

STEM Programs for Girls: Making Them Last

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**Abstract**

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The purpose of this research was to identify and describe the ways successful, informal STEM programs are sustained. This qualitative study included semi-structured interviews with five professionals who work or worked directly with the programmatic aspects of six individual successful, long term STEM programs for girls. Various documents were obtained to provide context. There is little research that focuses on sustainability but the results of this research aligned with a previous study where the researchers attempted to apply a sustainability framework from formal education. Several themes emerged which suggests that sustainability is not based on one factor but based on a constellation of factors and should be thought of sequentially as well as collectively in order for them to support each other. This suggest that when professionals are developing programs, while not only planning for the success of the program, they should integrate factors that specifically look at sustainability.

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## Chapter One

### Introduction

A strong STEM (science, technology, engineering, math) workforce is necessary to expand the nation's innovative capacity and economic competitiveness (Beede, 2011). As technology continues to advance at a rapid rate, STEM skills are becoming increasingly relevant across disciplines. However, women are highly underrepresented in STEM fields. Museums and informal programs can provide innovative spaces to engage girls in STEM topics.

According to Dr. David Kenneth Waldman, CSU-Global faculty member and advocate for advancing girls and women in science, “the disproportionate representation of women in these wide reaching and important areas results in male-dominated processes, politics, and programs” (Mellem, 2017). To create new or enhanced technology, businesses need input from a diverse workforce. One of the most practical ways to create that diversity is to be sure that women are an integral part of the workforce. For U.S. businesses it is crucial that the workforce be representative of the population, and increasing women in the STEM fields is one way to do that (Eishield, 2016).

With resources that many schools do not have, museums and after-school programs offer interactive, innovative, and standards-based activities complementing the school curriculum that can excite students and equip them with the skills to make informed decisions and pursue STEM fields (Miaoilis, 2011). This is supported by UNESCO's former Director-General Irina Bokova, in her speech at the World Science Day for Peace and Development in 2016, where the day was dedicated to the promotion of science centers and museums in pursuit of STEM. She stated that “these informal settings provide excellent ways to encourage girls, to pursue careers in science as

well as serve as privileged places of education, providing innovative initiatives to promote the learning of science outside the classrooms (“Science center’s and museums,” 2016).

A number of museums have been offering STEM-based programs for girls for at least the last decade and they continue to rise. For example, The Greater Opportunities Advancing Leadership and Science (GOALS) for Girls, a program at the Intrepid Sea, Air and Space Museum in New York City, The Connecticut Science Center and their program, Women in Science, Girls in Science at the Burke in Seattle, Washington, and Girls in STEM at the Arizona Science Center. While there is a body of research around the affectedness of museums and afterschool STEM programs and on what makes them successful, this research builds on what works and looks specifically at sustainability, with the hopes that more of these programs will be started, successful and sustained.

The goal of my research study is to describe the variables that support sustainability. The research is guided by the following research questions:

1. What is the nature of the infrastructure of such programs?
2. What are the unique characteristics of the program that provide opportunities for sustainability?
3. What are the unique characteristics of the program that provide challenges for sustainability?

While this study focused on identifying the variables of sustainable practices for STEM programs on youth girls, and how successful programs can adopt sustainable practices, other types of programs may benefit from the results.

## Chapter Two

### Literature Review

This chapter will synthesize relevant literature from four main areas; gender inequality in the STEM field and the contributing factors, the nature of science learning in informal settings, features of successful informal science learning settings and the impact, and a sustainability framework of afterschool programs.

Learning opportunities that take place outside of school have been referred to in many ways, for the purpose of this research, the term “afterschool” and “informal” are used interchangeably and refers broadly to afterschool, summer learning opportunities and in museum settings.

#### **Gender inequalities and the underrepresentation of women in STEM**

Science, technology, engineering, and mathematics (STEM) are widely regarded as critical to the national economy. Concern about America’s ability to be competitive in the global economy has led to a number of calls to action to strengthen the pipeline into these fields (U.S. Department of Education, 2006). Expanding and developing the STEM workforce is a critical issue for government, industry leaders, and educators. Women make up 48% of the total workforce, according to U.S. Census Bureau statistics, but represent 26% of computer scientists, a smaller proportion than 25 years ago (US Census Bureau, 2014). This means that many products that are a part of our daily lives have been developed without input from women.

Adding diversity to STEM occupations result in increased creativity and innovation fueled by different perspectives about issues and how to solve them (Beede, 2011). In the 2015, a report published by the American Association of University Women (AAUW), “Solving the Equation: The Variables for Women’s Success in Engineering and Computing” states; “women’s

experiences, along with men's experiences, should inform and guide the direction of engineering and technical innovation. We simply can't afford to ignore the perspectives of half the population in future engineering and technical designs" (pg. 2). AAUW is a leader in educating our nation's leaders on the steps to building a high quality and global competitive workforce. This report draws on a large and diverse body of research, and highlights recent research that explores the factors underlying the underrepresentation of women in these fields. The report argues for changes in the workplace and college environments as a necessary preamble to women's full participation in engineering and computing (Corbett et al. 2015). Even though the report highlights the inequalities in the professional workforce and education at the university level, there is a recommendation section in the report that suggests how educators, at any level, in any context, can engage girls in STEM. This section has a strong emphasize on the influences that informal science educational settings have on girls.

The gateway too many high-paying STEM jobs is a STEM degree. In elementary, middle, and high school, girls and boys take math and science courses in roughly equal numbers, and about as many girls as boys leave high school prepared to pursue science and engineering majors in college. Yet fewer women than men pursue these majors (Hill et al. 2010). According to statistics from the National Science Foundation (2017), the number of women earning bachelor's degrees in STEM is still low. In 2014, only 19.8 % of first-year female students intended to major in STEM fields compared to 41.5% of first-year male students. The percentage of female students with the intention to major in engineering, mathematics, statistics, and computer sciences, and physical sciences was especially low at 5.8%, 2.1%, and 2.1%, respectively (National Science Foundation, 2017). Dr. Laura Hoopes, a biology professor at Pomona College, asserts that gender differences in confidence in STEM subjects begin in middle

school. Likewise, children, and girls especially, develop beliefs that they cannot pursue particular occupations because they perceive them as inappropriate for their gender. And well-documented gender differences exist in the value that women and men place on doing work that contributes to society, with women more likely than men to prefer work with a clear social purpose. Since most people do not view STEM occupations as directly benefiting society or individuals, STEM careers often do not appeal to women who place a high value on making a social contribution (Hoopes, 2011).

Despite the tremendous gains that women have made in education and the workforce during the past fifty years, progress has been uneven, and certain scientific and engineering disciplines remain overwhelmingly male. An earlier study published by the AAUW, “Why so Few? Women in Science, Technology, Engineering, and Mathematics,” examined over 400 academic articles and studies that were written in the last twenty five years on the topic of women in science and engineering. Articles from the fields of psychology, sociology, education, economics, neuroscience, and endocrinology were examined (Hill et al. 2010). The report concludes evidence that social and environmental factors contribute to the underrepresentation of women in science and engineering. The rapid increase in the number of girls achieving very high scores on mathematics tests, once thought to measure innate ability suggests that cultural factors are at work. Thirty years ago there were thirteen boys for every girl who scored above 700 on the SAT math exam at age 13; today that ratio has shrunk to about 3:1 (pg. 5). This increase in the number of girls identified as “mathematically gifted” suggests that education can and does make a difference at the highest levels of mathematical achievement. While biological gender differences, yet to be well understood, may play a role (Ceci et al. 2009, Hill et al. 2010). It was concluded that there are three emerging trends to explain why there is a gender imbalance in

STEM; gender stereotyping, school institutional effects, and the societal construct of prevailing gender roles. These three trends are widely recognized in the field.

“Students are basing their educational decisions in large part on their perceptions of a field, and not having early experience with what a field is really like makes it more likely that they will rely on their stereotypes about that field and who is good at it,” states Associate Professor of Psychology at the University of Washington, Sapna Cheryan (Cheryan et al. 2017). She led a 2016 study comparing gender disparities across STEM fields by critically reviewing over 1200 papers on the underrepresentation of women in STEM. Her findings identify this stereotyping is due to an over masculine culture that discourages women from pursuing STEM fields or topics at any age, due to the belief that STEM is a “boys thing” (Cheryan et al. 2017).

