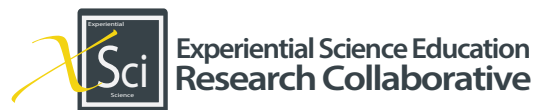Latina SciGirls Research / Portal de Investigación

Latina SciGirls:

Addressing Barriers to Promote Hispanic Girls' Positive STEM Identity Development Through Media, Outreach and Role Models

FINAL RESEARCH REPORT

Experiential Science Education
Research Collaborative

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Executive Summary

This report presents findings of the *Latina SciGirls* mixed methods study, investigating the experiences of young Latinas participating in informal STEM programs across the U.S. that utilized the *SciGirls* educational model (including the *SciGirls Seven* strategies) and augmented with materials and practices intended to better serve Hispanic girls. The project was led by Twin Cities Public Television with funding from the National Science Foundation as an AISL *Innovations in Development* project. The STEM-related identity framework and research model used to guide this investigation is presented along with the results in relation to the study's research questions:

1. How does the experience of participating in Latina SciGirls impact Hispanic girls' STEM-related identity development (if it does)?
2. What are the impacts of the project's role models?
3. What are the impacts of parents, family or friends?
4. What modifications to the STEM Identity framework are indicated by the findings?

Quantitative methods included statistical analyses of pre-post surveys across 10 program sites using a composite of the STEM Career Interest Survey; The Girls' Interest in Nature and Science Scale, and the Science Identity Scale, and inclusion of evaluation data surveying site leaders on different program elements. Qualitative methods included case study investigations using interviews, focus groups, and researcher observations across 3 sites representing different geographical, cultural, and types of informal STEM learning programs.

Findings from the quantitative analysis aggregated across ten program sites indicate that girls reported higher rates of emotional connection to STEM (an important component of STEM-related identity development) after exposure to the various *Latina SciGirls* interventions (paired samples t-test; $p < 0.05$). Younger girls (9-11 age levels) reported significantly higher rates of both emotional connection (paired samples t-test; $p < 0.05$) and personal relevance *to* STEM after participating in a *Latina SciGirls* program (paired samples t-test; $p < 0.05$) while older participants in showed significantly less interest in mathematics careers after experiencing the programs (paired samples t-test; $p < 0.05$). Results are taken with caution due to small sample sizes and effects sizes.

Site-by-site comparisons revealed that four programs in particular outperformed others in terms of STEM-related identity development gains on certain composite indicators, including girls' interest in potential careers in careers in all four STEM categories (Science, Technology, Engineering, and Math) (paired samples t-tests; $p < 0.05$), enjoyment of science and emotional connection to science.

Notably, results examining the predictive value of parent STEM-related attributes to participant scores at baseline, yielded three significant results: Parents with a greater emotional connection to science related positively with their child's emotional connection to science prior to the intervention (multiple regression; $p < 0.05$); Parents with greater interest (or involvement) in engineering careers related positively with their child's interest in engineering careers prior to the intervention (multiple regression; $p < 0.05$); Parents in a science-related profession were more likely to have a child interested in a science career prior to the intervention (multiple regression; $p < 0.05$). Findings also suggest that parent careers and STEM-related identity did not play a mediating role in the effectiveness of the program experiences *during* the program implementation. Importantly, these findings provide an evidentiary basis for the predictive value of STEM-related identity constructs in explaining child STEM-related identity using parent STEM-related identity indicators not seen before.

Case study analyses show positive outcomes for the development of STEM-related identities as both social identities (demarking membership and belonging within a social group) and role identities (as seen with increased interest in STEM careers and through the impacts of role models). Cross case analysis revealed that girls' program experiences primarily served to validate and reinforce their pre-existing positive STEM-related identities in terms of enjoyment of STEM, enhanced interest, motivation, and intentions to increase their STEM commitment through increased participation in STEM learning and STEM-related relationships in the future. Personal relevance and social engagement emerged as the most powerful themes. Those programs that included highly structured and embedded social engagement opportunities as a method of STEM learning combined with content and activities designed to be personal relevant had the greater STEM-related identity impacts for girls.

The impacts of role models was revealed to be highly variable and complex across the programs in the study. Results suggest that the idea of role modeling within STEM learning contexts can influence young minds in multiple ways beyond introducing STEM-based role identities to participants. These include: Stories of personal STEM-related life trajectories, Exploring the integration of STEM with gender and ethnic identities in terms of being a STEM professional and a Latina and still having "a life" beyond STEM, and; In terms of participants having close personal interactions and relationship-building with STEM role models that results in powerful "agency-lending" outcomes for participants. Unpacking the concept of role models through the lens of multi-modal "identity influencers" appears warranted.

An important theme emerging from role model engagement in the programs was "agency-lending" -- the idea that 'because I see and/or know someone who is like me doing something that I have not yet done, I develop a sense of agency for the same activity – a sense that I too can do it.' Agency-lending appears to be based both on: (1) The protégé perceiving a high level of personal similarity with the exemplar and on; (2) The depth of their interaction in terms of contact hours, frequency and/or meaningfulness to the protégé.

Implications of the findings in terms of the founding hypothesis of the project are discussed through a social identify theory lens. The hypothesis was that *the SciGirls model, when augmented to address specific barriers to STEM engagement of Hispanic girls ages 8 to 13 and their parents, will promote the development of positive STEM identities in Hispanic girls.* These barriers include: Socio-cultural dispositions that don't traditionally include STEM; Varying degrees of language barriers; Underrepresentation of Hispanic STEM role models. Findings suggest that the *SciGirls Seven* strategies are largely validated. Those sites employing a well-designed synthesis of the *SciGirls Seven* with strategies intended to serve Latinas in ways specifically addressing the above barriers generated several positive indicators of STEM-related identity development over programs that did not. Most of the identity impact was seen in two categories: emotional connection to STEM and enjoyment of STEM. Both of these occurred through the establishment of personal relevance made possible by multiple modes of social engagement (peer-to-peer, role models, parents, leaders) and both critical elements of durable STEM-related identity development.

Finally, indicated adjustments to the conceptual framework and research model are discussed along with recommendations for future education practice and identity research.

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Introduction

Latina SciGirls Strategies was a National Science Foundation–funded project led by [Twin Cities PBS](#) in partnership with [St. Catherine University](#), the [National Girls Collaborative](#), and [XSci](#) (The Experiential Science Education Research Collaborative) at the [University of Colorado Boulder's Center for STEM Learning](#). This report presents the methods and findings of a mixed-methods study designed to contribute to improved programming and knowledge in STEM-related identity development for young Latinas. The study tests the hypothesis that*: The SciGirls model, when augmented to address specific barriers to STEM engagement of Hispanic girls ages 8 to 13 and their parents, will promote the development of positive STE-related identities in Hispanic girls.* The research effort focused on the STEM-related identity outcomes for Hispanic girls engaging with multiple implementation variations of the augmented SciGirls model at ten participating sites across the U.S.

This study was intended to contribute to understanding what works and why in building positive STEM-related identities for Hispanic girls and the need to proceed from a sound theoretical research base in hopes it may translate into better STEM educational strategies for girls and boys alike at those critical ages where deterministic attitudes and decisions about STEM occur in concert with the intense identity construction of pre-teen and early teen years.

The *Latina SciGirls* Project

The overall Latina SciGirls project set out to test the *Latina SciGirls* model using a set of materials and activities designed to address STEM engagement barriers among Hispanic girls. Twin Cities Public Television (tpt) produced six half-hour video episodes of *Latina SciGirls*, filmed in Spanish, showing groups of girls and their Latina mentors investigating culturally relevant science and engineering problems. Additionally, tpt created a series of family and girl-friendly role model videos of Latinas in STEM fields. Tpt provided all new videos and activity guides in Spanish, as well as methods to connect with Latina role models, to 16 geographically diverse Hispanic-serving *SciGirls* education outreach organizations nationwide in order to enable those informal STEM learning programs. Of those 16 sites, 10 were able to complete participation in this study – which examined STEM-related identity outcomes for young Latinas participating in those programs.

Importantly, embedded within the tpt-created materials and activities used in this project, are the following set of research-based strategies for engaging girls in non-traditionally female studies. These strategies, called the *SciGirls Seven,* included:

1. **Girls benefit from collaboration, especially when they can participate and communicate fairly**. Girls thrive when they work together to make science, technology and engineering an intentionally social experience.
2. **Girls are motivated by projects they find personally relevant and meaningful**. Girls become motivated when they feel their task is important and can make a difference. If girls see how STEM is relevant to their own lives their attraction to these subjects is likely to increase.
3. **Girls enjoy hands-on, open-ended projects and investigations**. Educators and role models can encourage and promote exploration, imagination, and invention by encouraging girls to ask questions and find their own paths for investigation.
4. **Girls are motivated when they can approach projects in their own way, applying their creativity, unique talents, and preferred learning styles**. Girls should take ownership of every step of the scientific and engineering process, including designing their own investigations, collecting data and communicating their findings and results.
5. **Girls' confidence and performance improves in response to specific, positive feedback on things they can control—such as effort, strategies, and behaviors**. Self-confidence can make

or break girls' interest in STEM. Adults can support girls' efforts by encouraging their problem-solving strategies; allowing them to struggle and/or fail; emphasizing that their skills can be improved through practice.

6. **Girls gain confidence and trust in their own reasoning when encouraged to think critically.** Educators should cultivate an environment that encourages creative thinking, questioning, trial and error and authentic, personal discoveries.

7. **Girls benefit from relationships with role models and mentors**. By hosting field trips to work sites, visiting classrooms, or working with afterschool programs and summer camps, female role models tangibly demonstrate how girls can explore and succeed in STEM. Seeing women who have succeeded in STEM helps inspire and motivate girls, especially when they can relate to these role models as people with lives outside of work.

