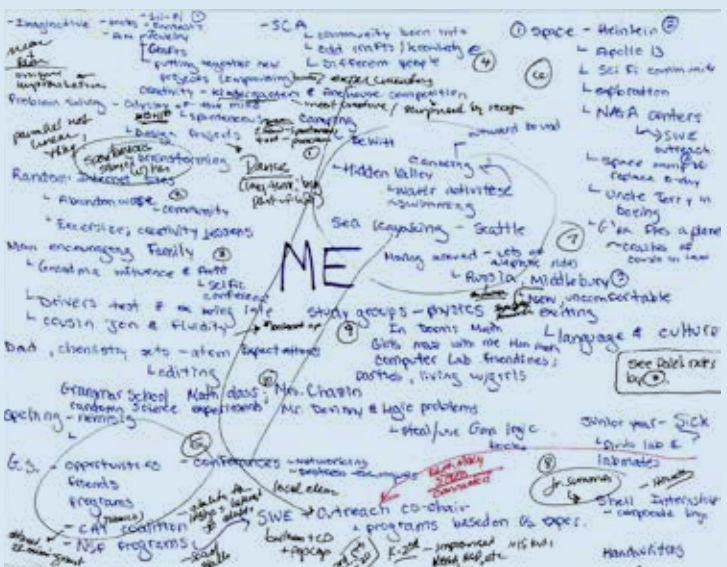
Last summer [exitors in semiconductor  
 sea quantum mechanics  
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 tomatoes / peas  
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 - more sensitive / discriminatory  
 to paper issues  
 Eureka  
 - when / now looking more widely  
 Educational / research  
 Ph.D / self  
 ? - understanding your own learning process  
 - within  
 - both parents (dropped out of school)  
 Sister and astrophysics (3 years younger)  
 3 - CC conceptual physics  
 structural engineering  
 EPIC University of Ok  
 AP classes running out of words

Cool Girls in Science #1  
 physicist  
 gardener  
 reader  
 knitter  
 someone!  
 feminine  
 martial artist  
 walker  
 wishing I had a full time job (financial stability)  
 proud of accomplishments  
 liking writing  
 feel like I'd like to spend more time doing it  
 busy  
 well read and well rounded

Never had a question - validation that all women / girl students / professors  
 Cool and fun / interesting / helpful  
 Change the curriculum  
 tour for people who are interested  
 Everett  
 1st diploma  
 3 years of physics  
 8 years (1 year Math)  
 6th overall good feelings associated with attending the camp  
 wish  
 also surprised when I went back as staff but so few of the participants seemed interested in anything but geology or bio

terrific slaughterhouse videos  
 turn  
 First group  
 7th grade (15)  
 Friday the 13th  
 25 people in class  
 2 weeks  
 few years later  
 shift person

RURAL GIRLS IN SCIENCE  
 Jane (over story became great friends, roomed together in college)  
 fun  
 explorations  
 tent  
 people and contributing engagement  
 Going back to be a counselor  
 being surprised that so many of the girls who participated did a year of college & got





## Investigation 2: Web-Based Questionnaire

Findings from the PMMs provided an understanding of the range of possible outcomes that could result from girls' informal STEM experiences and served as the foundation for creating a valid and reliable questionnaire. In keeping with our theoretical framework, young women's own language and ideas were used to help focus item development within the three dimensions of CoP (the program mission, the network of people, and the skills and practices they engaged in as participants). In close collaboration with our national Research Advisory Committee, which included the program leaders for the projects from which we were drawing our study participants, a matrix of data categories and sub-categories was developed for inclusion in the questionnaire.

Because young women in our study were scattered around the country (and in a few cases around the world), the instrument was administered via the web. A web-based questionnaire also provided an added benefit: we could design a set of distinct questions for each unique program. This allowed young women to answer tailor-made items about program activities in which they participated. It also provided an opportunity for us to verify the accuracy of their responses since we knew the structure and activities of each program.

The questionnaire reflected the CoP framework shaping the study. We designed questions to reflect a general understanding of each program, and in particular, how the CoP framework was manifested in each (see Appendix for questionnaire). We tested the usability and reliability of the instrument in several ways: circulating first drafts to project team members for comments and suggestions, having advisors complete a close-to-final draft, and piloting the online tool with three young women attending Oregon State University.

## Investigation 3: Life Story Development; Review and Vetting of Findings

In November 2012, we held a three-day gathering of approximately 50 individuals in Philadelphia. This gathering included two groups:

- o For the first day and a half, participants included young women who had completed the questionnaire, the research team, and the project advisors.
- o During the second day and a half, we added a diverse set of leaders (in addition to our advisors) in science education, gender, and youth development who play significant roles in shaping, implementing, studying, and funding programs for girls. These leaders held a variety of positions professionally; they included program developers, policymakers,

educators, researchers, evaluators and funders. All, however, had one thing in common: a passionate belief about the importance of including young women in science.

We used the first day and a half to discuss and vet our initial analyses with eight young women who had participated in the study and our Research Advisory Council. The young women were asked to write and share "seven-minute" stories of their experiences within their respective programs, and they generated lists of program characteristics that they felt made their program distinct or similar to the others. The stories were audiotaped and transcribed.

On the second and third day, our research participants and Research Advisory Council were joined by a diverse set of "guest" leaders. The goal was to share our findings and then listen carefully to the voices of the participants and to the discussions, feedback, implications, and future directions for programming and research that emerged. Our intention was to integrate these ideas into final reports, publications, and other dissemination efforts.

During this time, our advisors and guests, all science-engaged women themselves, shared their stories as well, which helped to confirm findings from the perspective of women living "science-rich" lives. There also were opportunities in whole-group discussions for our advisors and "guest" leaders to talk with the girls about various issues related to STEM and informal programming for girls. Topics discussed, often in a lively manner, included girls' and women's attitudes about mathematics, reasons they had participated in these programs, what their motivations for staying involved were, and how prominent and important science was from their perspectives. In addition they helped us think about which findings would make a fairly immediate contribution to national conversations about girls and STEM.

We listened carefully to the feedback, implications and future directions for programming, evaluation and research that emerged. The input from the eight young women who had participated in the study, our Research Advisory Council, and "guests," each of whom is a critical stakeholder with interest in supporting informal science programs for girls, shaped further data analysis and the framing of findings in this document within a national context. Their advice was invaluable. As critical stakeholders the eight young women who participated in the study, our Research Advisory Council, and "guest" leaders will now help us disseminate the findings through their networks.

# AN OVERVIEW OF THE SURVEY FINDINGS



As described in the prior chapter, we conducted three investigations, including (1) Personal Meaning Mapping/ in-depth interviews, (2) a web-based questionnaire (see appendix), and (3) group conversations and the development of stories about girls' informal STEM program experiences and their perceived impacts.

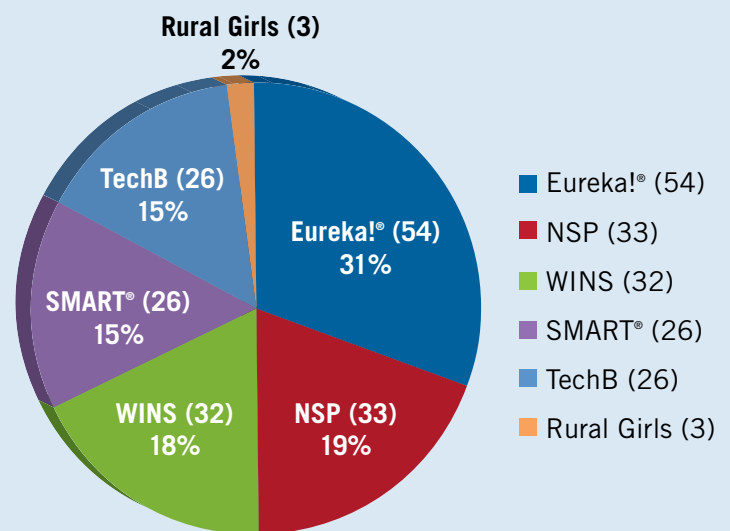
This chapter presents overall findings from the web-based questionnaire, while the next chapter explores the individual experiences and perceived impacts through the stories of eight participants. We analyzed the questionnaire data, testing ten hypotheses, from which three clusters of outcomes emerged. Women's perceptions of the long-term impacts of informal STEM programs clustered into the following three categories:

- (1) Participants formed long-lasting memories of their experiences in the programs.
- (2) Program experiences influenced women's attitudes toward and understanding of STEM, shaping future education, careers, leisure pursuits, and ways of thinking about what science is and who does it.
- (3) Participation in these programs helped to shape women's personal identities and their life trajectories.

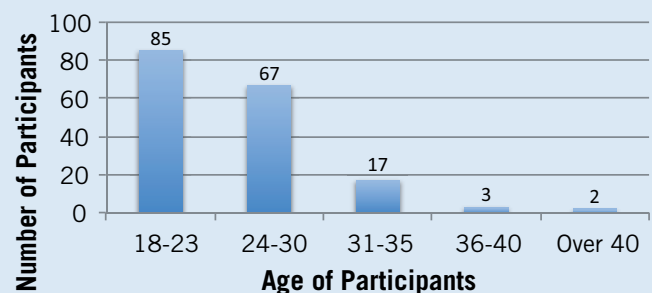
## Survey Sample

Research participants included 174 young women, recruited from the six programs described in the last chapter. Specific descriptive statistics for these women are presented in the following figures.

## Program Representation



## Age of Questionnaire Participants





## Questionnaire Findings

We learned that girls' experiences with STEM contributed to a wide range of long-term impacts as these girls became women. In this section, we present findings of young women's closed- and open-ended responses to the questionnaire. (See Appendix for Questionnaire.)

### Memorable STEM Learning Experiences

We probed women's memories of the program through analysis of four different questions:

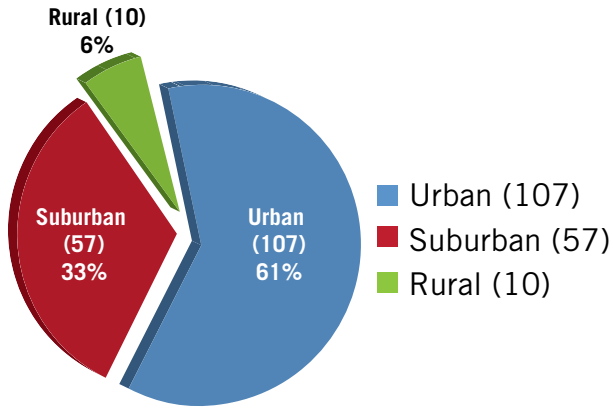
- o What specific memories do you have about science in the program?
- o What was the highlight of your participation in the program?
- o What was the low point of your participation in the program?
- o Describe one way in which you think this program influenced you.