A lack of pre-college experience is another major challenge according to this study. The gender gap in STEM interest is smaller among high school seniors at schools with stronger math and science offerings, the researchers note. But courses in computer science, engineering and physics are less likely to be offered and required in U.S. high schools than courses in biology, chemistry and mathematics, leaving students with little information about what those fields are like and who might be suited for them (Cheryan et al. 2017).

Social norms incorporate stereotypes of different roles assigned to different genders and thus influence gender associations with “math and science ability, occupational selection, and career trajectories” (Bradley et al. 2002).

The research for the past fifty years has focused on the representation of girls and women in these fields, primarily on the obstacles preventing more girls and women from entering STEM fields. A 2012 study asserts that it is now time to shift the focus toward understanding and developing solutions for “what works” for girls who show interest and engage in the fields of

STEM. Girl Scout Research Institute (GSRI) conducted a large scale study consisting of a literature review and qualitative and quantitative methodologies designed to better understand how interest in STEM can be developed in girls (Modi et al. 2012). The qualitative portion of the study consists of the results of eleven focus groups with girls ages 8-18, to examine girls' perceptions and attitudes about STEM subjects and careers. They were conducted in six diverse geographical locations in the United States. These locations were chosen in collaboration with local Girl Scout councils, who helped provide groups of girls with STEM exposure as well as groups of girls without STEM exposure for comparison. A total of 140 girls participated in focus groups. About half of the girls were Girl Scouts, and about half of the girls had some form of STEM exposure in the past (e.g., STEM camp, after-school program, Girl Scout event). Girls were a mix of racial/ethnic backgrounds; primarily Caucasian, African American, and Hispanic (Ibid). The quantitative portion of the study sampled 852 girls ages 14-17, in both diversified geographical region, urbanicity, and racial/ethnic breakdown. They identified that girls had a strong interest in STEM, but there was an enormous amount of influence of gender stereotypes and the belief that science careers are less significant than other careers (Modi et al. 2012). The report concluded with two major take a ways that have the potential to transform the national conversation about girls and young women in STEM: as opposed to the past stereotype that even girls who perform well academically are not interested in STEM, their research demonstrates that interest among girls is there, it just needs to be primed. Secondly, the challenge that remains is how to turn girls' interest into action and make STEM the winner in the competition for girls' attention when it comes to career choices (Modi et al. 2012).

### **The nature of science learning in informal settings**

For decades, efforts to improve STEM education have focused largely on the formal educational system. Learning standards for STEM subjects have been developed, and assessments of various kinds have sought to measure STEM learning, but students do not learn about STEM subjects just in school (National Research Council, 2014). A recent study shows that children spend less than twenty percent of their waking hours in school. Opportunities lie in enrichment programs that take place during the afterschool hours and the summer (Afterschool Alliance, 2011). In a recent study, Lauresen et al. (2013) conducted a survey of over 400 out-of-school science programs and found out that roughly half of their of all programs in their sample were represented by just three organization types: nonprofit organizations (25%) and universities and colleges (26%) and museums at (15%). Also concluded is that the 23% of programs offered by museums, science centers were notable for the diversity of participants in that they served 58% girl and 51% other than white registrants (pg. 40).

Informal STEM experiences support both learning and participation by providing unique opportunities to engage with and connect with science in an inquiry-based manner without the academic requirements of memorization and standardized testing (McCreeley et al. 2013). Public discussion on learning usually focused on the experiences and outcome associated with schooling. Yet the focus on traditional academic activities and learning outcomes is fundamentally at odds with the way in which children learn across various social settings (Bell, et al. 2009). A 2009 National Research Council study looked at learning science in informal environments by examining all different kinds of informal setting and how often children and families spend there. The time children spend pursuing hobbies or activities of their own choosing, often provide them with the experiences and skills relevant to scientific processing and

understanding. The learning outcomes far exceed the typical academic emphasis on conceptual knowledge (Bell et al. 2009). Their study was guided by the theoretical framework of the idea of lifelong, life-wide, and life-deep learning, which has been influential in effort to develop a broad notion of learning, and incorporation of how people learn over the life course, across social settings, and in relation to prevailing cultural influences (Bell et al. 2009, Banks et al. 2007).

Lifelong learning refers to the acquisition of fundamental competencies and attitudes and a facility with effectively using information over the life course, recognizing that development needs and interest vary at different life stages. Learners prefer to seek out information and acquire ways of doing things because they are motivated to do so by their own interest, needs and curiosity, pleasure and sense that they have talents that align with certain kinds of tasks and challenges (pg. 12).

Life-wide learning refers to the learning that takes place as people routinely circulate across a range of social settings and activities, like after school programs. Learning derives in both opportunities and patterned ways, from this breadth of human experiences and related supports and occasions for learning that are available to an individual or group. Learners need to learn how to navigate the different underlying assumptions and goals associated with education and development across settings and pursuits they encounter (pg. 12).

Life-deep learning refers to the ideology, beliefs and values associated with living life and participation in the cultural workings of both communities and the broader society. Such learning reflects the moral, ethical, religious and social values that guide what people believe, how they act and how they judge themselves and others. This focus on life-deep learning emphasizes how learning is never a culture free endeavor (pg. 13).

Taken together these concepts help bring into view the breadth of human learning, and emphasize the broad reach of informal settings. It was concluded at the end of the report that 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 in science (pg. 25).

It was also concluded from that report that informal learning settings, especially designed environments such as museums and science center's contribute to the six strands of informal science learning. The strands of science learning is a framework that articulates science-specific capabilities supported by informal environments. It builds on the framework developed for K-8 science learning in *Taking Science to School*, which was developed by the council in 2007 (National Research Council, 2009, 2007). The strands include, 1: Experience excitement, interest, and motivation to learn about phenomena in the natural and physical world. Strand 2: Come to generate, understand, remember, and use concepts, explanations, arguments, models, and facts related to science. Strand 3: Manipulate, test, explore, predict, question, observe, and make sense of the natural and physical world. Strand 4: Reflect on science as a way of knowing; on processes, concepts, and institutions of science; and on their own process of learning about phenomena. Strand 5: Participate in scientific activities and learning practices with others, using scientific language and tools. Strand 6: Think about themselves as science learners and develop an identity as someone who knows about, uses, and sometimes contributes to science (National Research Council, 2009).

Designed environments such as museums, science centers, zoos, and aquariums contribute to all six strands of informal science learning in the following ways: 1) interest in science is kindled by visiting; 2) scientific knowledge is gained; 3) scientific reasoning is

engaged in, particularly when exhibits are interactive; 4) reflection on the science process occurs when exhibits give visitors opportunities to do so; 5) science processes are actively experienced; and 6) science identity is developed as visitors identify (National Research Council, 2009, Rossiter, 2013) .

Successful informal STEM programs avoids the “transmission of information” model of teaching and learning but rather the emphasis on project-based, hands-on, and student-directed inquiry, often carried out collaboratively. Programs such as Carnegie STEM Girls, have been evaluated and recognized for their hands-on programs tailored just for girls which utilizes the 250 hands-on STEM exhibits that Carnegie has to offer (Mathias, 2015). The use of hands-on activities to learn is intrinsically more interesting and appealing to young girls when compared with less active ways of engaging in science (Rossiter et al. 2013). Having a girl-centered, all girls environment create a low pressure setting, allowing girls to explore and experiment without the fear of boys judging.

### **Features of successful informal science learning settings and the impact**

STEM afterschool learning opportunities and experiences for the underserved and underrepresented communities of youth and in particular for girls was the focus of this large scale evaluative study by Afterschool Alliance (2011). Offering opportunities for such youth to learn science and be exposed to STEM careers during out of school time, especially at a young age has been recommended as a potential approach to improving representation of these populations in STEM (McCreedy, 2013).