It should be noted that each *Latina SciGirls* site ran different informal STEM education programs. There was wide variability across programs in implementation factors, including type of program, duration of program, attendance at online program leader trainings, integration of required program elements, consistent use of *SciGirls* videos and resources, and use of strategies from the *Engaging Latino Families Guide* and incorporation of every *SciGirls Seven* strategy. The official program requirements included:

Program Leader Training Requirements:
- Attend a one hour welcome webinar
- Attend a series of training webinars: site leaders were trained in the use of *SciGirls* gender equitable strategies for engaging girls in STEM (scigirlsconnect.org/scigirls/) and in the use of best practices for engaging Latino families in STEM (scigirlsconnect.org/latina-scigirls-guides/);
- Attend 2 webinars on the new *SciGirls* Spanish-language resources
- All sites were provided with dubbed PBS SciGirls episodes, Spanish-first PBS SciGirls episodes, and multiple role model videos;
- All sites were provided bilingual materials for girls and families;
- All sites were provided STEM activities to go with the PBS episodes.

Implementation Requirement:
- Offer a 16-32 hour (or more) *Latina SciGirls* program, including a Family Fiesta, for at least 10 girls in grades 5 through 8
- Involvement of one parent/caregiver per girl (through the Familia Fiesta)
- Include at least three female STEM professionals, including at least one at the Family Fiesta
- Incorporate strategies from the *Engaging Latino Families Guide*
- Incorporate every *SciGirls Seven* Strategy in every program

Decisions on whether and how to apply this training and/or use these materials was highly variable from site-to-site. This study includes both aggregated and site-by-site comparison analyses from participant and parent perspectives. It should be noted however, that references to the "intervention" found in the aggregate analyses of this report, refer to a broad range of program implementation designs and realities. More detailed site-comparison information can be found in the project evaluation report compiled by the project's evaluation team.

Data from 10 responding sites are included in this analysis:

University of Puerto Rico	San Juan
San Antonio Prefreshman Engineering Program	San Antonio, TX
Sci-Port: Louisiana's Science Center	Shreveport, LA
Girls Inc of Orange County	Costa Mesa, CA
McMath Middle School (Dallas Society)	Denton TX
Cameron Park Zoo	Waco, TX
Science Workshop (Children's Museum of Houston)	Houston, TX
New Jersey After School Care Coalition	Westfield, NJ
Children's Science Center	Fairfax, VA
Con Mi Madre	Austin, TX

Study Context

The larger context in which this study is positioned to contribute is based on the challenges of all girls' entry into STEM, which includes the challenge of developing a positive science identity against gender stereotypes (Notter, 2010; Brickhouse, Lowery, & Schultz, 2000), and maintaining that science identity within a prevalent anti-science attitude among America's youth (Osborne, Simon, and Collins, 2003). This challenge is amplified for Hispanic girls who must contend with the additional issues of socio-cultural dispositions that do not traditionally include STEM, varying degrees of language barriers, and underrepresentation of Hispanic STEM role models (Leslie, McClure & Oaxaca, 1998; Villegas, M. A. S., & Vincent, K. M., 2005). It is also based on research indicating that sustained engagement of girls with STEM-related activities (including ultimate career choice) requires holistic human experiences that include emotions and social components (such as role modeling) in addition to STEM content and process knowledge (Notter, 2010).

Research Model

The conceptual framework for this research is Social Identity Theory as described by Tajfel and Turner (1979) and later synthesized into Identity Theory by Burke and Stets (2000), which encompasses different types of program influences on identity development. Specifically, these include:

(1) Role identity: the meanings an individual assigns to different positions/functions they hold or perform in society;

(2) Social identity: the meanings an individual incorporates into their sense-of-self based on affiliation with or formal/informal membership in social groups (gender, age, family, class, ethnicity, interests), and;

(3) Personal identity: the meanings an individual incorporates into their sense-of-self as unique or distinct from others (what makes us different).

Together, these categories influence our ideas of who we are and who we want to (and attempt to) become, guiding our self-perceptions and our choices, including what we believe we can do (and what we cannot do) (Burke & Stets, 2009). In this investigation, the research team was especially interested in any positive STEM-related identity development, or the degree to which one integrates STEM into their sense-of-self as a result of their participation (McLain, 2012). To guide the investigation, XSci began with a theoretical framework that identifies distinct STEM identity construction zones. Construction zones include the cognitive factors of agency, content confidence, emotional connection and personal relevance, and associates these factors with specific behavioral outcomes important in STEM-related identity development (capacity, STEM concept, attitudes and self-efficacy, future choices). These zones and outcomes are based on prior research demonstrating their importance in leading to outcomes considered indicators of positive science identity (Hunter,

Laursen, & Seymour, 2006; Tennhoff, W., Nentwich, J. C., & Vogt, F. 2015; Van Driel, Beijaard, & Verloop, 2001; Weinberg, Pettibone, Thomas, Stephen, & Stein, 2007; Brickhouse, Lowery, & Schultz, 2000; Chachashvili-Bolotin, S., Milner-Bolotin, M., & Lissitsa, S. 2016.) (see Figure 1).
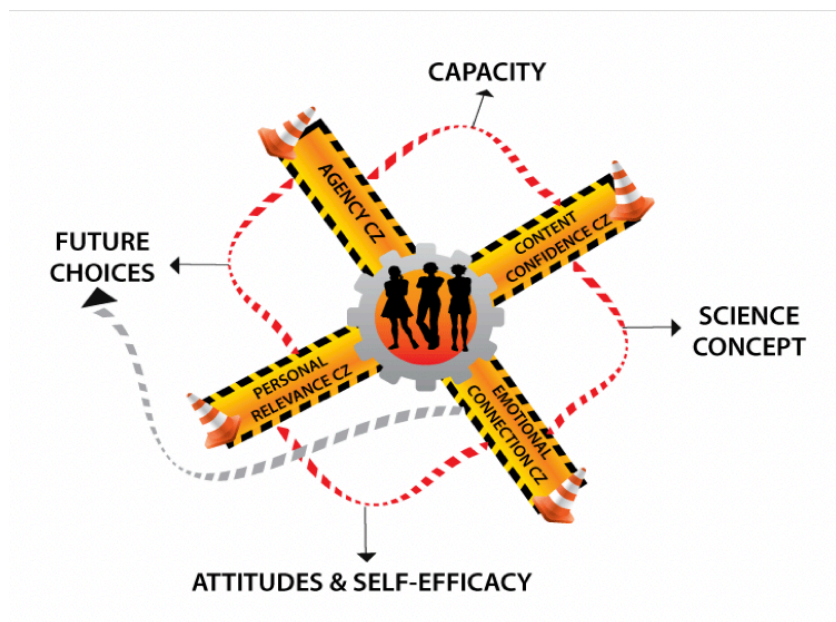

Figure 1: STEM Related Identity Construction Zones

Operationally, the research effort sought to determine if *Latina SciGirls* impacted these zones and outcomes for Hispanic girls, as well as examine potential impacts of parents and role models, including both women STEM professionals and Hispanic girls featured in the Latina SciGirls videos.

Research Questions

1. How does the experience of participating in Latina SciGirls impact Hispanic girls' STEM-related identity development (if it does)?
2. What are the impacts of the project's role models?
3. What are the impacts of parents, family or friends?
4. What modifications to the STEM Identity framework are indicated by the findings?

To address these questions, the research team used a mixed-methods design. The quantitative research included pre-post surveys of participants and their parents. The qualitative research included site-based case studies of three different informal education programs across the country. These included multiple site visits during their program implementation, interviews with program participants and their parents, and researcher observations of program implementation. These study components are presented in detail in the following sections.

Quantitative Research
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1. Survey Methods

To measure the impact of the *Latina SciGirls* project on participants in aggregate, responses from a composite survey administered before and after exposure to the intervention were compared. The survey consisted of the combination of the STEM Career Interest Survey, including all four subscales (Kier, Blanchard, Osborne, & Albert, 2014); The Girls' Interest in Nature and Science Scale (modified) (Flagg, 2015), and the Science Identity Scale, currently under validation testing (McLain, 2017).

The survey consisted of 69 common items, which align to several key concepts. For each key concept a composite score was generated. See Appendix A for a list of the corresponding item for each concept. Each composite score was calculated by summing the responses to the items associated with that composite (reverse scoring when appropriate for negatively worded items) and then dividing by the total number of items. The following composites were created:

- Personal Relevance
- Agency
- Emotional Connection
- Content Confidence
- Enjoyment of Science
- Science Career Interest
- Technology Career Interest
- Engineering Career Interest
- Mathematics Career Interest

Cronbach alpha coefficients were computed to examine the reliability of each composite.

In a prior administration of the same survey (for the *SciGirls Strategies* project), the Cronbach alpha coefficients indicated good reliability (above 0.80) for the composites related to STEM Career Interests and Enjoyment of Science. Agency and Emotional Connection composites were slightly lower, but still considered acceptable (above 0.70). Personal Relevance and Content Confidence were lower still (0.65-0.69).

In the administration of the survey for this study (*Latina SciGirls*), the computed Cronbach alpha coefficients indicated good reliability (above 0.80) for the composites related to STEM Career Interests and Enjoyment of Science. However, the Cronbach alpha coefficients for the remaining composites were lower for Personal Relevance and Emotional Connection (ranging from .54 to .60). The coefficients on Agency and Content Confidence were too low to be considered reliable.

Therefore, due to low reliability, the Agency and Content Confidence outcomes were excluded from analysis.[1] The decision was made to analyze the Personal Relevance and Emotional Connection composites, but to treat results more tenuously since there is less confidence in the assumption that these items accurately measure a singular construct. There are several reasons that may explain the lower reliability values:

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[1] Exploratory analyses with these outcomes resulted in no statistically significant findings.

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1. The sample size for *Latina SciGirls* is small (considerably smaller than in the prior administration of the survey), meaning that any "noise" or atypical variability will have a greater influence on reliability calculations;
2. The survey was translated into Spanish prior to administration. It's possible that the translation did not always convey the same meaning that was expressed in the English version;
3. The sample included young participants (grades 2-8) who may have had difficulty reading and/or interpreting the items in English or in Spanish;
4. The SIS is a new measure and may need further refinement before it performs as a highly reliable instrument.