We coded open-ended responses to these questions based on a rubric developed to capture the full range of memories (See Table 1).

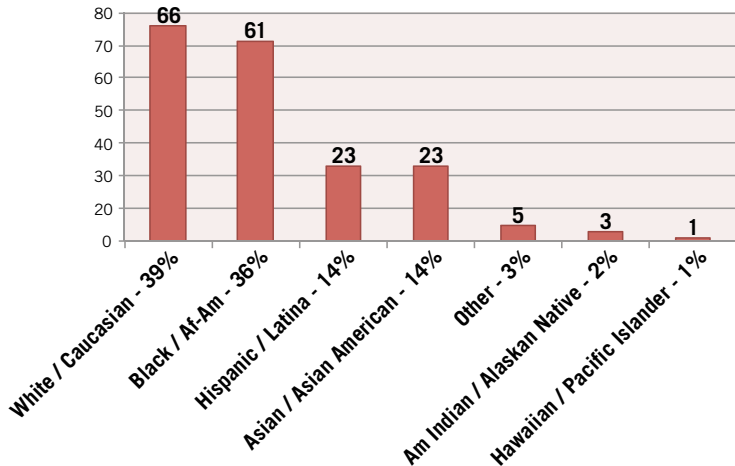
**Young women had lasting and detailed memories of these programs.** These included memories of specific skills and practices in which they engaged, as well as the people with whom they interacted, such as mentors, program leaders, and peers. One unanticipated finding was that women's memories remained constant regardless of the length of time that had passed since they had participated—that is, women's memories were equally detailed whether the program had been five years before or 15! The fact that experiences in these programs were so salient offered one indicator of potential learning and possible evidence for the cascading influence of these experiences.

**Women's strongest memories included events or activities that stood out from the norm.** Field trips, unique "adventures" (such as launching rockets), and social connections were particularly memorable (Table 1). Women's memories were matched with what we knew had been offered in each of the programs. Although the question focused specifically on science, many women described more general recollections, such as feeling more empowered to take on technical challenges (changing tires, light bulbs, etc.) or the role the program played in building confidence, shaping identity, or furthering personal development. With regard to STEM specifically, young women recalled and described

## Geographical Location During Program



## Participant Ethnicity



significant moments in their STEM program experience that had a profound impact on their perceptions of STEM and/or women in STEM. Some women also could specifically recall and recount instances in which they had learned STEM content.

Table 1: Specific Memories about the Program (n=159)

SPECIFIC MEMORIES	n	%
Trips, experiences, or internships	86	54%
Activities, experiments, or specific classes	82	52%
Social relationships	48	30%
Learning/increased interest in science	43	27%
Personal development	23	15%
Negative memories	1	1%
Other	5	3%

Note. Multiple responses allowed

As described earlier, to understand how participation in one of these programs influenced girls' lives, we focused our study design around the concept of a Community of Practice (CoP). Findings showed that each programs' community of practice elements (mission, community, skills/practices) were central to women's memories.

#### Mission of the Program:

- o *The EUREKA! Program helped me to become a much more independent and confident person, which is exactly what I needed at the time.*
- o *Techbridge really contributed to my interest in the science field.*
- o *It was fun and I liked the way the program gave [an] opportunity to learn in new ways. I liked the way they let us think about solving a problem [and] then gave us the whys behind the science.*

#### Community:

- o *I definitely remember meeting lots of girls and women to whom I could relate.*
- o *WINS opened that door for me and allowed me to take part in free programs and gave me mentors, especially female mentors.*

- o *Meeting [a] female scientist who had discovered a species of fish not known to anyone (Ratfish).*
- o *Forming lasting relationships with my teachers and peers.*

#### Skills and Practices:

- o *We went on a lot of camping trips and learned a lot about the outdoors.*
- o *I remember making the weather video, teaching younger girls to build rockets.*
- o *The highlight was working at Highland Hospital as an intern. This experience was one of the major factors that influenced my decision to join the health field now.*
- o *The nature/camping trips–PEEC (Pocono Environmental Education Center), Assateague Island, day hiking trips. Growing up in the inner city, this was my only real exposure to "the great outdoors," and it was really fun!*
- o *Learning chemistry components...watching how I could make the properties of things change with just a little knowledge. It was fun!!!*
- o *Pure learning high. I was thrilled to be exposed to so much science, of such varied scope, at a down and dirty level.*

#### STEM Learning, Understanding, and Attitudes

*When we asked women in an item with a drop-down menu whether they were working in a STEM-related career, only 17% of those responding indicated that their careers were related to STEM. However, when we coded an open-ended item in which women had written in their occupations using a modified rubric we created of STEM occupations identified by the U.S. Bureau of Labor Statistics, we found that 48% of the women were working in STEM-related careers.*

In thinking about the potential impact of informal experiences on future STEM engagement, we sought to consider participation in STEM from different angles. This included impacts related to future education, careers, and leisure pursuits, as well as how these experiences shaped girls' ways of thinking about what science is and who does it. In addition to the recollected science experiences described above, we also analyzed four additional STEM-related dimensions:

- o Attitudes towards and perceptions of science;
- o Enhanced awareness and understanding of science, including science careers;
- o Increased participation in science communities, both professional and vocational;
- o Identification with science.



### Attitudes and Perceptions

Young women who discussed how their attitudes and perceptions changed as a result of being actively engaged in doing and thinking about STEM said:

- o *I became more confident in my math and science skills as a girl.*
- o *I learned that there's much more to science than what we are taught in the textbooks in school.*
- o *I wasn't in love with science, but getting involved with WINS allowed me to explore a different outlook on this field and built my sense of wonder and interest in this area. WINS helped me to become more open minded to the experiences one could gain from being open to truly exploring new things and not only on the bare essentials.*
- o *I loved the atmosphere of wonder and creativity regarding the sciences. It was like life's mysteries were being disclosed to us through this SMART classroom. I felt capable of learning things that were considered "unladylike," like worm anatomy for instance.*

When asked to describe their memories of the program, 67% of the 159 women who responded made specific reference to positive attitudes or perceptions towards science (Table 2).

Table 2: Specific memories about the program related to attitudes towards and perceptions of science (n =159)

ATTITUDES TOWARDS/ PERCEPTIONS OF SCIENCE	n	%
Positive attitude towards/ perceptions of science	106	67%
No mention of attitudes/ perceptions	53	33%

Note. Multiple responses allowed

Women were also asked, "Describe one way in which you think this program influenced you." A third of those who responded to this open-ended question indicated they perceived that their attitudes towards/perceptions of science had changed (See Table 3).

Table 3: Descriptions of how the program influenced participants (n =159)

INFLUENCE	n	%
Personal development	87	53%
Changed my attitudes towards/ knowledge of science	48	29%
Furthered future career/goals	39	24%
Helping others	10	6%
Exposed me to mentors	10	6%
Other	9	6%
Negative comment	2	1%
N/A	1	1%

Note. Multiple responses allowed

### Awareness and Understanding of Science

Women also discussed how participation in these programs enhanced their awareness and understanding of science and introduced them to a variety of science content and science-related careers. The comments of these participants reflect these impacts:

- o *This program influenced [me] to go to college and get a degree in a science-related field and one day go to medical school.*
- o *I feel like I got a lot out of this program—I ended up pursuing a math degree. This help[ed] me to do more research and realize that I wanted to major in Electrical Engineering in college.*
- o *It gave me a chance that no other program or my school did. I was a poor white girl in a good school who no one paid attention to and was dying for a different type of science than what school offered (only lab sciences). I craved environmental and animal science programs. [The program] opened that door for me and allowed me to take part in free programs.*

### Participation in STEM Communities

Many of these young women attended college and over half who responded to a question about their major in college pursued STEM majors (53%)—a substantially higher percentage than the national figure of 15% of first-year female undergraduates (Higher Education Research Institute, 2007). STEM majors include computer science, mathematics, engineering, physical and life sciences, medical degrees, and

science education (see the frequency breakdown in Table 4). Majors were defined based on a recent study examining STEM degrees and careers in the United States (Langdon, McKittrick, Beede, Kahn, and Doms, 2011).

*Table 4: Major course of study participants focused on or are currently focusing on during education (n = 144)*

MAJOR	n	%
*STEM major	76	53%
Medical field	32	22%
Life science	31	22%
Engineering	13	9%
Physical science	12	8%
Computers and Math	6	4%
Science education	2	1%
*Other major	68	47%
Arts/humanities	31	22%
Social Sciences	27	19%
Management/business	22	15%
Social services	15	10%
Education (non-science)	11	8%
Communication or Journalism	10	7%
No major selected	2	1%

*Note. Multiple responses allowed on subcategories*

It is important to note the potential disconnect we found in our data between what is understood by a woman to be a science-related career and what actually is one according to the U.S. Bureau of Labor Statistics. When we asked women in an item with a drop-down menu whether they were working in a STEM-related career, only 17% of the women responding selected the STEM career option. However, when we coded open-ended items in which women had written in their occupations using a modified rubric we created of STEM occupations identified by the U.S. Bureau of Labor Statistics, we found that 48% of the women were working in STEM-related careers. Table 5 shows the distribution of these occupations.

*Table 5: Participants' fields of employment (n = 108)*

FIELD	n	%
*STEM field	52	48%
Medical field	15	14%
Computers and Math	13	12%
Science education	12	11%
Engineering	6	6%
Life science	5	5%
Physical science	2	2%
*Other field	56	52%
Management/business	42	39%
Education (non-science)	19	18%
Social services	15	14%
Retail/sales	14	13%
Arts/humanities	10	9%
Law	4	4%
Social sciences	3	3%
Other	3	3%

*Note. Multiple responses allowed on subcategories*

### Identification with Science

There was evidence that informal STEM programs helped some women develop an identity with science (see Table 6); they become more comfortable, interested, and knowledgeable as science participants:

- o *It was fun and interesting and my favorite part was feeling like I was doing something I was good at. Just a wonderful and valuable experience. I learned a lot about science, myself, and gained some valuable relationships. While participating I always thought of the future, such as me using similar activities in the future as a teacher.*
- o *Eureka inspired me to actively participate in science and math because I found it could be fun when it pertained to me.*

### Other STEM-Specific Impacts

There were a significant number of young women who discussed other STEM impacts. For example, many discussed how these programs inspired them to use STEM in jobs that are not STEM-related, or to continue to explore lifelong STEM learning by visiting museums, and/or engaging in hobbies. Some were very clear that these experiences offered confirmation that a science career was not for them, but they have a better appreciation of its importance in their life. For example:

- o *I am now a very successful law student who is interested in the things that affect our environment.*
- o *Visiting The Franklin Institute was a great experience and has contributed to my interest in continuing to visit museums.*
- o *I grew my interest in hands-on projects and learning in science and art, which continues today. I still go camping and remember all the birds and plants I learned to identify as a Scout.*
- o *I learned a lot more about science and technology through the projects we did, but also realized that while the material was interesting, it was not something I wanted a career in.*
- o *Science is not my best subject, but because of the program it has made me understand this subject more.*

### Personal Identity, Social Capital, and Civic Engagement

In addition to STEM learning outcomes, women perceived that participation in free-choice/informal STEM programs positively influenced a) their personal identity and agency, b) their social capital, networks, and skills (leadership and other life skills), and c) their commitment to civic engagement. We explored some novel approaches to tease out these influences.