This study summarized evaluation reports from afterschool STEM programs that focus on underrepresented audiences across the United States and identified common trends and strengths that afterschool learning brings to STEM education (Afterschool Alliance, 2011). Like

many programs nationwide, several of the programs highlighted in this study were designed specifically to provide services to underrepresented populations in STEM fields, and many also focused on providing girls with exposure to science and female role models. Thus they are reaching some of the very children and youth we need to better engage in STEM fields and careers. Evaluations presented here were collected by casting a wide net to solicit reports from afterschool programs across the country through various communication channels as well as searching through evaluation databases. Several of the programs used pre- and post-program surveys and focus groups to measure change in students while a few continued to track their students after they left the programs. There were also some that measured academic achievement through administering pre- and post- program tests as well as recording grades and standardized test scores. Some evaluation studies also surveyed parents and program staff (pg. 2). The study results showed that attending high-quality STEM afterschool programs yields STEM-specific benefits that can be organized under three broad categories: improved attitudes toward STEM fields and careers; increased STEM knowledge and skills; and higher likelihood of graduation and pursuing a STEM career. Research also showed that an early interest in pursuing science and engineering is a better indicator of whether a student will pursue a career in these fields than a student's grades in school (Tai et al. 2006, Afterschool Alliance, 2011). Increasing interest early on is critical so that students are motivated to develop the knowledge and skills required to pursue more rigorous math and science courses in high school (Afterschool Alliance, 2011).

#### *Museums STEM program settings*

The Association of Science-Technology Centers (ASTC), which represents 353 U.S. science center and museums reported that nearly 63 million visits are made to these science centers and museums a year (Miaouis, 2011). Ioannis Miaoulis, president and director of the

Museum of Science, Boston and former dean of Tufts University School of Engineering, states in a US News articles, that science centers and museums can play a key role in STEM education.

With resources that many schools do not have, museums offer interactive, standards-based activities complementing the school curriculum that can excite students and equip them with the skills to make informed decisions and pursue STEM fields. And 82 percent of these institutions also offer teacher professional development, aligned with best practices (Miaoulis, 2011).

Calabrese and Brickhouse in their 2006 study, “Engaging girls in science” singled out the value of being in the midst of the real community of practice that is afforded to those who are introduced to science in the presence of exhibitions, collections and scientists. This and other distinctive features make museums and science centers are especially conducive to providing a setting and approaches to learning that are appealing to girls. Museums, science center and all other informal settings are in a position to support girls on an individual level, to not only gain the confidence in STEM skills, but also exposing them to unique innovative spaces to see how important science matters, to see how important they are.

Abby Longcor, Senior Director of The Tech Challenge, a successful STEM program for girls at the Tech Museum of Innovation in San Jose California, outlines six elements they implement in their programs and also advocate to all STEM programs in making program accessible and attractive to girls. They include personal relevance, empathy, innovation, creativity, collaboration, and mentors (Longcor, 2016). This primary program at the museum invites students in grades 4-12<sup>th</sup> to use engineering design processes to solve real-world problems which culminates in a two-day showcase when teams put their solutions to the test (“What is The Tech Challenge?” 2018). In an evaluative report of the program from 2011-2016, shows that

92% of participant have a greater STEM understanding and 85% became interested in becoming a scientist or engineer (Cross Program Evaluation, 2011).

In 2014, The Lang Science Program of the American Museum of Natural Sciences was the focus of an internal evaluative study done on the long-term participations. The Lang Science Program was of particular interest due its multi-year program though which youth move in cohorts. It is intended to support youth girls who are traditionally underrepresented in STEM. The primary research question was looking at the ways long-term participation of out- of- school science programs shape the interest, motivation, and ability of young women of color to pursue and persist in STEM majors (Adams et al. 2014). Using a retrospective approach in which they asked alumni of the program to reflect on their experiences in the Lang Science Program. Using a narrative approach to analyze the data enabled them to uncover themes about how these young women built strong interests in STEM and developed related identities over the years. The design of the Lang Science Program is critical to the effectiveness of long-term participation. Lang offers diverse STEM-related experiences, allowing participants to engage in different ways of practicing science. The results of their study showed that the relationship between long-term participation in the Lang Science Program and the young women's STEM affinity-identities and career trajectories developed into in four key themes: building a collective identity, belonging in a physical place, broad exposure to science topics and careers, moving from the museum to college. These young women persisted in STEM not only because of family support but also because having gone through a rigorous museum program, they knew they were capable. Furthermore, they were committed to doing science because of their years at Lang (Adams et al. 2014).

### **Sustainability framework for afterschool programs**

Most STEM afterschool programs begin with innovation plans and funding for a single project. That project supports development, implementation and sometimes a limited amount of dissemination (Koch et al. 2012). There comes a time when all projects are faced with the question of how to grow and sustain themselves. Afterschool programs where projects are implanted often have limited capacity to sustain programs on their own given high turnout in staff and continuing the program. This lack of capacity may be intensified if staff lacks STEM knowledge needed to understand concepts, discern important learning goals and effectively enact curricula. As a consequence, many high-quality projects in informal science education do not last beyond the grants that fund their development (Koch et al. 2012).

In 2012, The SRI International's Center on Technology and Learning published a sustainability framework for afterschool STEM programs. Evaluation research on girls' learning of computer science and on the capacity of afterschool staff and organizations to provide computer science programming lead to their description of a research-based approach to sustaining and scaling afterschool STEM programs for girls. Education research has articulated the features for scaling and sustaining innovations in school, but missing from the informal science research fields are models of how programs in the innovation phase of a first project can plan and prepare for scaling and sustainability. However, frameworks for scaling and sustaining school-based innovation provide insights for developers of afterschool STEM programs (Koch et al. 2012). Cynthia Coburn, a well-known educational researcher outlines four interrelated dimensions for scaling and sustaining education innovations; depth, spread, shift and sustainability. These dimensions highlight specific areas that can be thought of sequential by developers as well as collectively as they can reinforce each other. *Depth* refers to the impact of

innovation on youth learning and educators practice. *Spread* is the traditional notion of scale: the spread of a reform to a greater number of afterschool sites. *Shift* in innovation ownership requires that practitioners responsible for the implementations, not developers of the innovation, have full authority for the innovations, including ongoing support, professional development and future implementations. *Sustainability* means maintaining the depth of the program and allowing for acceptable adaptations, and over time in less than ideal conditions (Coburn, 2003).

SRI and Girls Inc. designed and developed a program, Build IT, with this research in mind. Build IT is a two-year afterschool and summer curriculum designed help middle school girls develop fluency in information technology (IT), interest in mathematics and computer science, and knowledge of IT careers. Build IT is a problem-based curriculum consisting of six units that capitalize on girls' interest in design and communication. SRI and Girls Incorporated of Alameda County (GIAC) designed the materials and professional development to teach technology and computer science skills not only to girls but also to afterschool facilitators who are primarily young women, while building facilitators' capacity to provide this programming. To anticipate the challenges of building a scalable, sustained program, developers designed Build IT to unfold in multiple stages. Rather than waiting to think about sustainability and dissemination until after the program design had been articulated, scale and sustainability plans were integral to the concept (Koch et al. 2013).

Evaluation data from the Build IT program development, implementation, and scaling success and challenges over the five years in the Girls Inc. network of affiliates, indicated five strategies for achieving, scaling and sustaining of informal science learning programs in afterschool settings. They are as follows: co-design process, building partnerships, developing

ownership, professional development infrastructure, and developing frames that allow the program to evolve (pg. 62).

- Co-design process

Developers from the learning sciences and youth development fields collaborated to develop a rich, usable curriculum that meets the needs of youth and their communities. Using a co-design approach for both the curriculum and professional development can provide a systematic way to approach usability and capacity building (pg.63).

- Building partnerships

In order to spread and achieve scale, an innovation must influence the organization's norms and principles, including policies, curriculum implementation, and professional development (Coburn, 2003). Proven impact, ease of use, and fit with the organization are critical factors in achieving scale. Partnerships can support an innovation's spread.

- Developing ownership from the beginning

During the initial stages of design, typically curriculum developers and researchers drive improvements to designs. External grant funding typically supports the work to revise initial designs to reflect what developers are learning from testing them in programs. When the grant ends, however, there may be no additional revisions to designs, since follow-through depended on funding the time of developers and researchers. To sustain the ongoing revisions needed to keep designs fresh and responsive to learners' interests and needs, projects need to transfer ownership to practitioners for revision before the grant ends (pg. 64).