2. Respondents

Respondents were participants identifying as female among ten different *Latina SciGirls* program sites across the U.S. (including Puerto Rico), constituting a convenience sample, based on site leaders' and participants' willingness, availability, and timing of their program engagement.

There were 284 participants who completed the before-intervention survey and 158 who completed the after-intervention survey. Of those, the before-and-after-intervention survey data were able to be linked for 105 participants. The 105-person sample included 54 participants at an age and grade-level category of K-5 (actual grade levels of 4-5, ages 9-11) and 51 at an age and grade-level category of 6-10 (actual grade levels of 6-8, ages 12-15).

Parents of participants were also given a very similar survey to characterize their STEM-related identities and careers. For the parent survey, composites of the same nature as in the participant survey were created (reliability coefficient patterns were similar to those of participants). Of the 105 participants with complete data, 41 had parent data as well.

3. Analysis

To assess the impact of the *Latina SciGirls* intervention in aggregate on participants, a series of paired samples t-tests were conducted. The analysis looked at the effect of the intervention on each of the composites. Because this study involved multiple comparisons of related outcomes, the False Discovery Rate (FDR) method[2] was used to maintain an overall Type I error rate of five percent. In this kind of analysis, differences on each outcome between pre and post time points are examined.

In addition, separate t-tests were run to see if effects were specific to younger participants (K-5th grade-level category) or older (6th-10th grade-level category). To see if the observed differences in composite scores were statistically significant (and thus, highly unlikely to be due to random chance) seven t-tests were conducted; one for each composite. Then, fourteen t-tests were conducted, looking at each outcome for the two age-level groups (lower grade-level and upper grade-level).

Next, parent outcomes were analyzed in connection with their own child's outcomes to examine any potential predictive power for parent-child STEM-related identity outcomes, as described in more detail below.

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[2] The false discovery rate method adjusts the alpha level required for statistical significance. Benjamini, Y. & Hochberg, Y. (1995). Controlling the false discovery rate: a practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society,* B, 57, 289–300.

Finally, two kinds of analyses were run to examine site-by-site participant outcome differences across programs. One of these analyses used shared data from the project's evaluation team.

First, for sites with 10 or more paired pre-post responses, paired samples t-tests were conducted for each program site and for each composite outcome, and then compared.

Second, hierarchical linear modeling (HLM) was used to examine additional site-based program features (as revealed in the project's evaluation) against participant composite outcomes. These program features included:

- Use of SciGirls profile videos
- Use of SciGirls episodes
- Whether youth worked on a project designed to be personally relevant and meaningful to them
- Whether youth communicated findings to the group using a variety of techniques
- Whether youth expressed their individual viewpoints within a group setting
- Whether youth used solid evidence to support claims when communicating findings
- Whether youth developed relationships with role models or mentors
- Whether youth discussed STEM careers
- Total hours of programming
- Total number of participants

This program information was obtained through site leader surveys conducted by the project evaluators. It should be noted that this analysis was conducted post-facto from data collected for the evaluation that was not originally intended for HLM examination, so the analysis should be considered exploratory in this regard. Also, the Puerto Rico site was not included in the Evaluation data. For more discussion of how these features were characterized and captured, see the project Evaluation Report.

For this analysis, a 2-level HLM model was used, with participants (level 1) nested within different site-based programs (level 2). Each program feature was run against each key composite outcome, resulting in 90 initial models total. As 2 key composites were ultimately found unreliable (as noted above), the final result was 70 model total. However, this analysis presented several issues, casting its results into doubt, as discussed below.

4. Results & Discussion
A. Participant STEM-Related Identity Composite Indicator Outcomes
There was one significant overall difference between before-intervention and after-intervention aggregated composite scores. Participants reported higher rates of emotional connection after exposure to the intervention as compared to scores before the intervention (paired samples t-test; $p < 0.05$).

For younger participants (K-5 grade category) specifically, there were two statistically significant aggregated results. Younger participants reported higher rates of emotional connection and personal relevance after exposure to the intervention as compared to scores before the intervention (paired samples t-tests; $p < 0.05$).

For older participants (6-10 grade category), there was one statistically significant aggregated result. This result was not favorable for the intervention as it indicated the older participants

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showed less interest in mathematics careers after exposure as compared to scores before exposure (paired samples t-tests; $p < 0.05$).

Table 1 provides descriptive information on composite scores at both time points overall and for each grade group. Effect sizes[3] are noted for statistically significant results. Note that for each significant finding, the effect size is small, ranging from 0.24 to 0.44. This indicates that while the program did indeed affect STEM-related identity for young Latinas, in each instance the magnitude of that effect (positive or negative) was relatively small.

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[3] Effect sizes of about 0.20 are typically considered small, 0.50 medium, and 0.80 large. Cohen, J. (1992). Statistical power analysis for the behavioral sciences. Hillsdale, NJ: Lawrence Erlbaum Associates

Table 1. Composite Scores, by Time and Grade Group
Note: The first three composites are on a scale of 1-4 and the remaining composites are on a scale of 1-5

Composite	Group	Time	Mean	Std. Deviation	Effect Size
Personal Relevance	Overall	Pre	2.95	0.61	--
		Post	2.98	0.65	
	K-5	Pre	2.86	0.66	0.33
		Post	3.06	0.61	
	6-10	Pre	3.04	.054	--
		Post	2.90	0.68	
Emotional Connection	Overall	Pre	2.75	0.60	0.24
		Post	2.90	0.60	
	K-5	Pre	2.78	0.64	0.44
		Post	3.07	0.50	
	6-10	Pre	2.72	0.57	--
		Post	2.73	0.64	
Enjoyment of Science	Overall	Pre	2.61	0.49	--
		Post	2.58	0.54	
	K-5	Pre	2.60	0.46	--
		Post	2.62	0.49	
	6-10	Pre	2.63	0.53	--
		Post	2.54	0.59	
Science Career Interest	Overall	Pre	4.21	0.64	--
		Post	4.22	0.66	
	K-5	Pre	4.17	0.65	--
		Post	4.24	0.68	
	6-10	Pre	4.25	0.64	--
		Post	4.19	0.64	
Technology Career Interest	Overall	Pre	4.12	0.69	--
		Post	4.20	0.66	
	K-5	Pre	4.19	0.70	--
		Post	4.34	0.59	
	6-10	Pre	4.04	0.68	--
		Post	4.06	0.70	
Engineering Career Interest	Overall	Pre	3.97	0.69	--
		Post	3.99	0.67	
	K-5	Pre	4.00	0.74	--
		Post	4.08	0.68	
	6-10	Pre	3.93	0.63	--
		Post	3.90	0.66	
Mathematics Career Interest	Overall	Pre	4.15	0.73	--
		Post	4.10	0.78	
	K-5	Pre	4.17	0.78	--
		Post	4.23	0.78	
	6-10	Pre	4.12	0.67	0.34 (unexpected direction)
		Post	3.97	0.76	

B. Predictive Value of Parent Attributes to Participant Score at Baseline

Aggregated analyses were performed to look at participant interest and STEM-related identity based on parent careers and STEM-related identity. Two kinds of analyses using parent data were run. The first examined the extent to which parent career and STEM-related identity was predictive of participants' *baseline* scores. The second judged the extent to which parent career and STEM-related identity was predictive of *changes* in participant scores from pre to post-intervention timepoints. The goal of these analyses was to better understand how parents may have influenced participants *prior to* their exposure to the program and *during* exposure to the program.

For the first analysis, multiple regression was used, where the participant baseline values on each composite was predicted using the parent score on the same composite, controlling for grade level. Out of the seven composites, there were two statistically significant results. Parents with a greater emotional connection to STEM related positively with their child's emotional connection to STEM prior to the intervention (multiple regression; $p < 0.05$). Similarly, parents with greater interest (or involvement) in engineering careers related positively with their child's interest in engineering careers prior to the intervention (multiple regression; $p < 0.05$).

Using a slightly different approach, a similar regression model was run for each of the participant baseline composite values, this time looking at the predictive value of having a parent in a STEM-related profession. When this parent predictor was used, one statistically significant result was found. Parents in a STEM-related profession were more likely to have a child interested in a STEM career prior to the intervention (multiple regression; $p < 0.05$).

Importantly, this data goes beyond prior research showing a connection between parent and child's interest in STEM, to provide an initial evidentiary basis for the predictive value of these STEM-related identity constructs in explaining child STEM-related identity using parent STEM-related identity. This may prove to be a valuable — and currently underutilized — tool for programs intending to inspire more Latinas to pursue STEM learning.

C. Predictive Value of Parent Attributes to Changes in Participant Scores Over Time

The goal of these analyses was to better understand how parents may have influenced participants *during* their exposure to the program.

Multiple regression was used, where the participant outcomes post-intervention were predicted using the parent score on the same composite, controlling for pre-intervention composite score and grade level. Out of the seven outcomes, there were no statistically significant results (multiple regression; $p \geq 0.05$).

Using a slightly different approach, a similar regression model was run for each of the participant composite scores post-intervention, this time looking at the predictive value of whether a parent was in a STEM-related profession. When this parent predictor was used, there also were no statistically significant results found (multiple regression; $p \geq 0.05$).

These data suggest that parent careers and STEM-related identity did not play a mediating role in the effectiveness of the intervention.

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Table 2. Predictive Value of Parent Career and Identity in STEM for Child's Baseline and for Child's Change Over Time, by Model

Note: Statistically Significant Results Which Show Positive Relationships Indicated by an "+"

Models	Personal Relevance	Emotional Connection	Enjoyment of Science	Science Career Interest	Technology Career Interest	Engineering Career Interest	Math Career Interest
1. Predictive of Participant Baseline							
Parent composite value		+				+	
Parent in a science profession				+			
2. Predictive of Participant Change Over Time							
Parent composite value							
Parent in a science profession							

Participants were also asked about their beliefs about science before and after the intervention. They were presented a list of responses and asked to select all that applied. Response patterns before and after are displayed in Table 3. Treating each option choice as an outcome, the changes from pre to post-intervention were analyzed using McNemar's test. There were no statistically significant differences (McNemar's test; $p \geq 0.05$).