Women were asked to describe one way in which the program influenced them. This data was coded in a variety of ways that allowed us to think specifically about these topics. For example, as shown in Table 6, 67% of the women responding mentioned that the program influenced their personal identity (which included a combination of self-image, self-esteem, confidence, and leadership descriptors), and 22% specifically noted that the program influenced their science identity (relationship to and connection with science).

Table 6: Descriptions of how the program influenced participants with regards to personal identity (n = 164)

INFLUENCE	n	%
Science identity	36	22%
Personal identity	110	67%
Self-esteem	28	17%
General personal identity	25	15%
Leadership skills	20	12%
Gender identity	17	10%
Other	11	7%
No mention of identity	54	33%

Note. Multiple responses allowed on subcategories

Women were also asked to identify important influences in their lives by distributing 20 points across 8 possible influences (e.g. school, your program, mentor, sports, youth activity, family and friends, other, or none) for the following statements: 1) *Helped me feel that I have a good future*, 2) *Made me feel successful*, 3) *Exposed me to new science learning opportunities*, 4) *Helped me to recognize my strengths and weaknesses*, 5) *Increased my self-confidence*, 6) *Made me proud to be a girl/woman*, 7) *Made me proud of my racial/cultural background*.

Table 7 shows that “Your Program” was the most significant influence in two areas related to this research: *Exposed me to new science learning opportunities* and *Made me proud to be a girl/woman*.

#### Example: Question 32, #5

The following exposed me to new science learning opportunities:

(Please distribute 20 points among the influences described below. If none of these contribute to the statement, put all 20 points in “None.” Please ensure your total equals 20 points.)

- School \_\_\_\_\_
- Your Program \_\_\_\_\_
- Mentor, Leader, Facilitator \_\_\_\_\_
- Organized Sports \_\_\_\_\_
- Organized Youth Activity \_\_\_\_\_
- Family & Friends \_\_\_\_\_
- Other \_\_\_\_\_
- None \_\_\_\_\_

Table 7: Descriptive statistics for the distribution of points among important influences

Influence by Statement	School	Your Program	Mentor Leader Facilitator	Organized Sports	Organized Youth Activity	Family & Friends	Other	None
Exposed me to new science learning opportunities	6.09	7.35	2.23	0.24	1.36	1.96	0.53	0.16
Increased my self confidence	3.02	4.36	2.78	1.6	1.77	5.58	0.8	0.16
Made me proud to be a girl/women	2.17	6.63	2.83	0.98	1.09	5.2	0.73	0.35
Made me proud of my racial/cultural heritage	1.86	2.25	1.8	0.52	1	8.77	0.57	3.24
Helped me recognize my strengths an weaknesses	5.2	3.46	2.77	1.23	1.47	5.18	0.77	0.03
Helped me feel that I have a good future	4.32	3.33	2.77	1.09	1.51	6.43	0.56	0.05
Made me feel successful	4.94	3.59	2.37	1.28	1.66	5.19	0.85	0.03

### Personal Identity and Agency

Women perceived that these programs greatly contributed to who they are today, shaping their personal identity, including their gender and cultural identity, as well as contributing to self-awareness, self-confidence, and agency:

- o *It made me a strong, confident woman. It gave me the confidence I need as a young women to grow and to be successful in a male-dominated world.*
- o *It encouraged me to get a job in a science or engineering field to help pave the way for more women who want to have science or engineering jobs. It influenced me to have the confidence to be smart, and to own my intelligence. It also allowed me to find out that I deserve to be smart*
- o *It has made me unafraid to try new things or things where women of color are a minority. I feel more knowledgeable, more self-confident, a much stronger young woman than I ever thought I'd be.*

### Social Capital, Networks, and Skills

Women also perceived that these programs contributed to their social capital, networks, and skills (leadership and other life skills). One area in particular that was remarked upon by participants in programs that included older girls (WINS, Eureka, and Rural Girls) was the support offered to them in identifying, visiting, and applying for college, a challenge for many of these women since they were first generation college students. These programs offered resources for youth and families, skill-building, and trips to visit colleges:

- o *I remember going on many field trips and particularly the college tour that we took. It helped me select the college that I attended after I graduated from high school.*
- o *It was through this program that I was able to get my first exposure to the work field. Through these experiences, I was able to shape my leadership and interpersonal skills for future jobs and interviews. It was because of the staff members' support and help that I made it to college today.*

Access to social capital in science specifically, for instance knowing a female scientist or interacting within the community of professional scientists, also was critically important for some women:

- o *It gave me mentors, especially female mentors. It also gave me a network of professionals that helped me grasp how to be professional and the opportunities that science has for women. No one in my family or immediate circle had gone to college or worked in science so these introductions were invaluable.*
- o *Meeting women from various professions ranging from structural engineer to construction manager.*
- o *Being introduced to successful women in the field I also remember that one of my favorite classes to attend during the Eureka! summer was the careers class because we got to meet female professionals.*

### Civic Engagement

Women also discussed how these programs shaped their commitment to civic engagement in general. For example, girls reported staying connected to the program in some



way, often returning as a mentor or to help with special events. Some women even worked as paid staff for the same program in which they had participated or worked in other youth-serving kinds of organizations as social workers, teachers, and counselors. Women shared their commitment to civic engagement in a variety of ways:

- o *It made me want to continue volunteering because you can see when the lights come on in the eyes of the kids you are helping.*
- o *Also, a few times a year I return to Techbridge to serve as a role model and to aid the instructors in the activities.*
- o *I was able to help people and my community during service projects, and be part of something positive. Earning my [Girl Scout] Gold Award and using the leadership skills I learned over the years.*
- o *I was able to learn from the way the science training was done and build a disability awareness program in my community.*

## Cascading Influences

And, finally, it was apparent that activities and experiences had made their way into women's lives and relationships, connecting to other experiences both at the time of the program and well into some women's futures. While hard to capture, these examples show the potential role of cascading influences in women's lives in powerful ways. For example:

- o *I think the program had a great influence on my life, specifically in choosing to pursue studies in math and science. I am currently studying chemical engineering at UC Berkeley. I was always strongest in my math and science classes at school, but I mostly credit Techbridge with exposing and introducing me to many different possible careers in engineering, science, etc. that exist for me. Thus, I believe Techbridge helped me imagine or begin to think about various careers in science and engineering as possibilities.*
- o *Going to Carollo Engineers [on a field trip] to meet with the people there. One female engineer gave me her card and then I contacted her later for a school project and we met one on one. She showed me how waste management was done.*
- o *I used a lot of the projects I learned at Girl Scouts with the kids I babysat for when I was in high school. They all loved me after that.*

This cascading influence was further evident when some women who are now parents noted the impacts their experiences were now having on the next generation:

- o *We started a compost bin. That's really fun for me and my kids. We use it for my garden.*
- o *[I] model to my daughter how to be an intelligent, strong, and successful African American woman, helping children.*
- o *I can't express enough how much the program helped me. I wouldn't be who I am today. I'm more aware and involved with my kids in every way, both nurturing their education and their physical activities because I know how important that is. Now that I'm a mother of three, looking back at my years in the program, I wish my parents were more involved in my education and in my growing up as a teenager because it is so important.*

# DEEPER REFLECTIONS



## Exploring the Impact of Informal STEM Experiences on Individual Women

Eight women (6 who attended the convening and 2 additional research participants) allowed us to more deeply explore their personal perceptions of the influence of informal STEM program experiences in their lives. They participated in different programs, yet their experiences and the impacts they perceive are remarkably similar to one another. These highlights of women's stories richly enhance the overall findings from the questionnaire, particularly the three sets of outcomes we observed, and contextualize, personalize, and bring life to the overall findings. Their names are pseudonyms and the locations noted represent where the individuals participated in their STEM program, not where they live today.

### Story 1: "Shyla"/Northeast USA (Girls Inc. Eureka!)

According to Shyla, Girls Inc. "kick started" her life. When speaking to other convening participants, she said with emotion: "If it were not for Girls, Inc., I would not be standing in front of you right now." Shyla is a triplet who grew up in a "chaotic" family in Massachusetts. She became involved with Girls Inc., and, after taking part in a writing program, went on to be involved with the Eureka STEM program.

Shyla attended college, majoring in criminal justice with a special focus on homeland security and terrorism. She returned to work at Girls Inc. in the middle school Eureka and Odyssey programs, and the high school sexual health programs. Although she no longer works for Girls Inc., she is an active volunteer in the Girls Inc. college

mentoring program. Shyla currently works as an Intensive Case Manager at a nonprofit that serves adults recovering from mental illness.

### Memories of Program Experiences

Shyla has strong positive memories of her Girls Inc. experience, in general, and her Eureka experience, in particular. This was Shyla's first experience away from her "womb mates" as she calls her two triplet siblings, and her first experience with boundary-expanding activities such as STEM projects, ropes courses, and public speaking opportunities. In Shyla's case, it is difficult to separate and tease out the general impact of Girls Inc., a youth development organization committed to "inspiring girls to be strong, smart and bold," from the impact of the STEM-specific Eureka program.