- Professional development infrastructure

Professional development supports play a key role in sustaining a program. As programs move towards sustainability, resources for professional development and other assistance to

facilitate implementation often dissipate, especially for programs attempting to achieve scale as well as sustainability. A strategy some programs have employed is to share professional development responsibilities with sites from the beginning (pg. 64-65).

- Developing and aligning frames that allow a program to evolve

A single project that initiates a cycle of program development typically presents a single “frame” to a potential funder, in order to win support for the project. The term frame draws from the writings of Goffman (1974) and from social movement theory (Snow & Benford, 1988); it refers to a specific definition of a problem to be solved, a path to its solution, and a rationale that makes the solution a compelling one to the audience. The need for a youth program related to science and technology program, for example, might be defined in terms of the need for more widely accessible pathways into STEM careers for youth of color, or in terms of the need for a more compelling entry point into engineering careers for women. The solution proposed is typically a curriculum, a program, or a design for professional development, and the rationales include appeals to past work and expertise that make the developers the right team. A proposal frame is rarely enough to sustain a program across multiple projects or to convince new groups to fund new development related to the program or to implement it in new settings. A key task for sustainability is to develop multiple frames that establish congruence among the frames for defining problems that funders and implementers may bring (Koch et al. 2013).

The report concludes with their recommendations for the direction of sustainability which includes that an institution anticipate from the earliest stages of innovation development and beyond initial funding the following: the contexts of use and usability of the innovation in that context, the organization’s capacity to support implementation in those contexts, and the types of future contexts. The process can begin with careful attention to developing plans for

dissemination and sustainability. Such plans require more than plans for sharing what is learned with relevant communities of practice and more than a strong institutional partner that makes a promise to sustain the program on its own. It requires a well-specified theory of implementation that delineates roles and responsibilities for implementation and a plan to conduct research on implementation that identifies the strengths and weaknesses of the program as well as the frequently invisible work required to sustain programs. The work of supporting programs is ongoing; making visible the scope and nature of that work during the life of the program can help programs better plan for sustainability. Programs need to consider business models for continuing to sustain an innovation's ongoing implementation, and when appropriate, plans for building research programs to support the innovation's evolution in ways that carry across multiple projects (pg. 65).

### **Summary**

There is statistics on the underrepresentation of women in the STEM fields, and even though the awareness and acknowledgment has grown tremendously in the last decade, there is still a large gender gap. There is a push for museums to address STEM topics in their programming and there is recent literature that shows the impact that well design elements of successful STEM programs have on girls leaning of STEM topics. Finally, there is significant research on sustaining and scaling STEM programs in informal and out-of-school settings. This research builds on that research by focusing specifically on STEM programs for girls in museums.

## Chapter Three

### Methods

The purpose of this research study was to identify the characteristics and factors that promote the sustainability of successful STEM programs for young girls. This research was guided by these questions:

1. What is the nature of the infrastructure of such programs?
2. What are the unique characteristics of the program that provide opportunities for sustainability?
3. What are the unique characteristics of the program that provide challenges for sustainability?

I used a qualitative descriptive approach with semi-structured interviews to explore these questions. Gathering data from multiple sources, such as interviews, documents and websites, I reviewed all the data and organize it into categories or themes that cut across all of the data sources. This holistic approach allowed me to draw upon multiple perspectives, identifying the many factors involved in a situation or practice, and sketching a larger picture of principals of sustainability that these programs are adopting (Creswell, 2014).

### **Sample**

#### ***Research Context***

I selected six individual STEM programs first examined in the published retrospective study, *Cascading Influences* (2013). These six STEM programs have been evaluated and found to be exemplary and highly successful informal science programs for girls. *Cascading Influences* explored potential long term influences on the participants of the individual, long-term, successful programs. This was the first study of its kind at the time. What ties these programs together is that each one represents 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 and adults, who were involved in an ongoing way (Cascading Influences, 2013). The study concluded that the participant's experiences with STEM in these programs contributed to a wide range of long-term impacts as the girls became women. For example, in an open-ended questioner, 48% of the women were working in STEM-related careers, currently (pg. 18). When asked to describe their memories of the program, 67% of the 159 women who responded made specific references to the positive attitudes or perceptions towards science (pg. 19). Lastly, women were asked to describe one way in which the program influenced them, 67% of the women responding mentioned that the program influenced their personal identify, which included self-image, self-esteem, and confidence, while 22% specifically noted that the program influenced their science identity (pg. 21). The researchers concluded, that it was apparent that the activities and experiences made while attending these programs, had made their way into women's lives and relationships, connecting to other experiences both at the time of the program and well into the women's future (pg. 23).

The intention of this study is to explore the characteristics that relate to sustainability within the programs themselves, not the participants or other elements of the programs.

The six participating institutions are; The National Science Partnership for Girl Scouts and Science Museums (NSP), Techbridge, Women in Natural Science (WINS), Girls Inc. Operation SMART (Op. SMART), Girls Inc. Eureka! and Rural Girls in Science (RGS).

Program components on participating institutions was pulled from on their respective websites and Cascading Influences report (2013). Natural Science Partnership for Girl Scouts and Science Museums (NSP), offered workshops for Girl Scout leaders who then returned to their troops where they implemented the NSP program which consisted of seven hand-on activity

guides, kits and directly correspond to Try-Its and badges for Brownie and Junior Girl Scouts. Usually over a course of 5-7 weeks of troop meetings. As girls advanced to middle and high school, they had the opportunity to help facilitate the training of adult leaders or offer science activities to the younger girls.

Techbridge began as program at Chabot Space and Science but in 2011 spun off to become a non-profit on its own. It is a free, once-a-week afterschool program places in school that introduces girls to STEM careers through hands-on projects, field trips, role models, career explorations opportunities, family outreach, teacher professional development, and academic and career guidance. Also offered are summer programs for the girls to continue exploring STEM topics and careers and are only open to girls participating in Techbridge after-school programs and alumnae.

Women in Natural Sciences (WINS) of the Academy and Natural Sciences in Philadelphia, engages participants in classroom lessons, science experiments, behind-the-scenes museum tours, daylong, weekend, and week-long field trips.

Girls Inc. Operation SMART is an approach that each organization can apply to its own programming. It can include informal activities and intensive summer activities. Programs for teenagers focus on career awareness and often provide in-depth exploration of STEM careers. Many individual affiliates design and implement local Op. SMART programs as well.

Girls Inc. Eureka! is an intensive five year STEM afterschool, summer model for affiliates. Affiliates can customize it but the primary structure is that fifty percent of the programming that they do for the girls is STEM, twenty-five percent is personal development and twenty five percent of sports. The first two summers of Eureka! are on a college campus and

that is the same process for all affiliates, the third year is a paid internship, and the fourth and fifth year can vary depending on the affiliate.

Rural Girls in Science was a comprehensive, free, program developed with partnerships with students, teachers, counselors, parents and community members. This summer program allowed the girls to focus on a community issue and solve it using STEM topics. In addition, each school-based group participated in ongoing-activities during the school year and two working meetings.

### ***Professional Participants***

I used purposeful sampling of staff members involved in the programmatic and managing of these programs. Due to the longevity of these programs, the staff members who were most involved, either currently or in the past were contacted. They were recruited through either contact information found on their website, their institutions Facebook page, mentioned in the study or recommended by another individual from the institutions. A total of ten people were contacted and five were interviewed. Potential participants received an initial email with a brief description of the study's purpose and process of the interview. Participants who responded then agreed to an informal phone conversation to explain my research further and then asked for any documents that they would be willing to share. Table 1. lists the institution, the positions of the professional interviewed and how long they have been affiliated with that program, the selected program and how long the program has been active. Protocol was approved by the university IRB.

Table 1.