Table 3. % of Respondents Selecting Each Response, Before and After the Intervention

I consider science to be (select all that apply to YOUR opinion):		Percent Checked
Knowledge, facts, or content	Pre	51
	Post	53
The group of people who do science	Pre	29
	Post	27
A process or method for investigating questions	Pre	37
	Post	47
A special way of thinking about or viewing the world	Pre	52
	Post	56
Something I like	Pre	57
	Post	58
Something I dislike	Pre	4
	Post	5

D. Site-By-Site Comparison Across Composite Outcomes

For sites with at least 10 paired pre-post responses, paired samples t-tests were conducted for each composite outcome. Note that due to low numbers per site, there is a loss in statistical power. In other words, pre-post differences need to be quite large before they will appear statistically significant within small samples. Table 4 gives descriptive information and analytic results. In the table, bolded values indicate effect sizes for statistically significant results. Highlighted outcomes show pre-post differences that were large, but did not reach statistical significance (likely due to small sample size) to see if any other sites stood out.

Table 4. Results of Site-by-Site Analyses

		Children's Science Center	Con Mi MADRE	Girls Inc of Orange County	McMath Middle School (Dallas Society)	University of Puerto Rico
Personal Relevance	Post Pre Effect Size	2.90 2.82 --	2.86 2.95 --	2.72 2.68 --	3.20 3.23 --	3.37 3.27 --
Emotional Connection		2.98 2.66 **0.49**	2.63 2.71 --	2.65 2.46 --	3.23 2.85 --	2.98 3.03 --
Enjoyment of Science		2.59 2.47 --	2.52 2.56 --	2.38 2.53 --	2.83 2.68 --	2.69 2.80 --
Science Career Interest		4.19 4.05 --	4.20 4.32 --	3.91 4.00 --	4.42 4.50 --	4.63 4.44 **0.96**
Technology Career Interest		4.23 4.15 --	4.11 4.20 --	4.05 4.08 --	3.98 3.83 --	4.34 4.05 **0.97**
Engineering Career Interest		3.90 3.96 --	3.81 3.97 --	4.02 4.05 --	4.07 3.74 --	4.12 3.89 **0.98**
Mathematics Career Interest		4.19 4.20 --	3.98 4.18 **0.66** (unfavorable direction)	3.81 3.78 --	4.25 4.40 --	4.21 4.01 **0.72**

Based on statistical significance, it appeared that the University of Puerto Rico alone outperformed other sites. If the University of Puerto Rico was also the largest site, by participant numbers, this result would be cause for skepticism, but this was not the case. Additionally, the effect sizes for these outcomes were medium to large.

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Based on other large (but not significant) pre-post outcome results, it appeared that Children's Science Center, Girls Inc of Orange Country, and McMath Middle School also had notable STEM-related identity impacts, as shown.

E. Site-By-Site Comparison Across Composite Outcomes and Program Features

Recall that 70 HLM models were used to examine participant composite outcomes against 10 different program features: Use of SciGirls profile videos; Use of SciGirls episodes; Whether youth worked on a project designed to be personally relevant and meaningful to them; Whether youth communicated findings to the group using a variety of techniques; Whether youth expressed their individual viewpoints within a group setting; Whether youth used solid evidence to support claims when communicating findings; Whether youth developed relationships with role models or mentors; Whether youth discussed STEM careers; Total hours of programming; Total number of participants.

There were 3 statistically significant, but problematic results:

- Sites reporting that participants worked on a project designed to be personally relevant and meaningful corresponded with lower participant scores on emotional connection, controlling for baseline values (HLM; $p < 0.05$).

- Sites reporting that participants used solid evidence to support claims when communicating findings corresponded with lower participant scores on emotional connection, controlling for baseline values (HLM; $p < 0.05$).

- Sites reporting a greater number of total contact hours corresponded with lower participant scores on interest in technology careers, controlling for baseline values (HLM; $p < 0.05$).

There are important reasons to consider these results with great skepticism:

First, and most prominently, the analytical sample sizes (including the small of number of sites (8) with feature data available, and the small number of participants per site) present a problem. The per-model sample size for this analysis was considerably smaller than the total sample, in some cases more than others. For example, when examining the impact of the use of *SciGirls* episodes and *SciGirls* Profile videos, only 5 sites had relevant data, thus limiting a more rigorous investigation of the effectiveness of those program features. Additionally, with so many models run, there is an increased chance of detecting artifacts rather than actual effects. The overall impact of these small samples sizes is to increase the likelihood of type I and type II errors (false positives and false negatives) and to reduce the statistical power of the test, or ability of the test to detect changes that are present.

Second, there were no clear patterns across any of the features examined. Given that the composite outcomes generated for this study are related (both through the STEM-related identity theoretical framework and, in some cases, evidenced in the Cronbach Alpha scores presented above), if one of the features was having a large impact (positive or negative), one would expect to see a single feature reach statistical significance for more than one outcome. But that was not the case here, casting doubt on the reliability of the results.

Third, for many of the program features examined, there is no clear fidelity of implementation. For example, what does it specifically mean that a program was designed to be personally relevant and meaningful to participants? What elements does such a strategy include or exclude? How shared is the understanding and implementation of such practices across sites? Although such questions are indeed addressed in the explanation of program features and how to implement them contained in the *SciGirls Seven* materials and site leader training, there is not direct indication of whether and how such strategies were implemented.   The program features were reported by site leaders (through evaluation surveys) and may not accurately reflect what participants experienced in each program. These unknowns and others cast doubt that this and other similar features describe the same things from site-to-site. Further investigation with additional data streams would be needed to better understand the details of the implementation fidelity issues.

5. Summary

The high level research findings from the quantitative analysis, and aggregated across the 10 program sites, indicate that girls reported higher rates of emotional connection after exposure to the various *Latina SciGirls* interventions. This was the only statistically significant composite indicator program impact in aggregate.   Emotional connection is an important component of STEM-related identity development, and one that is often a challenge to impact positively in formal education settings. The informal education programs examined here seem to have performed rather well in this regard.

Additionally, younger girls in particular (4th and 5th grade, representing 9-11 age levels) reported significantly higher rates of both emotional connection and personal relevance *to STEM* after participating in a *Latina SciGirls* program. Older participants in aggregate showed statistically significantly less interest in mathematics careers after experiencing the programs. Results are taken with caution due to small sample sizes and the fact that for each finding, effects sizes were relatively small, indicating the magnitude of both positive and negative impacts was small.

Especially compelling however were the results examining the predictive value of parent STEM-related attributes to participant scores at baseline, yielding three significant results:

- Parents with a greater emotional connection to science related positively with their child's emotional connection to science prior to the intervention (multiple regression; $p < 0.05$).
- Parents with greater interest (or involvement) in engineering careers related positively with their child's interest in engineering careers prior to the intervention (multiple regression; $p < 0.05$).
- Parents in a science-related profession were more likely to have a child interested in a science career prior to the intervention (multiple regression; $p < 0.05$)

Importantly, these findings provide an evidentiary basis for the predictive value of STEM-related identity constructs in explaining child STEM-related identity using parent STEM-related identity, not seen before.

However, findings also suggest that parent careers and STEM-related identity did not play a mediating role in the effectiveness of the program experiences in terms of enhancing participant STEM-related identity *during* the program implementation. Taken together, these data may prove to be a valuable for programs seeking to more intentionally integrate parents into informal STEM learning experiences in that parent STEM-related identity is indeed related to their child's STEM-related identity, but it remains to be seen how best to utilize this in informal learning design.

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Site-by-site comparisons revealed that four programs in particular outperformed others in terms of STEM-related identity development gains on certain composite indicators for girls, as follows:

- Puerto Rico excelled with significant results for girls' interest in potential careers in careers in all four STEM categories (Science, Technology, Engineering, and Math)
- Children's Science Center showed large gains in enjoyment of science, and career interest in science
- Girls Inc of Orange County showed gains in emotional connection to science
- McMath showed gains in emotional connection to science and career interests in science, technology, and engineering

Note that these findings are based on the sites providing 10 or more paired pre-post sample responses per site.

Finally, there are some negative indicators that despite intentional programming efforts (as described by program leaders) to be personally relevant to participants, ensure participants use solid evidence to support claims in their exploration of STEM content, and those sites having greater contact hours, participant emotional connection to STEM and technology career interest (respectively) seemed to decrease. However, sample size issues, lack of expected patterning, and fidelity of implementation across sites all serve to cast these results into doubt.

An exploration of how sites different in their programmatic design and delivery in greater detail is the subject of the qualitative research presented below.

Qualitative Research
_____

Case Study Methods

The team used site-based case studies to investigate participation impacts on girls' STEM-related identity development (LeCompte & Preissle, 1993; LeCompte & Schensul, 1999). The bounded system for this study was girls' participation in the Latina SciGirls program through one of three sites participating in the case study research. These three sites constituted a convenience sample based on site ability to participate, families' willingness to participate, and opportunities to visit sites at appropriate times. Note that four sites were originally included in the case study effort, but one did not complete the *Latina SciGirls* project.

These program sites each conducted informal STEM learning programs varying in type, content, size, duration, and other factors, as described below. Although the term "intervention" is used here to refer to each site's *Latina SciGirls* supported program, it should be noted that there was no specific curriculum, activity, or design expected of the sites by project leaders.   Rather, they used their own discretion on whether and how to implement SciGirls-related program elements, as noted above in the quantitative section of the study.

Case study data sources included:

- In-situ observations;
- Participant pre-post guided individual interviews;
- Parent pre-post guided individual interviews;
- Focus group interviews, including participant-generated identity indicators via identity card-sorts.

Note that site visits and interviews were conducted in Spanish and English by a Spanish-speaking member of the research team.