- o I'm a triplet, so it was a big deal to step away from my family. My sister went the first day, didn't show up the next day. So it was tough...a really tough summer, my first summer that I spent away from my sister for more than a few hours. So at that time, it was a big deal for me.*
- o I just remember at the end of the summer wanting to continue it. I called every day for the two weeks that we were off [from school] to figure out when do we start next? What else can I do? What other programs are there?, I want more friends. And that really just pushed me to enter into the programs that happened during the fall sessions and the winter sessions.*
- o I remember continuing on from the Eureka set of programs. They had middle school programming that focused on health and relationships. From then I became a Eureka senior, so that was a big deal for me, because then I actually got to give back a little bit of what I learned, which I enjoyed thoroughly. At this point*

*I became part of the bridge program that connected the middle and the high school sides [of these programs].*

### STEM Learning

While Shyla found science difficult, her experience with Girls Inc. allowed her to expand her horizons in the field. As a result, she says, her favorite television program is “Mythbusters” (a show which reveals the science behind popular myths), and her career choice ultimately involves science and technology:

- o I studied criminal justice in college with a focus on homeland security working on terrorist warfare; understanding the science behind IEDs and other terrorist tactics was extremely exciting.*

### Personal Identity and Social Capital

Shyla’s experience in STEM-related programs at Girls Inc. had a profound impact on her self-confidence and self-identity. For the first time, she visited colleges and museums, and began to see herself as a potential leader, able not only to provide guidance to other girls but also to take on challenges outside her comfort zone.

- o The summer was filled with trips to local colleges. I went to M.I.T. We experienced all kinds of museums, educational projects. I battled my fear of heights on a ropes course, and I still have the picture to this day.*
- o ...from there I continued on to high school, did a little bit of a career path program, which then was a pilot program but now, a fully operating program that kind of pushes girls to figure out what they want to do with their lives. Do you want to go to school? Do you want to go to the military? And that was really cool. Then I was able to do an internship...I did a stained-glass internship. Who does that?*
- o [For awhile] I worked for Girls Inc. Through the programs I was able to learn social skills and leadership skills, etc. It opened me up to a world of nonprofit work.*

### Story 2: “Kaitlin”/Southwest USA (Girl Scouts/National Science Partnership)

Kaitlin joined the Girl Scouts in high school, which was later than most girls. Since her troop was going to facilitate STEM activities with younger girls, they first experienced the kits and activities developed for NSP as learners. Then they facilitated them with a group of younger girls. Kaitlin commented that this was a defining experience, not only exciting for her as a “nerdy child,” who had had little opportunity to engage in hands-on STEM (her parents were not STEM-oriented at all), but

also a stepping stone to understanding herself and how much she enjoyed helping people learn. She did not appreciate it at the time, but ultimately this was a significant work experience.

While Kaitlin always found STEM exciting and engaging, math and memorization were stumbling blocks, which limited her opportunities to pursue “hard” science courses in high school and college. Kaitlin persisted in her interest in STEM and helping others by becoming a lead librarian in the health sciences library at a public university.

### Memories of Program Experiences

Kaitlin’s strongest memories relate to her experience with the NSP kits, which included materials for fun, hands-on STEM projects. As an older Girl Scout who would be “teaching” the kits, Kaitlin had the opportunity to open, explore, and prepare them for younger girls. This experience was important, not only because it was engaging, but also because it represented an opportunity to assume leadership.

- o I remember the science kits boxes. My troop leader and day camp leaders always let me open them and prepare for the activities with the other girls. Other than the science kits, I don’t remember other science in Girl Scouting.*
- o I loved being able to explore the science and then share with younger girls. I also remember a day where Senior Girl Scouts were able to lead science activities for younger girls at a weekend event.*

Kaitlin’s “older girl” status also provided her with access to training events. These were particularly memorable because they made it possible for Kaitlin herself to become a mentor to younger girls.

- o But where it changed for me was when our troop leader actually took our troop, because we were older, to a train-the-trainer event. And I think that was the first time I got training in how to teach someone else something. So from there, actually, in at least one of the summers, I worked with a day camp where I got to, as a senior Girl Scout, work with the younger Girl Scouts on those same projects that I had learned previously. And so that was really my first teaching—that was the first time I taught anybody anything. And I remember how much fun it was to work with younger girls, and how real it was, and how exciting that made, actually, Girl Scouts. It wasn’t just about the field trip at that point.*

### STEM Learning

While Kaitlin’s general interest in STEM started at an early age, her interest and confidence increased significantly

with her involvement with Girl Scouts and NSP. Of particular importance to Kaitlin were exciting STEM projects like rocket launches. Through her participation she developed a sense of connection to like-minded girls and women, and gained opportunities to share her enthusiasm as a mentor for younger girls.

- o *When I filled out this survey the reflection began on my life. If you asked me before where my interest in science came from I would have said space camp. But after taking the survey...I realized it started way before that.*
- o *That is what is amazing about science. These experiences allowed us to explore.*
- o *The Girl Scout science kits were my first experience with rockets (generally my parents didn't get me anything that involved flames) so when I built and launched my first rocket, I was so excited.*
- o *Looking back, I think that [experience with Girl Scouts and NSP] was the beginning of my love of teaching and my first true concrete experience where science was exciting. My parents are not, by any means, of the science variety, and they were okay with the nerdy child that was developing, but I guess they didn't know what to do with that. And so from there, that experience was really my first joyful "science is fun" where all the other geeky people were together.*

### Personal Identity and Social Capital

Like many of the girls who took part in these programs, Kaitlin gained a greater sense of personal competence through hands-on STEM experiences. In addition, she felt strongly that her experiences were a first step toward job opportunities and an important influence leading to her choice of career.

- o *I know that that experience helped me get my first summer job in college—because I was able to say, "I have already taught children to build rockets, and nobody lost a finger."*
- o *The NSP gave me actual real experience in areas where opportunities did not exist. By exploring science in a safe environment I was able to explore and learn in areas not in the school curriculum.*
- o *Science is really relevant in my job. I'm a librarian for future health care professionals. I work at a public university health sciences campus library. The university offers nursing, dentistry, medical, biomedical sciences and allied health professions degrees. I am a librarian and head of my library's reference and education programs.*

Today, Kaitlin not only works in a STEM-related career, but also takes part in STEM-related hobbies and activities. She "reads extensively in the history of science," and says, "I love the crime 'CSI' or 'Bones' type shows which highlight scientific methods. I also watch science fiction shows that are space adventure type stories. I also enjoy space documentaries and NASA specials."

### Story 3: "Amanda" / Mid-Atlantic USA (Girl Scouts/National Science Partnership)

Although Amanda was the first in her family to graduate from college, she shared the many ways in which there was a family expectation of involvement in science and technology. She remembered there was often paper pulp being made in her kitchen in preparation for many NSP workshops for leaders and girls. She also took apart computers and fixed them so that she could play computer games, and at an early age she attended science fiction conventions with her aunt. She determined when she was quite young that she wanted to be an astronaut. When interviewed at age 22, she felt this remained a possible pursuit, although being in the control room rather than in space was starting to have more appeal, in part because she considered it more intellectually challenging. Amanda was heavily involved in Girl Scouts, going to science training events with her mother, who was an NSP trainer.

### Memories of Program Experiences

Amanda's most salient memories of NSP were about being a young person in the role of facilitator. Like Kaitlin, she was one of the older girls that facilitated younger girls in STEM; because her mother was a NSP trainer, she also was able to teach adults. These experiences taught her about organizing materials, about how important it is to think about the learner, and about being in charge in a situation in which she was teaching adults:

- o *Going to the training, being trained and training other people - I would say that was it; that was the [biggest NSP influence]...being a kid working with adults.*
- o *Our troop taught [the Science Sleuth badge program] 3-4 times, and I always got magnets ...and I can [still] give you 20 minutes about magnets!*
- o *Training adults...I would go to the trainings with my mother, and even though I was 13 or 14, I would be in charge of stations with adults I would have to train.*

### STEM Learning

Amanda has been very strategic in exploring her path forward. She graduated with a degree in mechanical



engineering with a specialty in manufacturing. She was intentional in her conversations with experts about the best engineering path to follow to become an astronaut. Drawing on advice she got from mentors, some of whom she met through NSP contacts, Amanda chose mechanical engineering as her major because she was told it would be the most flexible type of engineering for what she wanted to do as a career. Just out of college, she was pursuing an opportunity with a company that would enable her to rotate through a variety of departments, which she hoped would lead to a position in the company's aerospace division. She clearly had a passion for science and education, as seen in her desire to "make engineering into something everybody else can understand."

- o *For [the Society of Women Engineers at my college] I was in charge of outreach. I did two different programs, which we did for a local elementary school and did as an afterschool program. And so a lot of those actual projects you had to improvise, because I didn't have a budget the first year. Whatever odds and ends - we did it. For instance, we used CDs for a little hover board. ...I saw on the internet what they said to use [and adapted and improvised]*
- o *One of the things that's really attracting me to this [new] job is that it is an interface between technical people and non-technical. I have had a broad tech background, but some of the things I have done are pure liberal artsy...*
- o *NSP gave me a lot of experiences with different types of science and even though it wasn't labeled as such - you go back and you learn that there are different types of engineering in there, but ... most of all it was the hands-on that did it for me.*
- o *And I think a part of it was also teaching other people about [science]. It was a big thing because that meant that I internalized what was happening...it wasn't just I went to a program once, we [her troop of older girls] put on the program.*

### Personal Identity and Social Capital

Like Kaitlin, Amanda's personal identity as a science learner and teacher was very apparent. She developed an appreciation for differences by being exposed to different people having different degrees of understanding about science and playing different roles in troop settings. Even without the history of college attendance, Amanda's family was committed to learning and achievement in general, and in science and technology, specifically. However, even with this support, she still felt that she needed to take action on her own behalf, building capital both socially and intellectually. She felt that she developed a number of life skills through the experience of teaching others about her passion, STEM:

- o *Rapid decision-making situations—there were times when we would run out of materials or some girl wanted to do something totally different...teaching without adults being present - usually there were two of us who were 14 [or] 15, teaching, and so you were really in charge!*
- o *GS was very good at giving opportunities to expand!*
- o *Workshops about learning and teaching - that is something I found useful, even now.*

Amanda's early interest in science and technology were fed by her experiences in NSP. Her Personal Meaning Map revealed a range of experiences outside of school, including family, camps, science fiction conferences, and home-based activities. She also spoke very clearly of the significant role that mentors she met through these experiences played in her education and career decisions. And most empowering of all for her, were the opportunities to facilitate the learning of others.

### Story 4: "LaTonya"/Southeast USA (Girls Inc. Operation SMART)

LaTonya participated in Operation SMART in an urban area in the southeast US. Her mother was a single parent and looking for summer activities for her and her sister. She signed both LaTonya and her sister up for the Girls Inc. Operation SMART program. LaTonya was really excited because of all of the computers and neat things to do. She did not want the program to end. She continued in the program after the summer even though her sister no longer attended. LaTonya was a very good student; she was her high school valedictorian, graduated cum laude with a B.A. in English and recently completed her J.D. in Law. She recently took her bar exam and is pursuing a certification in criminal practice and procedure, with the intention of focusing on environmental law.