<b>Institution</b>	<b>Position</b>	<b>Selected Program</b>	<b>Dates Active</b>
The Franklin Institute of Science, Philadelphia, PA	NPS Program Director and Director of Gender and Family Learning (1988-2008)	The National Science Partnership for Girl Scouts and Science Museums (NPS)	1988-2008
Chabot Space and Science Center, San Francisco, CA	CEO/Executive Director (2000-2015)	Techbridge	2000-Current
Girls Inc. US and Canada	Senior Learning Manager (2008-current)	Eureka!	1988-Current
The Northwest Center for Research on Women at the University of Washington	Principal Investigator (1996-2003)	Rural Girls in Science	1989-2003
Academy of Natural Sciences at Drexel University, Philadelphia, Pa	Manager (2008-2018)	Women in Natural Sciences (WINS)	1982-Current
Girls Inc. US and Canada	Senior Learning Central Manager (2008-current)	Operation SMART	1988-Current

## Interviews

The interview questions were semi-structured and included numerous probe questions in order to pursue emergent avenues of inquiry that arose during the interviews. For example, one of the questions was “what is the nature of the infrastructure of the program?” If the staff answered positively or vague, a follow up question would be, “how was it primarily funded?” For the full instrument, see appendix A. Four interviews were conducted remotely, and recorded on a smart phone and one interview was conducted in the office of the professional and

recorded on a smart phone and laptop. Interviews were taken place between February 21<sup>st</sup>, 2018 and April 17<sup>th</sup>, 2018 and lasted 30-60 minutes.

### Supplement Documents

I obtained supplement documents from either the professional that was interviewed or from the institutions website. These documents were used to provide context and additional information to guide my interviews. List 2. list's the name of the institutions, documents that were reviewed and central ideas of the documents.

#### List 2.

Program	List of Documents Reviews	Ideas identified
The National Science Partnership for Girl Scouts and Science Museums (NSP)	NPS Guidebook- "Partners in Science" -1997	A manual designed to help councils and science institutions introduce and implement NPS, providing models and ideas to stimulate participation (Franklin Institution, 1997).
	NSF Grant Award abstract	Three year project funded by NFS established partnerships between 7 Girl Scout councils and 6 science-technology museums in 6 regions across the nation to promote science interest and knowledge in young American women (NSF, 1992).
Eureka! & Operation SMART	2016-2020 Strategic plan	A strategic plan outline for their Gold Bold initiative which is to "leverage the network and the brand in innovative ways for high impact growth" (Girls Inc., 2016).
	Girls Inc. and the Lockheed Martin Partnership	This information page provides information on the partnership between Girls Inc. and Lockheed Martin. An overview of program activities and volunteer activities.
	About Eureka!	An overview of the program and includes evaluation data on impact of the program (2012).

	About Operational SMART	An overview of the program and the guide to successful implementation.
Rural Girls in Science	Summary of program  Program Rationale for 1994 grant proposal,	Outlines project justification, including the format of the summer program, staffing, project evaluation and assessment, 1994 Budget Explanation
Women in Natural Sciences (WINS)	RFA evaluation of 2016-17  2009 Evaluation of the program.	Two-phase mixed-methods approach to evaluate the WINS program's strengths and challenges, as well as the role each program component plays in WINS' success. Phase 1 of the research (Fall 2016) consisted of interviews with various WINS stakeholders. Phase 2(Fall 2016/Winter 2017) involved a broad survey of current and past participants, along with cost analysis of program components.  2009 Summative Evaluation results. It focused on the nature of the program participation, program structure, and implementation and program outcomes.

### Data Analysis

All audio interviews and documents were uploaded to a research project file using NVIVO. Data were analyzed using emergent coding from transcripts of the interviews. Several themes emerged from the interviews and were organized by research questions.

## Chapter Four

### Results and Discussion

The goal of this research was to identify and describe the ways successful, long term STEM programs for girls are sustained. This qualitative research included interviews with five professionals who were or currently a part of the managing or programmatic aspects of successful, long term STEM programs for girls. The participating programs were; the National Science Partnership for Girl Scouts and Science Museums (NSP), Techbridge, Women in Natural Science (WINS), Girls Inc. Operation SMART (Op. SMART), Girls Inc. Eureka! and Rural Girls in Science (RGS). Each section is dedicated to explaining the results of the study detailing characteristics found under each research question which were informed by the specific questions asked of the interviewed participants.

#### **Research Question 1: The infrastructure of the program**

This research question asked the interviewees to reflect on aspects of the infrastructure of the program such as funding, staff, and space. The infrastructure of the programs studied varied depending on a number of factors, including size and type of the organization affiliated with the program. Three key themes emerged from the interviews a) all participants mentioned receiving funding from a variety of funders and in addition, two participants noted the importance of meaningful relationships with those funders to encourage a diverse, long-term funding stream; b) most participants mentioned that being a part of an established organization allows the program to have unique and reliable resources; c) some participants discussed the value of having long term staff members and what that can mean for program sustainability.

*a) Having a diverse funding stream with meaningful relationships*

Most participants discussed the importance and need of having a diverse funding stream at any stage of the program. For example, Girls Inc. senior learning manager of both the Op. SMART and Eureka! programs, discussed receiving funding from not only grants but also individuals and corporations. Because Girls Inc. treats Op. SMART and Eureka! separately, they primarily have different funding sources. She explains,

“Since Op. SMART is an approach to STEM, and it is defined more loosely than Eureka! the general operations of Op. SMART is funded from sources such individuals and private grants (...). More specific funding within the umbrella of Op. Smart for specific programs or piloting specific programs come from long term corporate funders. Eureka! is a much more defined framework, and is regularly funded by an anonymous donor and then other funders just come and go.”

Common among participants was a conversation that early on in the program life cycle, there needed to be a diverse funding stream. The initial funding for two programs came from the National Science Foundation (NSF), either in the form of a planning grant, or the pilot grant but as soon as the NSF funding came to an end, they were soon faced with looking elsewhere, which lead them to seeking and successfully receiving funding in multiple corporations, and foundations. In another case, the project after the initial startup grant, “resorting to only local funding because it was easier to obtain,” but still consisted of multiple corporations and individuals. Another project that was primarily funded by a number of private grants and foundations for both general operations, found that every once in a while, they had to seek additional short term funding for a special one-off project, but it was mentioned how there was a need to diversify their funding stream.

One person explicitly discussed the importance of funder relationships to a sustainable funding stream’

“I think we've really mastered the art of really building and sustaining relationships with corporate partners and with funders so we're not just about writing reports when they are requested but really keeping in touch with funders to just like let them know the impact beyond just the numbers or the evaluation results. (...) So we got really important and helpful support in really large amounts over a long period of time. Being able to know that you've got funding year after year in really significant amounts really eases the burden of being able to plan for a program long term.”

Similarly, the WINS manager discussed her strategy as a way to build relationships;

“ (...) Being very transparent on what we do, and showing resources that we do [have], is a good thing because in more than one way then just, ‘hey, look it's nice’, but funders then are willing to re-up if need be. (...) By also having a good track record with funders, so the WINS have been able to have reliable funding for long time.”

This statement is supported in the WINS 2016 program evaluation. Conducted by an outside consultant, a two-phase mixed-methods approach to evaluate the WINS program’s strengths and challenges, as well as the role each program component plays in WINS’ success. Of the five key elements that contribute to the WINS success, was their reliable funding. The founder of Techbridge echoes this strategy of transparency with funders:

“I always made it a point of talking with our funders to find out and get input from them, to both find out what they liked about us, you know ways to improve, know some of the things that I heard from them that they really liked and appreciated from us it that we were always open and candid about our lessons learned.”

This may suggest that strategies such as transparency to build meaningful relationships with funders encourage sustainable and diverse funding.

*b) The program is a part of an established organization*

Many interviewees discussed that by being an integral part of an established organization, such as a museum or a university, the program was able to receive unique and reliable resources that enhanced the program. In addition a couple program mentioned the benefits the program provided to the organization and how this reciprocal relationship played into their sustainability.

One person discussed the benefits of having the genesis of the program at Chabot Space and Science Center and being established there for six years before splitting a way to becoming their own 501(c)(3),

“(…) in terms of benefits like at the start, it provided a strong infrastructure for us so that as we grew it provided HR support, or technology support, and fiscal over site. It [Chabot Space and Science Center] had partners throughout the community, that we were able to network with the so that helped us be able to sustain ourselves early on and to be a strong foundation that we could grow with staff and expand our programming. Then for Chabot it was great for them to have Techbridge because we're like a star, high performing program of theirs and it got lots of recognition from funders, (...), having a program for girls like now, today, there is so many of them, but back when we started there weren't that many so it had a lot of interest and appeal.”