For data analysis, the design described by Stake (1995) was applied to formulate a detailed description of each case. This included site and program descriptions, significant events, participant interpretations and quotations, researcher interpretations, and utilized a coding process (described below) to identify themes based both on the research questions and the theoretical framework of the study. All products were reviewed by multiple researchers in isolation and collaboration during analysis and interpretation phases.

For coding, the team used thematic analysis techniques based upon identity theory and the theoretical framework, including coding for identity-related cognition and behavioral indicators:

- Agency (one's beliefs about their STEM performance/competence);
- Reflected self-appraisals (perceived recognition they receive from others in the context of STEM), and;
- Personal interest in STEM (including content confidence, emotional connection, personal relevance).
- Capacity (to engage in STEM);
- Understanding of STEM concepts;
- Attitudes and self-efficacy regarding STEM, and;

- Choices or future aspirations related to STEM.

Pseudonyms were employed for all participants, parents, program leaders and educators, and other people mentioned.

Finally, it should be noted that this study was NOT program-centric; it was NOT intended to be a direct assessment of the *Latina SciGirls* program-related materials, activities, educator training, or other resources. Rather, it was participant-centric; seeking to explore participant identity development in the presence of *Latina SciGirls* related influences in their program experiences.

Case Study: Universidad de Puerto Rico Campus Verde

Program Description

Title: EcoChicas! Usando "STEM" para entender, estudiar y preparanos para desastres naturales (using STEM to understand, study, and prepare for natural disasters)

Type: Summer camp

Duration: 4 days (20 contact hours)

Size: 14 girls, ages 8 to 13, from urban, suburban, and rural areas. 5 girls and mothers participated in the case study.

Setting: EcoSolar House, University of Puerto Rico-Mayaguez campus

Content Focus: Sustainability
This program took place in the shadow of Hurricane Maria, which struck Puerto Rico on Sept. 20th, 2017 and became the island's worst natural disaster on record. The context for the EcoChicas program was therefore steeped in the struggle to recover, rebuild, and revive their home. The program's specific content focus of sustainability took many forms:

We chose topics relevant to how STEM can help us prepare better for hurricanes and extreme events. Since we have just gone thru the Hurricane Maria experience, we thought that would be of interest to most and serve as motivation. We included, building solar energy circuits, bridge building, birds watching (and looking at how different from before the hurricane, visited same place we had 2 yrs ago to count species) , same with trees (visited the TARS Tropical Agricultural Research Station) , clouds, meteorology (weather forecast instruments) , green chemistry , science in the kitchen, hydroponics, and vermicompost.

Project Leader,
Quoted from Latina SciGirls Evaluation

Leadership: The camp was led by a Ph.D. scientist with educational experience and expertise, along with support staff and a set of 4 guest scientists and experts who presented and/or facilitated camp activities.

Educational Activities Included: Construction of bridges with toothpicks and gummy bears, the development of electric solar circuits, visits to the Planetarium and Observatory of UPRM, the Tropical Agriculture Station (TARS), and even lessons on how dance salsa.

Students saw and learned from role models about what the meteorological radars are, clouds, they visited the Park of the Próceres in Mayagüez to determine the effect of Hurricane Maria on the birds and on the trees. They focused on the use of renewable energy, hurricane monitoring, managing hydroponics and learning to eat without promoting carbon dioxide emissions to curb global warming.

Parent Involvement: While parents where not intended to participate in the program, they were encouraged to stay if they wanted to. ALL parents opted to stay and participate during the entire program (including two dads on the last two days).

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1. Participant Experiences

A. STEM-Related Self-Appraisals, Reflected Self-Appraisals, and STEM Commitment

All the girls in the case studies for this site entered the program with self-appraisals of high STEM-related identity. Consequently, the program experience did not result in dramatic positive changes to the girls' self-perceptions regarding STEM – or any negative changes.

However, at the onset, only two girls reported high reflected self-appraisals for STEM-related identity (their perceptions of how others see them), with three reporting that friends and family would *not* see them as "STEM-people." Post-program, there are strong indications that their reflected self-appraisals changed toward more perceived recognition for their involvement in STEM. Likely this is due to a combination of forming new social bonds within the program and the participation of their mothers (discussed in more detail below).

While no girls reported changes in their perceived abilities to understand or participate in STEM activities after the program, there is ample evidence that the girls' program experience resulted in validation/reinforcement of their interest in STEM and increased resolve to pursue STEM. This too was associated with the social learning aspect of the program:

> *I enjoyed sharing with other girls and figuring things out together in teams.*
> Carmen

> *It was awesome to meet girls who like science too!*
> Natalia

B. Role Models

The topic of role models in the *Latina SciGirls* program broadly requires a clarification of the term. As in our prior associated study (*SciGirls Strategies*), the concept and even the term "role model" was unfamiliar to most girls, who were often confused when asked the question, "please describe your interactions with the program's role models," as seen in this example response:

> *I don't know, what is a role model? Like a super model?*
> Camilla

However, when recognized as influencers, heroes, visiting scientists, on-video characters, or even simply as special guests visiting the program on certain days, we gain insights as to how the girls perceived who project leaders *intended* as role models. Indications are that this is more than just a semantic difference, suggesting that the monolithic concept of "role model" is inadequate to describe the program experience of girls and the potential impacts of these influencers in more nuanced ways (discussed in more detail in the Cross-Case Analysis).

For the Puerto Rico site, despite the frequent and integrated use of *SciGirls* videos portraying intended role models, all of the girls' case study responses referred to in-person interactions with adult STEM professionals and college STEM students. This may indicate the in-person interactions with intended role models were more impactful and/or that video based intended role models were simply not recognized as such by the girls. However, all the girls responded very positively to these in-person interactions:

> *I loved meeting other scientists (role models), they were inspiring and I learned a lot from them.*
>
> Isabel

> *I liked the engineering students coming to talk to us and share their journey with us.*
>
> Carmen

Two themes emerged among participants regarding role models. The first, and particularly notable was the positive impact of **sharing life stories** that in particular portrayed the intended role model's successful **integration of STEM within their gender identities** and the broader experiences of living. For example:

> *I loved to learn more about the Doctors that shared their lives. It was inspiring to all of us girls who want to be in STEM. I can be one of them because I love science. I love that [Mary] does so many things. At her age I'd like to be able to do the same, be a scientist, a dancer.*
>
> Lucia

> *[I learned that] ...girls can not only exist to have kids.*
>
> Valeria

> *I think they were great and showed us there are no boundaries like more women studying engineering not only men.*
>
> Natalia

The second theme we have formulated as **"agency-lending,"** as revealed in the girls' appreciation of the hard work and long journey involved in a STEM career trajectory combined with a newly perceived possibility of following those trajectories. Again, this occurred through the intended role models sharing their self-stories:

> *They have worked really hard. I really enjoyed hearing more about how they dreamed of being scientists since they were little girls like me, and they did it. I saw how much all the scientists had to work to learn, I will do the same because I want to be like them.*
>
> Carmen

As seen in this example, the effect of agency-lending, (not to be confused with the financial version of the term), is the idea that 'because I see and/or know someone who is like me doing something that I have not yet done, I develop a sense of agency for the same activity – a sense that I too can do it.'

Agency-lending appears to be based both on: (1) The protégé perceiving a high level of personal similarity with the exemplar and on; (2) The depth of their interaction in terms of contact hours, frequency and/or meaningfulness to the protégé. Both of these components of agency-lending are variants of personal relevancy. In terms of its observable impact, agency-lending may most commonly be described as 'inspiration,' but goes beyond a simple umbrella concept to capture how and why such an impact occurs. Clearly, it is aligned with the most hoped-for outcomes for role-modelling efforts.

Overall, these responses demonstrate the multiple ways that intended role models can impact girls beyond simply modeling STEM jobs or interest in STEM alone. Considering the resonance with the girls on the theme of gender identity integration into STEM careers, the collective impact of their interactions with intended role models was to expand their schemas for whom a STEM professional can be and what a STEM professional does – importantly including life beyond STEM.

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C. Conceptions of Science or STEM

As noted earlier, while the overall quantitative results show no significant change in conceptualizations of science or STEM, there is strong evidence that girls participating in this particular program experienced a broadening of their conceptions of STEM. Importantly, this seemed to be anchored in their conceptions of what and how STEM professionals do their work, as in this example:

After these four amazing days I think science is so wide and it involves so much. I also learned scientists work together not in isolation or only in labs, as I thought.

Lucia

An important factor emerging behind this outcome was the program design relevance to the recovery from hurricane Maria. And it was not limited to the girls, but also extended to mothers who participated in the program:

Science is important in life. After the hurricane I have read and seen on TV that scientists are important. Being here at Latina SciGirls talking about science and helping communities makes me want to be a scientist.

Susan (parent)

D. Participant Program Reflections

Three themes emerged when girls were asked to reflect upon the program overall. First was how much **fun** it was compared to their prior experiences learning STEM in formal education environments:

I loved it so much and don't want it to ever end. Schools should be like this. We learned and had fun.

Carmen

At school my teacher is okay. We read a lot and I would like to do more fun things. I know science is fun but I struggle sometimes. Sometimes is very boring. When I do math at school I like it when there are real life problems I have to solve. [But here] the SciGirls teachers where amazing, I love them and I love the girls and that my mom is with me. They taught us so many amazing things I knew nothing about. I liked it that there were many challenges everyday.

Valeria

Second was the theme of **personal relevance through social engagement**. The program intentionally incorporated topics that the girls were interested in (in everyday life as well as pertaining to hurricane recovery), as seen in these examples:

They taught us about everything from clouds to weather stations and rain gauge and birds and technology and build bridges with gummy bears and satellite, cooking and making lip balms.

Carmen

Hands on is the way to learn. I like it that even in beauty products like the lip gloss is science. I am excited to share with my friends who like fashion.

Valeria

Additionally, the program was delivered in team-based formats; girls often formed small groups to accomplish tasks or explore questions. This combination of personally relevant content with social

learning effectively created opportunities for the girls to forge social bonds that enhanced their experiences:

I learned to see thing under a different lens... I learned to share with my new friends. I learned to ask the other girls what they thought. It was interesting because I said things so that the other girls knew I was brave and not shy.