### Memories of Program Experiences

LaTonya had strong memories of the program, particularly "the fun times and great staff." She also remembered all the "cool stuff," especially computers. Since she lived in a single parent home, money was tight. She did not have access to computers and special materials at home. One of the highlights she noted was that she was picked to participate. She also recalls the moment in the program, "When I learned to trust my judgment - at the end [of the experiment] when I saw what happened. I said to myself, why didn't I trust my judgment? I have to do that in the legal field—very vital now!"

### STEM Learning

LaTonya was involved in science fairs as a child, but described feeling like science was “huge and intangible.” Operation SMART helped to make science tangible for her: “made it real, and the scientists reachable—I valued meeting with female scientists who felt like ‘us.’”

LaTonya spoke at the convening about the widespread perception of science as being only what smart people can do:

- o *[In our small group] we talked about how much of a mystery science is to youth and how intangible it seems to them. And so I think that putting a label on science that it is the thing that smart people do actually discourages people from joining, because I may not think I'm smart. Maybe mommy at home is telling me I'm the little dumb girl. You never know what people's situation is. And we talked about how these experiences that you [offer] through Operation SMART, Eureka, WINS, Techbridge or NSP, make science tangible. So I think if the community could make science more tangible and keep it from being a mystery. And what I mean by keeping it from being a mystery, science is going to always be a mystery. But keep the people who do science from being a mystery. Then it will be more tangible. It will be more palatable to young people. And then that's how you get people to join. If we unveil the people who do science and keep it less secretive, then kids will be more inspired to go into science.*

### Personal Identity and Social Capital

LaTonya sees herself as a bright and competent person. As she said on her questionnaire: “I am now a very successful law student who is interested in the things that affect our environment.” She feels that Operation SMART contributed to this greatly: “It has enhanced my thirst for knowledge in all different fields.”

Like many of the women in our sample, LaTonya believes strongly in supporting her community and is a volunteer in many organizations, including her area Ronald McDonald House, an organization to aid low-income elderly and disabled homeowners, and an organization that advocates for deprived children. She believes that “service is a sound principle of life that helps girls become women.”

### Story 5: “Sarah”/Pacific Northwest USA (Rural Girls in Science)

Sarah grew up in a rural northwestern state and participated in the Rural Girls in Science program, beginning in 9th grade. Both of Sarah’s parents had dropped out of college, but her Dad loved science and was always reading books

about science and listening to science-related radio programs such as *Science Friday*. Similar to Amanda, Sarah “never had a question” about whether she would pursue further STEM education and a career. In fact, at about 14 she had decided to become a nuclear physicist. Sarah was an extremely dedicated and successful student and left high school after 10th grade to start at a community college: “I was in the Running Start program in its original form. That is, I didn’t have to take any HS classes at all except for Driver’s Ed.” At the time we interviewed her, she had recently completed a Ph.D. in Physics, an accomplishment that took 8 years. She now works as a scientist in research and development at a small firm in the Pacific Northwest.

### Memories of Program Experiences

Sarah had two types of strong memories related to her experience in the program. She remembered the activities; for instance she talked vividly about “dissecting a sheep’s heart and poking pig lungs,” that came from a local slaughterhouse. Sarah did comment that she wished the program had not been so focused on biology. She was also surprised when she returned as staff that “so few of the participants seemed interested in anything but geology or bio.”

Sarah also described her memories of the community that formed around the program. For instance, one component of the program was a one-week camp she attended during the summer on the University of Washington (UW) campus in Seattle, living in the dorms, eating in the dining halls and generally immersing herself in the activity of a campus. She discussed meeting “cool” women that “had lives,” including “boyfriends, travel and other interests.” Another unanticipated but very beneficial outcome of the summer experience at UW was meeting another girl with a similar background. They “became great friends and roomed together at college.” This was significant; since they were both the first person in each of their families to finish college, they were able to support one another through their undergraduate degrees.

### STEM Learning

Sarah’s story sheds light on another important reason a young woman might choose to participate in an informal STEM program, particularly in high school. Sarah knew she wanted to pursue a physics career early on, but as she got into high school and began more seriously considering this passion, she had questions about the science enterprise and community of practice that she would be entering. It was extremely important to her that she was “well read and well rounded,” since she also enjoys gardening, reading, martial arts, and walking and wanted a “real life.” Participation

in the program, particularly the UW summer program described earlier, provided opportunities for Sarah to meet and interact one-on-one with female graduate students and faculty for “validation” that a woman could be a scientist but also be married, have children and enjoy other pursuits. This opportunity to actively participate in the community of practice, that is to “try it on,” even just for a week, was critical to her decision to pursue her dream of studying physics which Sarah majored in, earning a master’s and a Ph.D.

- o *The program also helped me to aim higher than most of the jobs and mentors that were presented to us. While I completely respect fish hatcheries and the workers and it was excellent learning about them, many of us girls wanted to be rocket scientists and other things.*

### Personal Identity and Social Capital

Since Sarah was a first generation college student and grew up in a relatively isolated small rural community, she also discussed how the program helped her think about possibilities that she might have not otherwise considered:

- o *It really helped open my world so I could start to picture my life and what I really wanted to do. When you grow up in a really small town, some of us are not exposed to city life at all. Yes, our families wanted us to go to college, but since they had never done it they also had no idea what it took to move away and live in a completely foreign environment.*

In addition to achieving her goal to become a physicist, Sarah has also accomplished the other life goal she had. She is happily married and had her first child 3½ years ago with a second child on the way. Like so many of the women who were in our study, it is important to Sarah to make a contribution. She returned for one summer as a counselor to the Rural Girls in Science program, working with younger girls. She volunteers frequently for mentor programs and was unable to attend the convening because she was a speaker at an aeronautics symposium.

### Story 6: “Nancy” /West Coast USA (Techbridge)

Nancy is a twin, whose brother is profoundly autistic. Her father, who has a Ph.D. in philosophy, is very interested in science, and shared his enthusiasm with Nancy. Nancy’s interest in science emerged, in part, as a way to connect with her father—and to distinguish herself from her brother.

Nancy took part in Techbridge programs, and, by the time she was in high school, had a definite interest in science. However, like Kaitlin, math was a stumbling block for Nancy. Her experiences with Techbridge gave her a sense of competence and connection to STEM, and encouraged her

to consider a STEM-related career. Today, she is a lighting technician, working with a company that manages theater and corporate events.

### Memories of Program Experiences

Nancy has strong positive memories of her time at Techbridge. She was drawn initially to STEM because of her father’s encouragement. Once she became engaged in the program though, several specific events stood out for Nancy, including a meeting with a soil scientist and a field trip to Pixar where she was inspired by the technology behind the entertainment industry.

- o *I went to Pixar, and that just blew my mind to know that people who had toys [could use them in their profession] and they had this network, too, of professionals.*
- o *I went to this wonderful program and we just would take things apart and they [the staff] would be very nice. I really enjoyed that. ...And the last and most important thing is it provided me with a lot of positive memories. So years afterwards, in my leisure time, I read books about science because I have some positive associations. And so I think it contributed to my life greatly. I love it.*

### STEM Learning

While she participated in Techbridge, Nancy explored a number of STEM areas, and has strong memories of those experiences. Specifically, she recalled:

- o Learning to code in HTML 5;
- o Taking things apart to learn how they work;
- o Building a battery from a lemon;
- o Learning about digital technology at Pixar;
- o Using a telescope for the first time.

Some of Nancy’s reflections on her Techbridge experience are emotionally laden:

- o *Like, I met a soil scientist and that blew my mind—that there are things living in soil!*
- o *It made me realize that there is nothing to fear about technology. It’s all just junk that you manipulate.*
- o *Seeing Jupiter in a giant telescope and seeing how lonely it is out there in the vast darkness of space.*
- o *There are all of these things you think you can’t do - like code HTML. I have carpentry skills. My girly-girl friend was doing metal-working. And my other friend was working with lasers. The idea that you can do this in real life (not just watch someone) [was great].*

### Personal Identity Social Capital

In high school, Nancy was a self-defined science “geek” in search of like-minded friends. Techbridge provided a way in which to find teens with similar passions and sensibilities, interested in discussing STEM and science fiction. It also provided opportunities for meeting and engaging with role models and other adults with careers in STEM.

- o *...by the time I reached high school I already had a strong interest in science. But I was kind of an alien. And I didn't really realize this until I was reflecting back a little bit on it, but there would be two, [possibly three] scenarios in high school, [since] none of my friends were really into science. Either I could continue to isolate myself socially or my friends would develop an interest or I would change.*
- o *Basically Techbridge was a great vehicle for making friends... It gave me a chance to meet other scientists, professional scientists.*
- o *[Techbridge] provided me a network with a lot of professionals and grants and stuff that I would never even [have] looked at.*

Today, Nancy works as a lighting technician, and enjoys a number of activities and hobbies related to her STEM interests. For example, she says, “I still like to do experiments with batteries. It’s something that never went away.”

### Story 7: “Tenesha” / West Coast USA (Techbridge)

Tenesha grew up in a technologically-oriented family, and had an interest in science and engineering before her experience at Techbridge:

- o *This has always been something that interested me, even before it had its own acronym. Both of my parents have degrees in technology, and my Dad's an engineer, so he always was at home working on computers and explaining things, sometimes a little too much in depth, and I'd just [get bored]. He would always be explaining how things worked and telling me the connections and if you do this, this will happen, but you want to make sure you don't do this, because this happens and that's bad. So it was interesting having him show me all of that.*

However, it wasn't until her experiences at Techbridge that Tenesha felt she had her own personal interest in exploring STEM. Similar to Sarah, field trips and role models helped shape her awareness of STEM opportunities for women, and that such an interest would not preclude marriage and children. Currently, Tenesha is an athletic trainer at her college where she is preparing for a career in sports medicine. She intends to go to the U.K. for a master's degree in this specialization.

### Memories of Program Experiences

Tenesha's strongest Techbridge memories were of field trips taken to high-tech corporations including Pixar, Electronic Arts (EA) Entertainment, and NUMMI (an auto manufacturing plant that has since closed).

- o *When I went on field trips with Techbridge, I realized that not all science jobs are boring.*
- o *[One of my strongest memories is from when] I went on a fieldtrip to NUMMI and got to see the process that the cars went through when they were being made. I really enjoyed the field trips because they were fun, but I learned a lot, too. [At NUMMI] where they made Toyotas, they kept saying 17% [of the employees] were women - [I thought] I could be a part of that small percentage...*

### STEM Learning

Explanations of scientific discoveries, facts, and principles had always interested Tenesha in a general way, but had not engaged her to the point where she saw herself as a participant in the scientific process. Techbridge allowed her to participate in STEM activities, to learn through experience, and then to share what she had learned with others. This experience, she says, was transformative.