She also suggests that it was this support and structure opportunities that allowed for a smooth transition for Techbridge to spin off and continue their sustainability.

The WINS program manager brought up resources, such as having in house experts in science topics and a physical space for girls. She said,

“Obviously being a part of the museum, we have the staff support and things like that. (...) When we're going to talk about diversity and talk about birds, we have a live animal center and teacher naturalists that give lessons on birds so I'm not going give the lesson on birds, they do. We are still there but you know we use these resources that we have here (...) and the internships are given by some of the scientist here so being here makes it almost like a no-brainer that you get opportunities in the same building. So that's really an important thing (...) that we really have a place to call home (...). That is another thing that I think makes it a really important part of this program is that they have a place, a physical space, that they can call theirs. The WINS is an integral part of the museum because we actually provide employment but that's not money that comes from the institution to pay for the girls to do what they are doing. (...) it's a give-and-take, (...), this is our place the WINS is the Academy of Natural Sciences.

The interviewee from Rural Girls in Science discussed how having the program under the umbrella of the Northwest Center Research on Women, which was a freestanding research center at the University of Washington, provided the program with facilities and space on a college campus for the participants to visit. These visits and facilities on the University campus was a critical aspects to the program. The University also provided the resource in the form of the interviewee's salary and access to research assistants and a small budget for supplies.

This may suggest that when a program is an integral part of an established organization the participants are exposed to unique and reliable resources. In addition it can lead to benefits for the organization and a reciprocal relationship is created that promotes sustainability.

*c) Staff commitment*

All interviewees discussed the importance of having long-term staff, and a couple mentioned the element of having passionate, and collaborative staff members.

The WINS program coordinator discussed how in the 35 years of the program, there have been only four leaders. She was currently the fourth and going on her tenth year. This is echoed in the WINS 2016-2017 evaluation, where strong program leaders was found to be a contributing factor to the success of the program. The WINS program coordinator stated that,

“(…) having an assistant that is really strong in what she does and really dives in headfirst is also very important. (…) And I can say that knowing the other people, that they really embrace the program and everyone has added something to it to make it what it is. The collaboration among the people here and like I said I am not the only teacher, and [my assistant] isn't either, my education department and the scientist and the other people are willing to be a part of this, so this is really important. And it gives it the longevity and I really think that having people who are really committed to the position (…) also help make it and gives the girls a continuity and an anchor in at least one place”

Techbridges interviewee, as mentioned was the founder and CEO for over fifteen years, and she stated that the entire idea of Techbridge was driven by her passion in the subject matter and when she went to Chabot Space and Science Center with the idea of Techbridge, she saw the staff there shared her same passion. The same hard work and longevity is seen in the program director of NSP, who was connected with the program for the entire program life of twenty years. She spent many of the initial planning and piloting years working with volunteers and doing all the packing of kits, driving around and talking to the girls and families.

The senior learning manager of Girls Inc. is the only one in her position and has been there for over ten years. She explained on multiple occasions how her main job is to be a support system for the affiliates who are implementing either Op. SMART or Eureka! and for girls in program. These STEM program are under Girls Inc. Academic Enrichment and Support section of the organization, and their dedicated and trained staff is just one of the critical elements embedded into the program for success.

The principal investigator for Rural Girls in Science explains the commitment of her staff. She states “well you know of course the commitment of the principles so myself and [associate]. I'm sure she could've [associate] gotten a better paying job, so definitely you have to have some sort of commitment from the people involved.” Her and associate were an integral part of the program for entirety of the program which was fourteen years.

This may suggest that by having a key staff member, staff longevity, and those personal characteristics such as passion, and commitment, are a way of adding to the overall STEM experiences for girls which ultimately keeps the girls engages and an promoter to program sustainability.

### **Research Question 2: unique characteristics of the program that provide opportunities for sustainability**

Five key themes emerged a) most participants discussed how their program was fulfilling a need by serving a underrepresented population; b) commitment to the participants, all participants discussed how they are committed to sustaining the program; c) all participants discussed how partnerships and networking gave their program unique opportunities; d) all the programs consist of a positive program culture and all participants discuss what that looks like in

their program setting and how it is conducive for girls and science learning; e) It is not just about STEM; all participants talked about unique complimentary program design elements.

These results may suggest that these characteristics are layered and many are dependent on another, so by deliberately putting them in this order, it helps solidify the holistic idea to sustainable elements of a program.

*a) Fulfilling a need with an underserved audience*

Most interviewees discussed the acknowledgement of the underrepresentation girls and women in the STEM field. They all saw a need, and they imagined how an innovative, engaging program just for girls could change that scene in their community and even globally.

One participant discussed how she saw the need in her own community and how it impacted who the program served;

“ (...) I knew the girls in my community in Oakland California were not likely to get access to those opportunities [in STEM] and not because they didn't have the potential but because they were probably not going to be having opportunities and programs to support them. So from the start we were always really interested to serve girls who could most benefit, looking to serve girls in under resourced communities who were likely to be the first in the family to go to college, were attending school that were had free and reduced lunch for a majority of their students, youth of color. So over time you know we got more deliberate as we were like picking up schools to really have those requirements.”

Very similar are the girls in the programs for Girls Inc. which are primarily from low socioeconomic backgrounds, usually girls of color and usually first in their family to graduate high school, or first generation to attend college.

Another participants discussed how they try to reach girls with B average grades, and are also much be nominated by a teachers. She explains;

“We are looking for those girls that haven't had the opportunities, there are a lot of girls in the city who cannot, eighth graders, who haven't gone out much because it's dangerous in the streets or you know the parents have to have two jobs and is there a single parent and they have to stay home and take care of the younger brother so we're looking for people who need that extra help. And we take all that information into account, how much money the parents make, how many siblings, what their interests are. We choose fifty to interview and we pick twenty-five out of that for our new group of WINS I every year.”

Similarly, the RGS described their audience as being good students, but just have not had the chance beyond school to get experiences. RGS focused on rural girls, and at that time, there was no other STEM program around that had an audience of just rural girls. But this kind of selection changed from individual selection to entire school selections after the first year. RGS not only focused on rural schools, but rural schools who had a lowered rate of attending college after graduation. She also explicitly said,

“I think we obviously were fulfilling a need because I think if we had not been fulfilling a need we would have collapsed before.” She also spoke about the impact on the schools they chose; “When we started going out to the schools, so using the school as the unit not the individual girl, once they understood what we could bring to the table, they were really enthusiastic about it. So some of the schools have never had an official affiliation with the university so we were the first ones in their school and the success of the girls work was amazing”

In addition, because RGS were choosing girls from low income areas, RGS built into their program, salaries for the girls who's family relied on the girls income during the summer. They paid the equivalent of what the girl would be making during the summer so the girl may attend this summer camp. This was a unique characteristic to RGS and not mentioned in any other program.

*b) A commitment to a sustainable program*

One person explicitly discusses that from the beginning there was mind frame of having a sustained program, she states,

“We were making a commitment to the girls, to the schools and to their parents and felt like it would be so immoral to support them for three years and then say, sorry, our funding is over and we are done with this program, because we knew that these girls wanted to stay in their programs or their younger siblings did and or the teachers that we were working with. So you know from a social justice standpoint it was never about like moving onto a new program or closing down Techbridge, ever.”

Two other participants discuss that because there is such a huge underrepresentation of girls in STEM, there is a necessity of STEM programs and so staff makes STEM a priority within the organization and a commitment to the longevity of the program.

*c) Partnerships and networking*

Most of the programs have a strong partnership component either formally or informally.

Partnerships can provide valuable resources, not just funding, but facilities, role models and community access. Girls Inc., NSP and Techbridge illustrated how partnerships lead the program to expand in new ways and even develop new areas of the program. Techbridge interviewee mentioned networking with NFS partners which allowed Techbridge to be involved

in an evaluation program associated with Harvard, which leveraged them to partnering with the Exploratorium on a project. She stated,

“(…) we were able to become part of a bigger community with NSF partners which I think both help us become a better program and also helped us inform the field which then also made funders see us as something special and important that made them want to be able to fund us and broaden some new funders as a result.”