Isabel

This week I learned that it really is great to work with teams with other girls. I am shy but now I'm less shy.

Valeria

I am sad that LSG is over. I am sad. I wish it was another week at least. I am going to miss my new friends.

Valeria

The third theme emerged regarding **parent involvement** and the impacts the girls perceived in the program because of the presence of parents. It was overwhelmingly positive:

I was very scared at the beginning. There were too many girls I did not know but I ended up making new friends. Have my mom here was better.

Carmen

I liked that my uncle came one day to learn with me and support me.

Isabel

[PRE]: I hope they will be fun. I'm a little scared. I'm glad my mom is with me. I hope to learn a lot and make new friends. It's very exciting. It's scary.

[POST]: They taught STEM in a super fun way, I wanted to learn more. I was excited to come everyday. I'm sad it's over.

Valeria

Having my mom here was bonding. Although were at Girl Scouts together we bonded more this time, side by side. We came home everyday sharing with my dad about what we learned.

Natalia

This sense of value and bonding through parent-child engagement is also reflected in the parent responses, described in the next section.

Overall, among participants there were very few criticisms of the design or delivery of the program. There was only one indication of a negative experience, in which one girl felt overly challenged by some of the math included.

2. Parent Experiences

As noted above, parent engagement was optional in the program, however all mothers chose to participate. Two men, one father and one uncle, also participated near the end of the program.

This cohort of parents included one mother who was a STEM professional (an engineer) and the rest who were not. Four of the parents reported high STEM-related identity indicators prior to the program, with one of these being married to a chemist and the other a lawyer who had some professional STEM engagement. Only one reported a neutral STEM-related identity.

Parents not only supported their daughters' experiences of the program, but also reported gains in their own STEM-related learning and, in some cases, STEM-related identity development. Their perceptions of the value of the program emerged in the following ways:

A. Relevance of STEM to the Community

This theme most often occurred as the realization of STEM or science being used to make the world a better place – something highly tangible in the hurricane recovery context of the program.

> *[It was important] to know that STEM careers and scientists work on issues that impact the community. … I learned that engineering is about community and solutions. I like that. I think science definitely contributes to better our world. … It makes me hopeful for the future and today. I learned how important is science when supporting our community bounce back from a hurricane impact before and after. I had not made that connection.*
>
> Paula

> *STEM professionals are needed to advance society and heal communities like Puerto Rico. … Now I understand the value of the scientific process and how important it is to know how to solve real life environmental problems. I think that hurricane Maria was a blessing in disguise.*
>
> Nicole

Another element of this theme was the realization of how ubiquitous STEM actually is in the different areas of life and the inspiring effect that realization had on parents, as noted here:

> *I wish every teacher did a course like this one and learned how to effectively show students that science is not inside a lab but everywhere, in our homes and mostly, in what we do.*
>
> Julia

> *I did not expect to learn anything at all. I thought only my daughter would learn and I would just be there but I learned so much. I wish I had a similar experience growing up. I loved it. … I felt empowered and realized that regardless of any level of education we are a community and we are all a part of STEM.*
>
> Zoe

> *After this week I see STEM differently. While technology is a challenge because I reject it in so many ways as not to become addicted to it, as most people do. I now understand that it is also essential in the advancement of STEM discoveries and community.*
>
> Julia

Together, these indicators demonstrate fairly dramatic positive gains for parents in establishing much greater personal relevance of STEM (as presented in the program) in their own lives. This

reflects similar program impacts on their daughters as well, but also includes an air of surprise on the part of parents. In most cases it appears they were not expecting to learn as much in the program as their daughters did, if anything at all. Evidence indicates they did in fact learn new things and that the program served to link STEM with the positive messages of community, empowerment and hope, as they reported.

B. Role Models

The parents actually had quite a bit to say about the intended role models presented in the program. It was clear that the concept of role models was not nearly as unfamiliar to the mothers as it was to their daughters. And yet, we continued to see a plurality of impacts from these interactions beyond the mere exemplification of STEM roles and occupations.

The program successfully presented the intended role models as "whole persons" in keeping with *ScGirls r*ecommendations. The effects were varied, entirely positive, and included three themes. The first was **accessibility**:

> *We all had the honor of meeting all these scientists and learning about how they made it to become scientists with their family support. ... I loved how down to earth they all where. Very approachable and humble. The girls connected and so did the moms, and me.*
>
> Paula

> *Involving other scientists to talk about their specialty was incredible. It was inspiring, to learn from each of them. Each shared about its area of expertise.*
>
> Zoe

The second role model theme was **agency-lending** for daughters and their mothers alike:

> *I now see it possible for me to finish my Masters. I have self-limited myself and am now inspired and determined to finish. I told [my daughter] this. I will no longer feel frustrated. I want to be a role model [my daughter] and my son. Being a woman is not only about being beautiful.*
>
> Nicole

> *All the role models were an example to the girls. They walk the talk. They all demonstrated that we can all become professionals like them. They also showed respect to the moms who were not professionals like them. ... I would [now, post program] add ... and all the scientists and you [the LSG researcher] to my list of role models. You inspired [my daughter] and me so much. You're all down-to-Earth and kind women professionals.*
>
> Abril

> *It was great that they [participating girls] saw they can do it all, be an engineer and a singer too. Not one or the other. [My daughter] now wants to be a scientist and a painter. She loves art.*
>
> Paula

The third theme was the appreciation for the **journey to a STEM career** – complete with struggles against sexism, challenges of life balance, and the importance of family support:

> *They were all women and they all conveyed and shared their journey since childhood. They all struggled with being women and still wanting a family. Most had very supporting spouses but that's not always the case. They all have happy children, spouses and are accomplished professionals*

wanting more. I was about to cry when I heard their individual presentations and how they made it. To hear them say it takes a village because it's easy to say 'Su Se Puede,' but you need support and community. They were all so sweet to the girls and were able to share their love and passion for what they do. These were real interactions.

Julia

[We saw that] not only men are to become scientists. Inspiring girls included in STEM was very powerful.

Paula

These themes demonstrate a successful integration of role models into the program experiences for parents.

C. Parent Involvement

Like the emergent theme for the involvement of parents with the girls, their mothers reported significant positive impacts for the inclusion of parents with their daughters in the program – if not more so.   These impacts included the value of **parent-child engagement**:

It was great to bond with my daughter making sustainable cosmetics and taking about sustainable living. We are making plans. My daughter wants to make a business out of the lip balm. She is now super excited! I love that. I am excited because she usually is very shy. She struggles making new friends. This program gave her wings. Valeria felt empowered and happy. She left making plans and wanting to know more. I enjoyed seeing her talking with others and presenting out to the group about what she's learned.

Nicole

This is the first time I go to a camp with my daughter. I was against it at first but I enjoyed it so very much, So interesting. Both parents and girls learned so much. … I usually pay for her to have an experience but having the opportunity to do this together, to know about this program, was amazing. I'm beyond grateful. Thank you!

Zoe

The dynamic mother / daughter was special. I don't think the program would have been the same if they had been on their own. Being there and seeing them at work was inspiring and resulted in meaningful conversations. [My daughter] would not stop sharing in the car on our way home and share with dad over dinner.

Abril

I don't have enough words to describe how thankful and appreciative I am for these 4 days. Both my daughter and I learned a lot together while connecting as mother/ daughter. … My daughter and I bonded so much this week. I never thought this would happen and it was great.

Paula

Parent involvement impacts also included **parent-to-parent engagement** and the formation of a sense of **parent community** around the program:

… as a mom I enjoyed meeting other moms that even live very close to me and we are already planning on pursuing other experiences together.

Paula

The environment was great. No one wanted to leave. The community was strong, [my daughter] had never said she wanted to be a scientist and for the first time she said, "I am now going to be a scientist and a chef." She now asks when next program will be.

Zoe

I liked how all moms connected, now we have a WhatsApp group and are already sharing about what we learned and what comes next. And maybe start projects together.

Nicole

… what I appreciated the most, aside of the amazing agenda and experiences, was that it was an all-women week. Women and girls of all ages learning and enjoying together. Everyone involved contributed a great deal. It was magical.

Abril

There is also evidence that the program successfully generated powerful social learning experiences for all involved, rather than strictly educator-led, stand-and-deliver modes, as exemplified here:

Not only [program leader] and the other leaders taught us. Our daughters and other mothers were also teachers.

Zoe

Aside from a strong appreciation for this element of the program, these responses also reflect one of the unique values of informal and non-formal learning experiences – that of cooperative family participation. These kinds of cross-family interactions are more possible within informal learning scenarios and, as indicated, often do not need to be explicitly designed for in order to occur (recall that parent involvement here was optional and not expected).

Additionally, there was some possibility that the community-bonds may continue into the future beyond the time of the program, as indicated by the formation of the parent group in WhatsApp to keep them all in contact. Again, this is a sign of a powerful experience for parents as well as their daughters.

D. Parent Program Reflections

Finally, parents were asked to reflect on the overall program design and implementation. Here again the responses were overwhelmingly positive and reflect many of the earlier findings.

I loved the program leaders presentations about their lives. No one told Isabel what to do. No one had an agenda. No one helped them figure it out. The girls worked together regardless. At some point Isabel asked [program leader] for an answer and she said: 'go ask your group and other girls to see what they think.' Isabel asked all other girls from that moment until the end of the program and together found the answers.

Zoe

Spectacular. Fun for both girls and daughters. I felt like a girl again. … They were prepared and designed curricula that were varied, hands on, challenging and integrated many people, students,

dancers, even TV interview. They knew what they were doing and knew how to teach young girls and old moms at the same time -- now that's not easy but you guys made it so much fun.

Abril

Several parents noted the kinds of interactions the girls and parents had with both the program leaders and the intended role models, as well as the setting of the interactions:

Learning in a home setting like the EcoHouse showed me that I can do the same at home. Solar energy, water consumption and ingredients and products we choose.