- o *When I got into tenth grade, they explained to me how things worked as well, but it was a lot more than that because they allowed me to experience things. They allowed me to not only learn stuff, but also learn it and then teach it to someone else who was in Techbridge. Because if I could get it, then I'd be like, Oh, okay, then I can explain it to somebody else maybe a different way so that they can understand it better. And they allowed me to see things myself and do things myself and create things with big projects.*

### Personal Identity and Social Capital

Tenesha's thoughts about STEM and identity reflect a common concern that doing science and being a woman are mutually exclusive. Engagement with female role models who had not sacrificed a personal life or motherhood for their STEM careers helped to alleviate Tenesha's concerns in this area. In fact, says Tenesha the Techbridge experience “... encouraged me to get a job in a science or engineering field to help pave the way for more women who want to have science or engineering jobs.”

Some of the most significant aspects of the Techbridge experience for Tenesha included:

- o Being part of a group in which she felt empowered
- o Being where intelligence in a certain subject like science is alright, and surrounded by women who are similar in that regard



- o Having role models who show that they have a normal life—and can also continue in science or technology

And, says Tenesha, “I am now planning on attending grad school in London and getting my master’s in sports medicine, and I know that seems like it has no correlation with technology, but there are a lot of technological advances in medicine that I plan on using in my practice as an athletic trainer. So I’m excited to put those projects into the works, I guess. And Techbridge helped me find out what I wanted to do with my life, through field trips and different projects... [and discovering] Oh, this is really fun. Ah, I don’t like this as much. Oh, going to schools and going to Pixar and EA Games. It gave me experiences that I don’t know if I would be able to get other places.”

### Story 8: “Latesha”/Mid-Atlantic USA (Women In Natural Science [WINS])

Latesha grew up in an urban area with a difficult family life. She spent very little time with her mother or father, living mostly with her grandmother and aunt. Latesha was crazy about science and had been from an early age, particularly the ocean. She watched ER at age eight and loves watching forensic shows, anything on Discovery Channel, and reading. As she said about her participation in WINS, “It was JUST about science!! Forever! If it [WINS] wasn’t about science, I wouldn’t have gone there.” She earned a dual degree in Health Sciences/Physician Assistantship and works part time while raising three children with her husband.

#### Memories of Program Experiences

Latesha had very strong memories of WINS, particularly of trips “to Belize, the Pocono Environmental Education Center (PEEC), and to Assateague [barriers islands off the Atlantic coast].” Although she loved all the trips, the highlight, what she considered a defining moment, was the trip to Belize, where she studied marine biology on Ambergris Caye and visited Belize’s Blue Hole.

#### STEM Learning

The fact that science was the focus of the WINS program was a primary reason that Latesha applied for the program. To be eligible, she had to be nominated by a teacher, maintain a B average in school, and live with a single parent in a home with a minimum household income. These were all criteria that Latesha met and she was thrilled to be accepted.

Latesha felt that one of the things she took away from the program was strong knowledge in science. Latesha felt that a key component of what made WINS work (at least for her) was that it took place in a museum—as part of WINS they got to help curate and collaborate. The setting was really

important to her—she felt the museum venue provided real life examples of the concepts they were learning. Like other girls, she recalled being discouraged about science:

- o *When I realized science and math are closely related...for example, I would need to take Trigonometry and Physics to ensure entry into a science-focused undergraduate program [I was disappointed].*

Latesha now works as a Physician Assistant and plans to become a doctor. As one of the other young women at the convening said, “She’s going to make a great doctor.”

#### Personal Identity and Social Capital

Latesha already loved science, but the community she joined through WINS “solidified” her interest. She enjoyed meeting the scientists that were a regular part of the experience. For instance, she recalled being very excited to meet a marine biologist at The Academy of Natural Sciences. She also met a female scientist who had discovered “an entirely new species of fish, a Ratfish, not known to anyone.” This up-close encounter with an accomplished scientist who seemed like a regular person led Latesha to important realizations about science and the kind of people who can do science. Latesha recalled being “so impressed by her; [she was] a normal person, down to earth and tangible.” Latesha was really impressed with the community of practice at the Academy:

- o *Women and researchers in science - [who] genuinely cared about science and what they were doing...[they] took time to talk [to us] and ask questions.”*

Latesha felt that WINS helped her think about possibilities in her life that she might not have otherwise considered. It also provided a network of supportive peers and mentors. For example, Latesha recalled that:

- o *I have two friends [I met through WINS] who I remained friends after the program until this very day.*

Latesha is also a parent of three children. She indicated on her questionnaire (and confirmed at the convening) that she felt like she was a better parent because of her WINS experience:

- o *[I] didn’t spend much time with my parents and family growing up, and WINS helped me think about what was important. WINS really helped me see what someone might do in the future.*

# INSIGHTS AND IMPLICATIONS



In this final section, we offer insights from our research as well as a brief discussion of what we have learned through the research process. We also take a look at the questions that emerged as we learned more about the unique qualities of girls and young women in informal STEM programs. It is important to bear in mind, as you read this section, that we studied some of the most engaged women in six of the most successful informal girls' STEM programs in the country. Thus, these findings represent the potential these experiences have for long-term impact.

## What We Learned: Major Findings

By exploring the long term impacts of girls' informal STEM learning experiences in a wide range of successful programs, we have been able to describe some of the ways in which such participation can and does make a difference in girls' lives. We've also uncovered some of the more prevalent and consistent challenges to girls' pursuit of and identification with science. Following are some of the most important outcomes from the study:

### 1. Memories of STEM experiences became critical resources in girls' stories about their lives.

We documented the ways in which girls/women remember, talk about, and identify informal STEM experiences that were influential and even transformative in their lives. Findings confirm that these experiences were salient and, in some cases, powerful, as evidenced by the detail, diversity and emotional quality of the memories and stories women shared. Young women recalled engaging in hands-on science activities, trips, outdoor experiences, and specific skills and practices. They also had strong, positive memories of the

community of people with whom they interacted (mentors, program leaders, and peers). Years after the fact, these women could look back and say definitively that these experiences made significant contributions to their lives, both in the area of STEM and beyond.

For some of these women, STEM experiences were important relative to career choice. For others, they helped to build a sense of competence and a desire to teach or lead. In yet others, they suggested ways in which science could be an integral part of their daily lives. Many discovered that science was interesting enough to merit continued focus through reading, television, or hobbies.

### 2. Despite evidence of positive influences on women's views of science, data revealed continued tensions in the ways girls/women think about what counts as science, complicating their relationship to, and identification with, science.

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*The message that should be more intentionally communicated is "Yes, STEM careers are important and valued - but they are not the only way to engage in science." Although not all women in this study had traditional science careers, they were engaged in careers, interests, and hobbies that in many cases involved significant STEM content. In other words, they had STEM in their lives.*

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Evidence of a tension among girls and women about what "counts" as science - a topic raised in the late 1990s (Barr & Birke, 1998; Eisenhart & Finkel, 1998) - emerged from the data. The lighting technician, the lawyer supporting environmental efforts, and the health sciences

librarian all are engaged in STEM-related careers that exemplify an appreciation of STEM and identification with science as an integral part of who they are. This was not their perception, however. As revealed in our questionnaire and during conversations at the convening, women are conflicted about whether scientific thinking, content, and practices are exclusively the domain of those who engage in research in a traditional laboratory setting (the stereotypical bench scientist) or are a part of everyday life.

This finding also shows how our society's focus on traditional science careers, inherent in the "pipeline" metaphor may be discouraging participation in STEM or trivializing other ways of engaging in STEM. These perceptions may prevent or limit girls from valuing the science in their life. Focusing so sharply on this pathway to the exclusion of others may be off-putting. Ultimately, it may serve as a barrier to participation and commitment to science as a field of lifelong interest and engagement for girls and women. The message that should be more intentionally communicated is *Yes, STEM careers are important and valued - but they are not the only way to engage in science*. Although not all women in this study had traditional science careers, they were engaged in careers, interests, and hobbies that in many cases involved significant STEM content. In other words they had STEM in their lives.

**3. Informal STEM experiences served as opportunities for participants to first explore and then, through continued participation, meaningfully engage in a wide variety of STEM-related activities and practices, ways of thinking, and communities that led some women to develop positive relationships with science that moved well beyond what society credits or defines as science.**

Results show that the best programs provide more than involvement in engaging science activities. Exemplary programs offer participants opportunities to engage in authentic experiences embedded in rich social and intellectual contexts, participate in an immersive climate of positive thinking around potential, capacity, and confidence in STEM, and build social capital. Program experiences were effective when a meaningful community of practice was fostered that offered a diversity of access points and ways to engage, all adding value to joining, and importantly, wanting to continue to be a member of the community.

**4. Many women identified themselves as science learners and advocates who wish to share their passion and discovery of science with others.**

Some women in our sample who engaged in these programs as girls emerged with a desire to share their new knowledge, understanding, and appreciation of STEM with others. These women have become advocates for science, for girls, and for positive youth development efforts. These young women positively identify with science; they feel comfortable with, interested in, and knowledgeable about it. In addition, some are actively contributing to informal science education. These alumnae identify themselves as science learners and advocates and wish to share their passion and discovery of science as it was shared with them. From the perspective of the CoP framework underpinning this study, these women are now core members in the informal STEM learning CoP. They are enthusiastically trying to transform/influence other girls and young women through efforts that include teaching, facilitating, and mentoring.

## Barriers to Success

This research provides some interesting insights into barriers that continue to stand between young women and ongoing, significant engagement with STEM through careers and/or life interests. Specifically:

- 1. Continuing Stereotypes** Evidence points to the existence of continuing stereotypes about what "counts" as science. Intractable conflicts between a career in science and a home and family life also emerged. These stereotypes may explain why some women avoid STEM careers, even when they are actively interested in STEM and willing to dive into hands-on projects as girls. Informal STEM programs that offer girls opportunities to see a wide diversity of STEM careers and meaningfully interact with female scientists seem to be one way to assuage these perceptions.
- 2. Math Anxieties and Inexperience** Math is perceived as a barrier to science participation. This arose in the questionnaire data but also was an issue discussed at the convening. The feeling of the eight young women who participated was that fear of math turns many girls off from pursuing STEM further. There is a tension between appreciating that math is foundational for many science careers, and the perception that math is a prerequisite for ANY sort of participation in science which, for some, makes science participation less appealing.
- 3. Program Sustainability and Sensibilities of Program "Ownership" by Participants** When asked about any low points in participation, about one quarter of the women surveyed identified a low point related

to participation. A quarter of the low points related to availability and access to further programming or changes to the program while someone was participating. Women commented that they would have liked to have continued in the program, but it ended or a key staff person left. As a field we know that consistent funding and sustainability for such programs is often precarious, but hearing women talk about how these issues affected them directly made this issue even more apparent.