For Girls Inc. a large partnership with an aerospace corporation lead their program to have unique resources such as experiences with their employee which were experts in field, and hands-field trip with robots and engineering.

NSP’s partnership with Girls Scout was so strong, the NSP staff were able to help shape badges around the NSP kits. Three years after this Girl Scout leader training, the program expanded into partnerships with Girls scouts and local science museums and this was partnerships was the first of its kind at that time. With this type of partnership the interviewee explained some initial steps taken;

“(…) as we brought in museums and were training them and working with them, we were very strategic in terms of trying to recognize that Girl Scout council and science institutions were different. (…) There were some similarities and differences that needed to be acknowledged so that they could work well together. We addressed that in our training (…) building that trust, building that recognition, giving those people a chance to have that dialogue. It was getting feedback and being really sincere and responsive and intentional about asking questions and then trying to integrate feedback.”

This partnership really provided the girls with some unique experiences and interactions.

*d) Positive program culture*

Many of the interviewees discussed creating a positive program culture that is conducive to girls and science learning. The WINS program is a no judgement zone and the staff works hard on creating a positive program culture;

“So we have a real mix of girls and not only just by race, but ethnicity, and religion. (...) We always tell them and they know it's true, that you don't have to like me, you don't have to like everybody that's fine but you have to respect each other and we are here for this goal. So that something that we really push. The other thing that we do (...) in the program is that our office here is not [my] office, it's the WINS office so the girls actually have a place where if they need to and we tell him if you need a little break from school, a break from home, you just need to come and do homework, do you just need a break from reality, this is your place. You can just come, we are here whenever and whenever we're here we will just stop doing what we are doing, if the girls needs us here. That is another thing that I think makes it a really important part of this program is that they have a place.”

For Op. SMART and Eureka! programs, an integral part of their STEM programming is the environment that's its done in. It is a culmination of what they call, the Girls Inc. environment, and high support system. She explains with an example:

“I think is unique about Girls Inc. is the STEM programming that we do is the fact that we do it in a Girls Inc. environment and providing all that extra support. Instead of just doing that one off coding program, (...) and she wants to do more in depth you have those people around you that can help her find scholarships or other things to get access to those other things. The fact that she getting all that other support is what I think is key and critical in making her successful in STEM or to go on to post-secondary education.”

Similarly, the interviewee for NSP discussed that the Girl Scout Leader Training, provided a supportive environment for the leaders to learn in. She states,

“we were working with Girls Scouts leaders who were volunteers, who are not necessarily experienced in either teaching, facilitating or in science, (...), so building that support foundation for those leaders to learn in order for them to properly go back and be leaders to the Girl Scouts girls.”

Rural Girls in Science created a positive program culture by intentionally choosing field trip sites that conducive to all-girls learning and that were supportive and made the girls feel comfortable. The support came from teachers, role models, and RGS staff.

Techbrides founder truly believes that the environment the girls learn in, is vital and is often a topic that is brought up by the girls. She states:

“(...) whenever we have discussions with girls about why did you join or why did you come back (...). You know the whole notion about it being just for girls and it's kind of like unpacking that and seeing what does that mean. A lot of the girls would talk about the fact that it just felt safe for them. Just noting the contrast between what it's like in the school day in a classroom setting or even in an afterschool programs that are co-ed (...). The girls feel much more comfortable in the company of girls, they feel like they're able to kind of be more confident and not be worried that they don't know enough to try things out. To not be afraid of making mistakes and stumbling and not knowing things because there is nobody there to make fun of that. Being able to work on projects that are really fun for girls.”

She also discussed the challenges that an all -girl environment can produce, and what the staff at Techbridge did to try and facilitate a positive program culture;

“It wasn’t without challenges because you know there would be like personality conflicts or sometimes like racial divides within groups and really having to be intentional about building communities and social engineering to help make it a safe space because you know just having it be girls only isn’t enough, it really is thinking about how to make all those girls feel comfortable and safe and be able to promote community and teamwork and definitely having that girls only thing builds confidence and then having role models that are diverse and also are female and are able to tell her personal stories which is really important for the girls to be able to imagine a future to see how like technology or engineering that connects with them personally but having a family and being female”

Creating a positive program culture may vary slightly between the programs but it may suggest an understanding of the different types of girls the program is serving and allowing that environment to be safe and conducive to learning.

*e) It’s not just about STEM; complimentary design elements*

Engaging girls in STEM topics is more than just learning about STEM. All interviewees discussed that in addition to the core elements of the program, exposing girls to college and career exploration, having a strong role model component, and two programs focused on solving local real community problems were essential elements to their programs.

Girls Inc. has an approach to STEM learning and what that does is enable them and their affiliates to take programs that might be local and very specific to their area and adapt the guide of the Eureka! or Op. SMART programs;

“So we have a very defined framework for what Eureka! is, (...) So 50 percent of the programming that they do for the girls is STEM, 25 percent is personal development and 25 percent of sports. One of those sports is swimming and that’s very intentional because

swimming is a lifesaving skill, encourages healthy risk taking and it deals body image issues (...) The first two summers of Eureka! are on a college campus and that is the same process for all affiliates, the third year is a paid internship, and the fourth and fifth year can vary depending on the affiliate.

In addition to those complimentary design elements, the interviewee also discusses an essential element that is the foundation to their STEM approach;

“because Eureka! is so intense and resource heavy program (...) we have a lot of intentional support built in. (...) so that's been a huge part to why Eureka! has been so sustainable. It's just that amount of support that we put into it for affiliates (...)” So when a girl attends either op. SMART or Eureka! they are not just getting STEM, they are also getting college and career exploration, personal development, life skills, and healthy living skills.

Similar support and design elements are a part of the WINS program. The WINS program is broken up into WINS I and WINS II. WINS I is the first years which is an eight week summer program in which they get to utilize a lot of community places in the Philadelphia area, plus use the resources in the museum and attend a four night camping trip to the local mountain range. The program manager states how their curriculum for the first years mirror the three main subjects of the Academy, but as the girls move to WINS II which is for sophomore, junior and seniors, they are able to do more age-appropriate topics. She states;

“we also add classes on youth development and college and career exploration so the youth development we have things like budgeting, about branding yourself, about how to present yourself and a series called “Love yourself” (...) and then we also have the college tour, three nights, four days college tour usually, outside of the city. (...) We try

to make it where we get a large university, a small one and all girls school, or a historically black college.”

Because the WINS program has a host organization, the girls are given a unique opportunity;

“The other thing that WINS II has available to them is that some of them get employment at the museum and we call them the “explainers” which are the people that work in the front of the house of the museum. Then we also with the juniors and seniors, we give them the opportunity to work with scientist in what we call interns, behind the scenes so they are working in collections and some of the research areas so they could be cataloging stuff.”

Of the participants of the program, a staggering fifteen out of twenty girls receive a job at the museum, which end up to be about 1/3 of the WINS II. In addition, one of the seniors is hired to become, a WINS assistant. This is more than a job opportunity for the girl, it allows for practical experience in the museum field and they also provide mentorship to upcoming WINS girls and the current WINS I girls. The program coordinator talks about the mentorship role,

“(…) she is a mentor, someone else that the girls talk to. And she helps us make sure that if the girls have an issue and they feel like they have someone to talk to and if they don't feel comfortable talking to me or [my assistant], they have someone younger that they can talk to also.”

Rural Girls in Science, was a residential summer program for girls in the rural areas of Washington State and the interviewee discussed how their unique approach to STEM was solving real community issues that their town was facing. She states:

“(…) The idea of doing a project that was based on the needs of the town also increased sustainability because it made evident to the people of the town that this was important. In addition, the girls made a presentation at science conferences and to the stakeholders of the town and so in some cases it was the elders and in some cases it was the school (…) or the City Council. So it gave the girls many different levels of expertise.”

They were also able to utilize the University of Washington, Seattle campus for their college exploration component of the program. She said,

“The idea to bring them on the campus was to familiarize them with a university campus, especially the girls from eastern Washington. We wanted them to realize that when they were going to be working in the labs in the afternoon, they were the same labs that college students were using in the morning, so they were capable of being on a college campus and doing work just like the college students. (…) many of the schools [that participated in the program] have had zero people go to college.”