Julia

They leveled with the girls. They acted like girls. Sometimes when people are high intellectual level forget to talk kids' language. They all were able to use right language all could understand.

Abril

Everything was wonderfully done, performed. They were very organized and savvy. They all have PhDs and were very accessible to the girls and moms. The role model presentation were inspiring. An example to follow. Girls were able to identify with them.

Elena

Program criticisms reported by parents were rare. The few that emerged had mainly to do with the program pace and volume of content:

It felt very busy at times with no time for transitions, talks, snacks or mindfulness. I call it inhalation and exhalation. You take in and then you need to exhale and rest. To my daughter and I, it's important to pause and we came home pretty tired but mostly overwhelmed by the many things we did and learned.

Julia

However, even among those reporting criticisms, the overall value of the program prevailed, as seen in the following "take-home" messages that parents left with:

I thought STEM was more exact but was able to see another angle. Now I was able to see that it's all connected. For example, I used to see Math as Math but now I understand its part of many things and its connected to other things. I can now best support my daughters.

Julia

… That us women can do anything. I've taught this to my older daughters. But I've never seen a program that empowers women in such way. Aside of me empowering them, never seen it before.

Zoe

It's been a very enriching week for both moms and daughters. A time to pause to think about our impact on our planet. Understand that we are not separate from the planet.

Nicole

She [my daughter] said, "Mom, I am so happy. I want to make plans for my future." She internalized everything. Her self-esteem is stronger now.

Paula

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3. Summary and Researchers' Notes

Case study analysis of the Puerto Rico program revealed a highly intentional program design around disaster recovery based on the community's efforts to recover from Hurricane Maria. The design served to enhance the personal relevance of the program content for all participants. This, combined with highly engaging interactions with Latina STEM role models and meaningful involvement of parents (mostly mothers) helped to generate the gains observed.

Our on-site researcher observed several key contributors to the program's success:

- Strong positive relationships among staff, between participants and an abiding sense of trust and satisfaction for the program experience overall.

- Rich content-based activities that were fun and very well presented by PhD women/professionals as experts in different fields. A constructivist approach allowed students to integrate prior learning into subsequent activities. Several "challenges" were part of each day's agenda, sparking lots of interest, engagement and inquiries from the girls.

- Use of small-group activity-based learning and content delivery strategies that were well connected to the main focus of the program (natural disasters).

- Spanish language program delivery but with leaders who were all bilingual (many obtained their Doctoral degrees at a US University and all shared this educational experience and the importance of being bilingual).

- Effective program leadership from skilled professionals and experts in different fields. They provided high quality activities and developed strong relationships with the participants and their mothers.

- The program setting was highly engaging, with activities held both at Casa Eco-Solar, University classrooms, the Planetarium and lots of time out in nature.

- Family Engagement was crucial, with mothers fully engaged from day one. During pre-interviews it became evident that many had been waiting for the program to start and felt very special in having been selected for this program and opportunity – generating high levels of commitment and excitement. Several families had travelled from San Juan and where staying at a local hotel for the week in order to allow and support their girls in taking part of this opportunity and experience.

- Challenges of the program included the continual need to build and maintain program partnerships (in the community and the beyond), constant pursuit of funding through federal and local grants, and an inability to ensure the program's sustainability into the future, due to limited financial support.

Case Study: Cameron Park Zoo, Waco TX

Program Description

This camp was reported by its leaders to be designed especially for Latina girls between the ages of 8-13 who were interested in exploring the world around them and discovering that science and technology are everywhere. This camp was free of charge.

Type: Summer camp

Duration: 5 days (35 contact hours)

Size: 15 Latinas ages 8 to 13, from urban, suburban, and rural areas. 6 girls and their parents participated in the case study.

Setting: Cameron Park Zoo

Content Focus: Animals and STEM

Leadership: Program facilitators included the zoo's education coordinator and 3 volunteer staff (2 high school seniors and one college student). Note that none of the facilitators spoke Spanish and no intercultural strategies were used (e.g. bilingual program descriptions, materials, instructions, etc.). Each of the participating girls in the study spoke English, however not all of their parents spoke English or spoke English well.

Educational Activities Included: This program included SciGirls videos, visiting zoo exhibits, planning exhibit designs, bird-watching techniques, pelican feeding, wetland and nature walks, environmental water cycle content, and visiting and identifying African animals at the zoo.

Parent Involvement: Parent involvement was not a program feature. Parents were not invited nor expected to participate. Rather it was a "drop-off and pick-up" situation, with little or no parent-staff interaction. On the last day of the camp parents interacted with staff briefly.

1. Participant Experiences

A. STEM-Related Self-Appraisals, Reflected Self-Appraisals, and STEM Commitment

Four of the girls in the case studies for this site entered the program with self-appraisals of high STEM-related identity. One reported a more moderate but still positive STEM-related self-appraisal. Correspondingly there were no dramatic positive changes to the girls' self-perceptions regarding STEM.

Likewise, four of the girls reported high reflected self-appraisals for STEM-related identity (their perceptions of how others see them), with the same girl who reported a moderate positive STEM-related self-appraisal also reporting that others in her life would *not* recognize her as a "STEM-person."

While there was no direct evident growth in STEM-related self-appraisals or reflected self-appraisals for the participants, there was evidence from several girls that their existing STEM-related identities were validated and/or encouraged, as in this example:

I feel amazing and smart. Feeling that I'm good at something makes me feel that I want to continue to learn and thrive.

Clara
(post interview)

There was also evidence that the girls' appreciation of, and commitment to, STEM were both somewhat enhanced. One girl reported her time spent doing STEM-related things every week (outside of camp activities) increased along with intentions to keep it that way.

While no girls reported pre-post changes in their perceived abilities to understand or participate in STEM activities, all the case study participants reported having positive experiences during the program that reinforced their interest in STEM and that the program succeeded in making STEM fun. Importantly however, most of this was in reference to interacting with the animals at the zoo and with each other, more often than through the program's educational activities or exposure to staff or intended role models.

It was mostly about interacting with animals and birds. We touched them, fed them including fish. We touched snakes -that was scary but fun. … I had never touched a snake or a gigantic turtle, I loved that.

Julieta

B. Role Models

Once again, the predominant issue regarding role models was that the concept and even the term "role model" was unfamiliar to most girls at this site. In trying to conjure role models "on-the-spot" during an interview in response to the question of whom their role models were, one girl claimed:

I don't have one. My family?

Emily

Another girl preferred to list personal qualities she admired rather than identify people she emulated or looked up to. These qualities included honesty and genuineness.

Only one girl was ready for the question a-priori with a prepared response:

My dad and my mom are very curious like me, or better to say I'm like them. We love to explore and learn over the weekends. They are always getting me books from the library and we enjoy them together. I have the best parents in the world.

Clara

Other girls assumed the role model interview questions referred specifically to the program leaders, and so their responses revolved around them:

They were fun and young so it was cool, nice.

Rebeca

We met a woman scientist that used to work at the zoo. She showed us how she feeds the animals.

Ana

Although positive, these notions of role modelling perhaps fall short of the idealized or desired image of a STEM role model and certainly indicate a lack of effective intentional role modeling efforts within the program. No participant walked away from the program reporting the acquisition of new STEM role models or explicit role modelling experiences, whether with in-person or video-based intended role models.

In light of these responses overall, aside from the known difficulties with the concept of role models, it was clear that most of the girls' initial positive STEM-related identities were not linked to role models or STEM-related personal influencers. The exception of course was Clara, who not only identified that her parents were her role models, but also was able to say precisely why, in terms of exploration and learning – certainly STEM-supporting attributes.

There was only one response indicating the impact of a designed program exposure to a role model depicting career trajectory in the form of one of the program leaders:

I enjoyed seeing how [camp leader] loves her job and how she got to work here. She let us know about stories of the animals and let us touch many of them, feed them and know more what their lives are like.

Emily

But generally missing from this case is evidence of the benefits of intentional role modeling designed into the program (e.g. motivation, agency-lending, inspiration). Therefore, the central role modelling theme at this site was a **lack of effective role modelling experiences for the participants.** This may help explain why there was little or no change in the girls' self-perceptions or STEM learning as a result of program participation.

Notably, the program did include the daily use of *SciGirls* videos, which were produced in part for the purposes of role modeling, but the girls did not identify any of the people in these videos as perceived STEM role models.

Videos were usually presented to the participants between activities and displayed on a small screen outside -- not in a classroom setting. As observed by our researcher, this made it challenging for the participants as it was very hot outdoors and listening to the videos was challenging due to ambient noise. Additionally, there was very little prior framing or debriefing to contextualize how any given video was relevant to the program or to participants.

C. Conceptions of Science or STEM

As noted earlier, there was little or no evidence of gains in the girls' perceived abilities to understand or participate in STEM learning. However, there was evidence that they experienced a validation of their appreciation, commitment, and general interest in STEM as a result of the program.

For at least one participant, the program resulted in a deepening of her appreciation for dealing with more difficult concepts in STEM learning:

I know some things take time and I need to be patient and ask my teachers when I don't understand something.

Clara

In another example, the zoo became a newly recognized additional STEM resource to share with others:

> *I like to go out to find things in nature. I'll start coming to the zoo more often. I want to bring my grandparents and show them and tell them about all the animals including their names.*
>
> Danna

One participant did in fact mention one of the program's activities, but the example also highlights the emphasis on simple exposure to the zoo animals and their care:

> *I liked when we tried to represent the birds' different beaks and try to eat different food. We had fun. I liked it when we fed the pelicans. They went crazy. It was funny but it smelled very bad and I wanted to go. We also saw the rhinos, the tigers, the snakes and a couple of monkeys.*
>
> Rebeca

Finally, one participant reported an aspirational outcome of the camp in the form of a potential career trajectory – certainly a positive effect:

> *I would like to work with animals, maybe here at the zoo.*
>
> Emily

Overall, however, the central theme here is that there seems to be **very little program impact on the growth of girls' perceptions of science or STEM**, aside from the obvious animal attraction of the animals and simple observations or feeding.