## Recommendations to Informal STEM Educators

How do these findings translate into actionable strategies for practitioners in the field? Here are specific recommendations which build on our findings that building memories, creating a meaningful community of practice, providing personal development opportunities, and offering a broad understanding of the meaning of “STEM” were essential components of these programs, and were critical to creating programs which have the potential for long-term positive impact in girls’ lives.

- 1. Integrate rich and diverse STEM experiences into a program that offers participants a range of unique opportunities in which they are empowered to take charge, teach others, and learn authentic science skills and practices.** Many of the most memorable experiences described during this study included teaching younger girls, participating in novel experiences, managing ordinary but challenging technical tasks, and becoming more confident, active members of a community of practice that was rich and supportive.
- 2. Find ways to extend the experience beyond just a month or even a year, providing girls with an opportunity to find a “home” in their newfound STEM community.** Some of the “lowest” points for many of the girls surveyed involved the end of a program in which they had felt engaged. Some of the highest points involved “senior” (core) membership in a long-term community of practice.
- 3. Continuity is very important.** See your program as one step in a girls’ STEM learning trajectory. Your role is not only as a facilitator of science learning, but as a critical catalyst in helping girls move along their lifelong science learning trajectory, whether that is in pursuit of a STEM or STEM-related career or interest. Help girls see the next steps in their pathways. Many girls in this study were advised, mentored and supported long after they participated. This was particularly important for the young women who pursued STEM careers.
- 4. Expand your understanding of STEM activities and careers, focusing not only on traditional “research scientist” models but also on activities and careers that build on STEM knowledge and skills.** Many of the girls interviewed became very interested and capable in STEM areas ranging from life science to electronics, but because they were “stuck” in the traditional view that science is done in a lab, they did not see themselves as involved in STEM careers.
- 5. Integrate math more strategically into STEM programs as appropriate.** There is an opportunity for informal STEM programs to make math more engaging and meaningful by imbedding it into the rich authentic activities that are so common in such programs. If math is presented appropriately, it is possible to support learning about it in multiple ways, so that it is seen as less of a barrier. At the same time it is also important to help girls appreciate that math is not the gatekeeper to all pathways to science.
- 6. Consider viewing STEM as a vehicle for growth, rather than an end in and of itself.** Many of the girls reported in the questionnaire that they grew in their programs, not only in their STEM interests and capabilities, but also in their self-confidence, their range of interests, their awareness of career options for women, and their knowledge that women can and do take on serious careers while also marrying and raising families. In other words, STEM experiences and youth development can and do go together. Perhaps the most powerful STEM programs combine both.
- 7. Create programs intentionally, building on the community of practice framework and ensuring that each element of the program is present and explicitly acknowledged.** Impactful programs had a clearly articulated mission with an infrastructure and set of activities that reflected this. Apparent was the fact that program developers had thoughtfully considered not only what girls would “do” in the program, but also why they would be doing it (the mission), and with whom they would meaningfully interact and participate (other girls, including older girls acting as mentors; program leaders; family members; professional scientists and graduate students, etc.). Being intentional about integrating each of these community features into a program is key.
- 8. Understand the group of girls you are serving and have a clear sense of your STEM-related goals for the group.** Some programs, particularly those for



younger girls, were often activity or content focused, offering opportunities to explore and engage in STEM in fun and accessible ways. What girls remembered tended to relate to specific activities or content. On the other hand, programs for middle or high school-aged girls that focused explicitly on career awareness and training (for instance arranging field trips to science labs and businesses, offering internships and facilitating interactions with female STEM professionals), tended to support impacts focused on career awareness. Be clear about the age of the girl your program is targeting, your STEM goals, and how those goals tie to current youth and adolescent development research. Remember to incorporate all three elements of a CoP to insure multiple access points for engaging in the community you offer.

9. **Give girls an opportunity to reflect privately and publicly.** While not a claim we can substantiate with our quantitative data, what did emerge from our experiences with the PMMs and in-depth interviews, the questionnaire, and the gathering of participants was a sense of the importance of providing opportunities to process and reflect upon stories and experiences both internally and with others. This “storying” provided a context for generating questions, stirring up memories, and providing a new lens for viewing one’s past and future. The process also enhanced women’s understanding of the value of these experiences over time as they discussed and highlighted aspects of the programs they felt were most beneficial. Including opportunities for girls currently in your program to reflect upon what they are learning, about STEM, themselves, and the community is important. It is also clearly beneficial to offer such opportunities to alumnae.

## Lessons About the Research Process

As with any complex study, we learned a great deal about the research process itself. What worked? What was challenging? How could we have improved the process by how we engaged with and studied these women? Here are some of our key findings:

1. **Locating past participants for this retrospective study was far more difficult than initially anticipated.** The importance of not only collecting contact information, but also developing strategies for keeping this information updated periodically is essential to the

field’s ability to provide evidence of long-term impact. Our data also supports the value of maintaining these relationships as a way of continuing the cascading influence of a program.

2. **Personal Meaning Mapping was an effective tool for understanding women’s relationship to science and how participation in an informal STEM program had influenced their life:**
  - It provided a context in which young women could share and discuss informal learning opportunities in their lives, and, more specifically, their relationship to the program, science, and the others with whom they interacted (other girls, program leaders, mentor scientists, and graduate students). In particular, the unique way we used PMM (making two maps: with a “me” and “program” prompt) yielded extremely rich data and discussions. It revealed connections between young women’s lives, their perceptions of STEM, and their relationship to science. It warrants further exploration as a tool for understanding science identity.
  - It helped girls articulate the ways in which participation in these programs resulted in a wide range of impacts. Some of these impacts were STEM-related, but other outcomes included improved self-esteem, self-efficacy, and leadership skills.
  - It also provided a holistic view of the girls from their perspective, providing context for understanding the ways in which a particular program was embedded in their lives.
3. **Engage multiple perspectives in your research**
  - Leverage the expertise of advisors by fully engaging them at key points in the research process. We invited our advisors to participate early on and then engaged them again right after data collection. As a result they made significant contributions to the shaping of the research design, analysis, and interpretation of the data.
  - Involve study participants in collaborative ways. Doing so was extremely powerful, bringing authentic voices to the data and allowing for verification and enhancement of the data.
  - Bring together expertise from across fields to discuss preliminary findings with encouragement to be critical. Inviting policymakers, educators, practitioners, researchers, ethnographers, program

leaders and participants was very powerful and influential. The advice we received was invaluable, shaping further data analysis and the framing of findings in the study within a national context. While opening up one's work for critique and evaluation with colleagues and experts prior to completion comes with risk and vulnerabilities, it permitted a level of reflection rarely possible, and the product is much better as a result. We encourage our colleagues in the field to explore similar opportunities.

In closing, we've taken an important step forward with this study in terms of better understanding the potential long-term impacts of informal STEM programs for girls on women's lives in the long term. Perhaps not surprisingly, our findings suggest that we can both be hopeful about the possibilities they reveal, as well as discouraged by the seemingly intractable challenges the findings present.

We did find evidence that well-designed and implemented informal STEM programs for girls can offer rich and engaging experiences that result not only in short term impacts, but cascading long-term influences on women's future choices in education, careers, leisure pursuits and ways of thinking about what science is and who does it. There is ample evidence that these experiences can influence, even optimize girls' experiences with and relationship to STEM. Informal girl-focused STEM programs can provide opportunities for girls and young women to participate in and contribute to authentic communities in which women lead well-rounded lives that include families, leisure pursuits, and much more.

However, there is still much to understand, and as in any research effort, more questions are raised than answered. We look forward to engaging in future research efforts that will help to further our commitment to girls and science.

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# APPENDIX



## The Questionnaire

### Part 1 (Program Participation)

- 1) **Of the following programs, I was most active in:**  
[choose one only]
  - a) Girl Scouts and the National Science Partnership (NSP) - a program within Girl Scouting that provides leaders and older girls with resources to support the learning and facilitation of science, math, engineering and technology Try-Its and badge activities.
  - b) Women In Natural Science (WINS) - a science, math, engineering and technology enrichment program for Philadelphia girls, held at the Academy of Natural Sciences, Philadelphia.
  - c) Girls Inc. Eureka!® - a science, math, sports and career program for middle and high school girls that builds upon Girls Incorporated Operation SMART®.
  - d) Rural Girls in Science - a summer and school-based science, math, engineering and technology program for high school girls in Washington State that emphasized long-term research.
  - e) Girls Inc. Operation SMART® - builds interest and confidence of girls in science, mathematics, and technology.
  - f) Techbridge - an afterschool and summer program that encourages girls in technology, science and engineering founded by Chabot Space and Science Center.
- 2) **I participated in / remember the following:**  
[check all that apply]  
  
[Series of closed-ended statements highlighting key aspects of the program, like "I presented science activities to younger girls."]
- 3) **I participated in the [program] because:**  
[check all that apply]
  - a) My parent(s) made me
  - b) My teacher(s) made me
  - c) My sister(s) participated in the program
  - d) My friend(s) participated in the program
  - e) My mom was a leader
  - f) I wanted to participate
  - g) I was selected to participate
  - h) Other [please specify below]
- 4) **How long did you participate in the [program]?**  
I began the [program] in:  
\_\_\_\_\_ [insert year]  
I left the [program] in:  
\_\_\_\_\_ [insert year]
- 5) **If I continued in the [program], it was because:**  
[check all that apply]  
  
[Series of closed-ended statements about possible program-specific reasons for continuing to participate, e.g., "I met new people."]
- 6) **I left the [program] because:** [check all that apply]  
  
[Series of closed-ended statements about possible program-specific reasons for leaving, e.g., "I did not like it," "It was not fun/interesting."]



7) Please describe how you participated in the [program]. [check all that apply]

[Series of statements describing possible ways to participate, e.g., "I did the activities that were offered."]

8) Do you remember doing science activities as part of your [program] experience?

- a) Yes
- b) No

9) What specific memories do you have about science in [the program]?

[Open-ended]

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10) Do you have any physical reminders of your experience with the program? [check all that apply]

[Closed-ended list of possible physical reminders, e.g., photos, scrap books, journals]

11) Do you have any related digital memories that you are willing to share? (e.g. photographs, digital videos, etc.)

- a) Yes
- b) No

12) What was the highlight of your participation in the [program]?