Techbridge and NSP discussed that by piloting activities with the girls and speaking with the funders, they were able to gain personal input on what they wanted in the curriculum and activities and it was thru this evaluative process that both programs started to incorporate career explorations and a large role model component. Techbridge mentioned building into every single unit a curriculum of career exploration, and really being explicit and tying in what they're doing to a career. The NSP program discussed the role model component; “a really impactful opportunity for girls is to be able to actually teach others and facilitate others and so that's where older girls became involved, they would become involved often with leaders who have gone

through the program. They would get excited, and they would either facilitate activities to these younger girls.”

This may suggest that in addition to the core elements of STEM programs, complimentary design elements, such as college and career exploration, and becoming a role model were influential to the sustaining of the program. It was also discussed that due to the changing landscape and workforce in STEM there was a motivating factor in making sure curriculum was relevant, innovative, hands-on, age appropriate, and flexible.

### **Question 3: characteristics of the program that provide challenges for sustainability**

Finally, interviewees were asked about challenges they faced that hinder sustainability. Three major themes emerged a) interviewees discussed funding challenges either for materials, access or technology b) some interviews discussed the challenges of obtaining current technology c) specific challenges; each program discussed unique problems that arose and for some, these problems led to the program to ending.

STEM programs can be resource and material heavy and many of the challenges STEM programs are faced with involve not having enough funding for resources, and technology. All the interviewees mentioned struggling to get resources or give resources.

#### *a) Funding*

All interviewees discussed the challenges of obtaining funding, either short term or long term. WINS and Rural Girls in Science discussed how looking for funding and filling out grant paperwork is a tedious, time consuming job and how most often it diverted them from doing the actual work of development and implementation of curriculum. Techbridge mentioned the degree of having a too diverse funding stream; “When you get funding from a lot of corporations or foundation, there might be like specific requirements or projects for which you had to

designate that funding for, as opposed to more open ended funding.” Also mentioned are the changes in different funders and especially corporate partner’s interest can bare problematic issues on the funding stream. Girls Inc. discussed the funding issues for expensive STEM topics such a robots that are so popular.

*b) Technology*

Interviewees discussed that due to technology changing constantly and getting more expensive, obtaining technology whether it’s robots, or computers, is a challenge. Rural Girls in Science discussed that because of the schools location, in rural communities, many school participating in the program did not have up to date computers, if at all, so obtaining computers for an entire school, bared some challenges.

*c) Unique program challenges*

RGS had the challenge of keeping track of the participating girls. Because the program focus was in rural areas, girls who worked for migrant families would move around a lot, or leave and come back. Because RGS was committed to the longevity of the program, efforts to evaluating the girl’s perspectives were built into the program, but keeping track of the girls proposed an issue. An additional challenge was at the time of the program the RGS program director was also the director of The Northwest Research Center for Women, so having responsibilities at both places bared some challenges, and the lack of funding to get additional staff, led the program to collapsed.

NSP discussed that when the program expanded from the initial training project to the national partnership between Girls Scouts and science museums, the demand for the kits grew and it became beyond the capacity of the staff to create, pack and deliver the kits. A decision was made to hire a distributor, to pack and deliver the kits, but the cost of the kits tripled. This

proposed a problem, the kits were low tech and only had a value of \$20, but the company wanted to charge 3x that and it did not feel right to be charging that much for the kits. This created issues and tensions within the program and was a playing factor into the collapsing of the program

### **Additional Themes**

Due to robust nature of each program, additional themes arose that were out of the scope of my research questions. Two themes emerged; a) all programs had a training and professional development component b) most participants discussed the importance of being about to evolve over time.

#### *a) Training and professional development component*

In addition to providing activities or curriculum in STEM for girls, most programs consisted of additional training for anyone involved with working with girls and STEM either in their program or outside. Two participant discussed having training with the schools they worked with on gender disparities, about cultural sensitivities, about ethnic disparities and culturally sensitive ways about talking about that and how to address the girls. One program provided training opportunities for teachers to be able to host after school programs and be able to go on field trips, professional development with regular meetings in which they learn new curriculum and learn about new research. In addition, one program offered professional development with other providers and afterschool programs and in some cases it was providers that were doing girls programming at museums or at all-girls school, or at public schools that come for summer training or provide training to organizations to be able to support that. Also working with school districts to support professional development around out of school STEM programming and also with the focus on equity and access. Multiple programs had training for role models.

#### *b) Ability to evolve*

With the increase attention to STEM programming, technology always changing, there is more and more competition for resources. All participants discussed the need be able to evolve over time. Participants discussed that by knowing what is going on the field, the program can stay up to date and not become out dated. This can include anything from funding, to the topics being taught, and to who is interested in STEM topics.

## Chapter Five

### Conclusions and Implications

#### **Conclusion**

The purpose of this research study was to identify the characteristics and factors that promote the sustainability of successful STEM programs for young girls. Semi-structured interviews were conducted with five professionals at six successful, long term STEM programs for girls, asking them the nature of the infrastructure of the program, what characteristics promoted sustainability and what characteristics challenged sustainability. Results were coded and analyzed using a combination of a priori and emergent coding.

This study expands on the body of research on successful programs for girls by focusing specifically on the sustainability of the programs. I identified the following characteristics and factors;

- A diverse funding stream
- Staff commitment
- A part of an established organization
- Serving an underrepresented audience
- A commitment to the sustainability of the program
- Building partnerships
- Positive program culture
- Complimentary design elements

These results suggest that for successful programs to be sustained, there are interrelated dimensions involved.

## **Implications**

While significant research and evaluation studies appoint to what makes a STEM program successful, this research looked more specifically at what leads these programs to be sustained. There is little research that focuses on sustainability but the results of this research aligned with a previous study where the researchers attempted to apply a sustainability framework from formal education, which was outlined in chapter two (Koch et al. 2013). That research combined with my research suggest that sustainability is not based on one factor but based on a constellation of factors and should be thought of sequentially as well as collectively, in order for them to reinforce each other” (Koch et al. 2013). This suggest that when people are planning programs, while not only planning for the success of the program, integrating factors that specifically look at sustainability.

The greatest limitation to this study is that due to the complexity, longevity and robustness of each individual program, it was hard to get a complete understanding of the different aspects of the program in the time frame allotted.

Future research might use the sustainability framework as a guide to shaping the research to build on the research around sustainability.

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## Appendix A

### IDENTIFYING SUSTAINABILITY PRACTICES IN SUCCESSFUL STEM PROGRAMS

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#### Consent Script:

Hello, thank you very much for speaking with me today. I am asking you to participate in a semi-structure interview that will be used for my thesis research which is to identify and describe the characteristics that promote the sustainability of successful STEM programs for girls. This interview will take about 40 minutes. I will be recording the interview for research purposes. I may pull quotes and general facts from this interview and if so, I will include the name of the institution and your position. You may refuse to participate or to answer any question at any time without any penalty. Do you have any questions? If you have questions later you may contact me or my faculty advisor, Kris Morrissey, at any time.

Do you agree to participate? Wonderful. Let's begin.

#### Interview Guide:

In just a few sentences describe the program and the role you play within the program.

About how long was/has the program been active?

These next few questions are about the funding and resources of the program.

1. How is it the primarily funded?
  - a. Is the program apart of the line item budget of the organization? General operations funded?
2. What is the size of the staff who manages or helps in operations of the program?
3. Did the program start off being this way in the institution or museum?
4. Do you receive resources from outside the museum /institution? What are they?

My next set of questions are open-ended, and general, so please feel free to take in any direction.

5. What are the unique characteristics of the programs that provide opportunities for sustainability?

6. What are the unique characteristics of these programs that provide challenges for sustainability?

(If participants did not already cover these topics)

7. What is unique about the audience you serve?
8. How does the institution promote/market the program?
9. Is there an evaluation plan for the program?
  - a. How often?
  - b. Are the participants evaluated? And how often?
10. How does the program fit within in the community?

Great, and one last question:

11. In your own words, how would you describe why your program has lasted so long? Or, why do you think your program ended?