[Open-ended]

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13) What was the low point of your participation in the [program]?

[Open-ended]

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14) Describe one way in which you think this program influenced you.

[Open-ended]

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**Part 2 (Tell us about yourself)**

15) What three words or short phrases best describe you?

[Open-ended]

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16) As a child, my main interests were:

[Open-ended]

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17) Things I like to do now in my free time include:

[Open-ended]

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18) Do you have any hobbies that you consider to be science related?

- a) Yes
- b) No

19) If you answered YES above, please list these science-related hobbies.

[Open-ended]

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20) Do you watch science-related TV shows or movies?

- a) Yes
- b) No

21) If you answered YES above, please list these science-related TV shows or movies.

[Open-ended]

22) Are there science web sites that you use frequently?

- a) Yes
- b) No

23) If you answered Yes above, please describe the web site(s).

[Open-ended]

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24) How often do you visit institutions such as museums, zoos, and aquaria

- a) Never
- b) Once every few years
- c) Annually
- d) Several times a year
- e) Frequently

25) How often do you visit outside settings such as parks, lakes, rivers, campgrounds, and nature centers?

- a) Never
- b) Once every few years
- c) Annually
- d) Several times a year
- e) Frequently

26) Which individuals have most influenced the ways in which you think about science? Please rank your top three responses with 1 being most influential.

- Mother -----
- Father -----
- Sister/Brother -----
- Other family member -----
- Teacher -----
- Youth leader -----

Clergy -----

Friends -----

Other [please specify below]

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27) If you selected "Other" in the previous question, please identify you relationship to the person(s) you selected.

[Open-ended]

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28) During your school years, but outside of the school day, did you participate in science-related activities/clubs/organizations? (e.g. robotics club, nature camps, bug hunts, gardening, science interest group at church, environmental organizations, etc.) If so, please explain.

[Open-ended]

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29) Describe the most memorable moment when you were excited by science.

[Open-ended]

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30) Describe the most memorable moment when you were most discouraged by science?

[Open-ended]

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31) Describe any ways that you have maintained connections with the project you participated in, or with other people from that same program.

[Open-ended]

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32) For each of the following seven (7) statements, imagine that you have 20 points to distribute across eight possible influences (e.g. school, family, etc.) that make you uniquely you. If none of these contribute to the statement, put all 20 points into "None." For example, to show what makes you "happy" you might divide the 20 points up into the following categories:

School = 0

Your Program\* = 2

Mentor, Leader, Facilitator = 3

Organized Sports = 2

Organized Youth Activity = 4

Friends & Family = 8

Other = 1

None = 0

#1: The following helped me feel that I have a good future:

[Please distribute 20 points among the influences described below. If none of these contribute to the statement, put all 20 points in "None." Please ensure your total equals 20 points.]

School \_\_\_\_\_

Your Program \_\_\_\_\_

Mentor, Leader, Facilitator \_\_\_\_\_

Organized Sports \_\_\_\_\_

Organized Youth Activity \_\_\_\_\_

Family & Friends \_\_\_\_\_

Other \_\_\_\_\_

None \_\_\_\_\_

#2: The following helped me to recognize my strengths and weaknesses:

[Please distribute 20 points among the influences described below. If none of these contribute to the statement, put all 20 points in "None." Please ensure your total equals 20 points.]

School \_\_\_\_\_

Your Program \_\_\_\_\_

Mentor, Leader, Facilitator \_\_\_\_\_

Organized Sports \_\_\_\_\_

Organized Youth Activity \_\_\_\_\_

Family & Friends \_\_\_\_\_

Other \_\_\_\_\_

None \_\_\_\_\_

#3: The following increased my self-confidence:

[Please distribute 20 points among the influences described below. If none of these contribute to the statement, put all 20 points in "None." Please ensure your total equals 20 points.]

School \_\_\_\_\_

Your Program \_\_\_\_\_

Mentor, Leader, Facilitator \_\_\_\_\_

Organized Sports \_\_\_\_\_

Organized Youth Activity \_\_\_\_\_

Family & Friends \_\_\_\_\_

Other \_\_\_\_\_

None \_\_\_\_\_

#4: The following made me feel successful:

[Please distribute 20 points among the influences described below. If none of these contribute to the statement, put all 20 points in "None." Please ensure your total equals 20 points.]

School \_\_\_\_\_

Your Program \_\_\_\_\_

Mentor, Leader, Facilitator \_\_\_\_\_

Organized Sports \_\_\_\_\_

Organized Youth Activity \_\_\_\_\_

Family & Friends \_\_\_\_\_

Other \_\_\_\_\_

None \_\_\_\_\_

#5: The following exposed me to new science learning opportunities:

[Please distribute 20 points among the influences described below. If none of these contribute to the statement, put all 20 points in "None." Please ensure your total equals 20 points.]

School \_\_\_\_\_

Your Program \_\_\_\_\_

Mentor, Leader, Facilitator \_\_\_\_\_

Organized Sports \_\_\_\_\_

Organized Youth Activity \_\_\_\_\_

Family & Friends \_\_\_\_\_

Other \_\_\_\_\_

None \_\_\_\_\_

**#6: The following made me proud to be a girl/woman:**

[Please distribute 20 points among the influences described below. If none of these contribute to the statement, put all 20 points in "None." Please ensure your total equals 20 points.]

- School \_\_\_\_\_
- Your Program \_\_\_\_\_
- Mentor, Leader, Facilitator \_\_\_\_\_
- Organized Sports \_\_\_\_\_
- Organized Youth Activity \_\_\_\_\_
- Family & Friends \_\_\_\_\_
- Other \_\_\_\_\_
- None \_\_\_\_\_

**#7: The following made me proud of my racial/cultural background:**

[Please distribute 20 points among the influences described below. If none of these contribute to the statement, put all 20 points in "None." Please ensure your total equals 20 points.]

- School \_\_\_\_\_
- Your Program \_\_\_\_\_
- Mentor, Leader, Facilitator \_\_\_\_\_
- Organized Sports \_\_\_\_\_
- Organized Youth Activity \_\_\_\_\_

- Family & Friends \_\_\_\_\_
- Other \_\_\_\_\_
- None \_\_\_\_\_

**33) Please indicate your age: [choose one]**

- a) 18-23
- b) 24-30
- c) 31-35
- d) 36-40
- e) Over 40

**34) Please describe yourself: [check all that apply]**

- a) American Indian or Alaskan Native
- b) Asian or Asian-American
- c) Black or African-American
- d) Hawaiian or Pacific Islander
- e) Hispanic or Latina
- f) White or Caucasian
- g) Other (please specify)

**35) While participating in my program, I lived in an area that can be described as: [choose one]**

- a) Urban
- b) Suburban
- c) Rural

**36) Please indicate your education background.**

Attended, but left before finishing	Currently attending	Completed	N/A
High School			
Associate's Degree/Certificate			
Bachelor's Degree			
Graduate Degree			
Doctorate (Ph.D., M.D., D.O., J.D., etc.)			



37) Please indicate any specialization or major course of study you focused on or are focusing on during your education.

[Open-ended]

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### Part 3 (Your work life)

38) Are you currently employed? [choose one]

- a) Yes - Part-time
- b) Yes - Full-time
- c) No

\*Skip pattern used here

39) Describe your current situation: [check all that apply]

- a) Working outside my field/interests
- b) In a degree-related job
- c) In a science-related job
- d) Self-employed
- e) In a paid internship
- f) Volunteering
- g) Working full-time
- h) Working part-time
- i) Working and in school

40) Describe your field of employment and primary responsibilities.

[Open-ended]

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41) My long-term employment goal is to: [choose one]

- a) Never work
- b) Go back to school in the sciences
- c) Go back to school in a field other than sciences
- d) Remain or advance in my current field
- e) Change my field
- f) Other

42) If you chose "Change my field" or "Other" in the previous question, please explain.

[Open-ended]

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43) List three (3) characteristics you would use to describe an "ideal job."

[Open-ended]

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44) Describe your current situation. [check all that apply]

- a) In school
- b) Homemaker
- c) Between jobs

45) Describe your favorite topic or area of study.

[Open-ended]

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46) Describe a position/company/career most suited to your interests and abilities.

[Open-ended]

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47) List three (3) characteristics you would use to describe an "ideal job."

[Open-ended]

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## Part 4 (Program Impacts)

Below are six (6) sets of questions, each exploring a different set of potential impacts that could have resulted from participating in the program. For each idea, tell us if participating in your program influenced you in this way.

\* Choose 1 if you think you did not change at all in this way; "not at all."

\* If you were changed a little in this way, choose from 2-5 depending on how much you think you were changed, with larger numbers indicating a bigger change.

\* Choose 6 if you think you change in this way "a lot."

**48) Participating in the [program] has increased how much time I spend:**

- a) Watching TV shows about science
- b) Reading about science in my free time
- c) Noticing things about science in the news
- d) Talking with my friends or family about science-related ideas or issues

**49) Participating in the [program] increased my:**

- a) Knowledge of science
- b) Confidence in doing science
- c) Understanding of what scientists do
- d) Desire to have a career in science
- e) Desire to go to college
- f) Desire to take science classes in high school
- g) Interest in science at school
- h) Interest in participating in other science experiences
- i) Awareness of possible jobs or careers in many fields
- j) Awareness of jobs or career choices in science or a related field
- k) Connections to people in science or related fields
- l) Understanding of what people in science-related jobs or careers do
- m) Desire to find a science-related job/career

**50) Participating in the [program] has led me to:**

- a) Think about volunteering in my community
- b) Think about joining a science-related club or group

- c) Ask more questions
- d) Start a science hobby
- e) Visit science museums
- f) Become involved in my local science museum or youth serving organization
- g) Consider a future in science or a related field

**51) Participating in the [program] has helped me feel:**

- a) Confident to try new things
- b) Like a scientist
- c) More aware of what my strengths and weaknesses are
- d) Willing to take on a leadership role
- e) Interested in taking care of the environment
- f) That I have a good future ahead of me
- g) That I could be good at science or a related field

**50) Participating in the [program] has improved my ability to:**

- a) Interact with my peers
- b) Interact with adults
- c) Think about how my actions affect others
- d) Work as part of a team or group
- e) Share my thoughts and ideas with others
- f) Be patient
- g) Think critically as I make decisions or try to solve problems

**51) How has the [program] contributed to who you are as a person? Please give us an example.**

[Open-ended]

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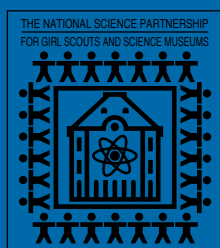
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