D. Participant Program Reflections

Two themes emerged from participants when asked to reflect on the camp experiences. The first and predominant theme was **personal relevance through their interactions with animals**. Comments on the animals permeated nearly all the responses to interview questions. This was coupled with how much fun the camp was because of their interactions with animals.

> *They (zoo keepers) all love them so much that all animals have their own name. We learned all about most animals. We touched some of them and learned about the things they like and not. I liked everything. Everything was different. But I think I liked the snakes because I had never seen them so close and touched them.*
>
> Danna

But these interactions also evoked other emotions as well:

> *[I appreciated] how the zoo staff worked to make it safe and happy environment for the animals. Sometimes I feel sad for the animals that they have to live behind bars.*
>
> Ana

Clearly, the animals had a powerful impact on the girls and were rightfully the centerpiece of the camp content and activities.

The second theme emerging upon reflection of the camp by participants was **personal relevance through social engagement**.

It was fun to meet and hang out with new friends.

Emily

I spent lots of time with my sister. We enjoyed making new friends.

Ana

By design, all program activities were conducted with all participants in one big group, as opposed to the girls experiencing smaller group-based learning. And yet, our researcher observed impactful small-group social learning and bonding nevertheless. The occurrence of these interactions were unstructured and occurred during down times when the girls self-selected into small groups and had informal conversations.

Despite not being an intended or designed-for part of the program, these opportunities for social learning within small groups were prominent in the girls' descriptions of the program. Combined with personally interesting and relevant content (interactions with animals in this case), the girls forged meaningful social bonds that enhanced their experiences:

I feel amazing and happy whenever I am learning with other girls.

Clara

Finally, among participants overall, there were very few criticisms of the design or delivery of the program. Those that did arise were centered on boredom at certain points of the program (discussed further in the researcher notes section below).

We were running out of things to do [towards the end].

Ana

This observation was coincident with portions of the camp that did not involve the animals directly and/or seemed to occur when the novelty of interacting with new animals wore off.

2. Parent Experiences

For this site, parent involvement was not part of the program design. Parents dropped off their girls in the morning and picked them up in the afternoons at roughly the same times as their normal school schedules (9:00 AM to 4:00 PM). Therefore, in our interviews and focus groups, parents mainly talked about their daughters' camp experiences secondhand, providing another lens on the impacts of the program as detected by parents and their conversations with their children at the end each day.

This cohort of parents included one who was a STEM professional (in the tech industry) and consequently reported high STEM-related identity indicators. Two others reported low and one reported moderate STEM-related identity indicators.

The parents universally supported their daughters' experiences of the program, regardless of their own relationship to STEM, and were in general very pleased with outcomes for the girls. Their perceptions of the value of the program emerged in the following ways:

A. Impact of Animal-Participant Interactions

This theme was pervasive across all parent responses and appeared to be the dominant outcome as well as the dominant expectation for the camp for the girls and their parents alike – fitting for a zoo-based program.

This camp provided our daughters an unmatchable opportunity to see animals that only someone who's ventured in the wilderness would see.

Dylan

[My daughter's favorite part of the experience...] Rhino feeding interaction. She could not believe how friendly looking they are but not in reality are dangerous animals. Seeing big cats and learning about adaptation. She could not believe turtles could grow so big and live to be over 100 years old!

Lucas

She learned about snakes, fish, birds, insects, big cats, mammals and there habitats. She was particularly touched by the gigantic turtles.

Ian

In one case, the parent of two sisters in the program observed a nuance to the interest in animals regarding their humane treatment:

They loved feeding and touching the animals and appreciated knowing that all the animals at the zoo were descendants of other zoo animals, unless they had been found injured or orphaned in the wild, and leaving them would mean their death. They felt closer to all animals after learning this. They were not so sure about a camp at the zoo because of that.

Dylan

Clearly, the interactions with the animals provided memorable learning experiences for the girls on multiple levels in terms of excitement, novelty, discovery, and empathy. The repeated emphasis on the animals from both participants and their parents suggests this was the central element establishing a sense of personal relevancy for the girls.

B. Role Models

The parents' comments on role models in the program and their impact on the girls parallels the girls' responses to a great extent. While the parents did not have the same difficulty with the concept of role modeling as the girls did, it was clear from the parents' responses that the program lacked intentional role modeling in its design.

When asked how the program included role models and the effect on their daughters, some examples included:

She did not say anything about that.

Lucas

I don't know if there were role models.

Dylan

> *Clara says they met a scientist but they did not get much time to interact.*
>
> Ian

The program did, however, make a concerted effort to include *SciGirls* videos within their daily routine, which were produced with role modeling in mind. Unfortunately, this effort was apparently ineffective in either presenting effective role models and/or engaging the participants overall. Responses suggest this may have been due to the manner in which the videos were used:

> *They projected videos outdoors, which were hard to follow due to the small screen and heat. This could be an activity that could be held in this conference room for example.*
>
> Ian

> *It was hard for her [my daughter] to understand and follow videos presented.*
>
> Lucas

Despite these relatively negative results in terms of intentional role modeling in the program, one shining example was reported by a dad that indicated the most positive outcome role modeling efforts could hope for – inspiration:

> *She left inspired and determined to become a zookeeper and feed and care for all animals. … I enjoyed seeing my daughter enjoy.*
>
> Lucas

This positive result suggests a degree of successful agency lending. However, due to the lack of evidence of intentional role modeling in the overall program design, this outcome seems to be an outlier.

Finally, it is worth including another father's thoughts on role modeling relevant to this program. This is the reason he gave for sending his daughter to this experience and others like it whenever he can:

> *When I was young I struggle due to language but I was top of my class. When I grew up we were taught that girls were housewives and should stay home. I don't believe in that. I will support my daughter to become a professional and independent. My wife is a role model on that.*
>
> Ian

C. Parent Program Reflections

Commensurate with the above findings in the participant experiences, two themes emerged from parents upon overall program reflection. The first was **general satisfaction** with the experience for their daughters, exemplified in this quote:

> *I like daughter spending a week here at the zoo learning all she can about animals, is important that she learns to have empathy towards them, all of them, big and small. She likes animals.*
>
> Ian

> *Danna and Rebeca came home with lots of things to share. They were happy and excited everyday. One way we measure if our girls like something is the fact that they wanted to come everyday.*
>
> Dylan

The second theme was **personal relevance through social engagement**. Aside from the animals, the girls and their parents frequently brought up the value of new friends and the social aspects of learning STEM together.

Her favorite part was talking, sharing and interacting with new friends. We found out that one of her new friends lives close to us. We already met her parents and we will put intention in furthering STEM experiences for both girls.

Ian

My daughter made new friends she want to stay in touch with.

Ashley

They made new friends and although both are very shy they got excited.

Dylan

The parents also reported some critiques of the program. Several had concerns with the presentation and setting of the program elements:

[The girls were] asked to watch videos on a small screen out in the heat.

Dylan

I have made the suggestion that next summer the zoo consider having more learning indoors as it's very hot here in the summer and Clara felt dizzy at times due to the heat. No need to have the girls out in the heat all day. It's not safe.

Ian

And one parent commented on the lack of bilingualism at this program and the need for more bilingual STEM programming in the community overall:

…small towns like WACO would highly benefit from having more STEM programs at local schools. These programs need to be bilingual as many families are not. We continue to see more migrant families moving into the region.

Ian

3. Summary and Researchers' Notes

Case study analysis of the Cameron Park Zoo program in Waco, Texas revealed a somewhat successful program in terms of STEM engagement, while not as effective in terms of STEM-related identity development. As one might expect, the animals were the most salient and impactful component in this zoo-based camp experience. While close-up participant-animal interaction was certainly perceived as the highlight of the camp by the girls, in some ways its predominance seems to have overshadowed other aspects of the camp and/or camp leaders' attention to those other aspects.

This was evident in the lack of effective intentional role modelling and lack of participant STEM concept enhancement, for example.

On the positive side, the camp succeeded in making STEM fun, validating girls' pre-existing STEM interest and commitment, and providing personal relevance of STEM learning through both animal-participant interactions and social engagement among the girls.

Our on-site researcher observed several key contributors to the program's outcomes:

- There were positive relationships with obvious bonding between participants. Most girls made new friends. However, there was very little bonding of participants with program leaders and facilitators.

- Aside of interacting with animals (a significant positive element of the camp), most hands-on STEM learning activities seemed of little interest to participants. Several students who had attended the year before indicated they were the same activities as the previous year.

- Learning activities and STEM content delivery strategies fluctuated between highly engaging animal interactions (interacting with animals, feeding them, touching many of them and also, learning about their origin and stories) and participant fatigue and boredom. Hot weather contributed to participants feeling unfocused, thirsty and tired.

- The program leader was well prepared and solely responsible for most of the educational interactions. Two zoo professionals also facilitated a couple of short activities. However, it seemed volunteers helping to lead the program lacked preparation and background information. Two were seniors in high school and one a college freshman.

- The program, despite claiming to be customized for Latinas, was held only in English with English-only leaders and materials, apart from the Spanish language *SciGirls* videos.

On this final point regarding language, of special note is an observation related specifically to immigrant families that impacted some of the girls to various degrees. Since the participants in the camp spoke English well, it was not an issue for them that the camp leaders did not speak Spanish. In fact, one Latina participant herself did not speak Spanish:

Yes. I don't speak much Spanish and I need to learn more. It's an obstacle at school and there are kids I can't talk to because they don't speak English so well either, but we manage somehow.
Clara

This example is indicative of the complexity of the immigrant status of families. Here we see a generational divide within immigrant families. Clara was born in Waco. The language barrier for her is reversed from that of her parents, who had to learn English as a second language. For Clara, Spanish is her second language. Speaking mostly English made her more accepted among her Anglo school peers, but also made her feel othered from her own membership in the local Latino community.

For many educational program designers, the common assumption is that Latina and/or immigrant children face ESL barriers in their learning, which is of course indeed a big obstacle. But here we see another common but less-recognized issue – children of Hispanic immigrants who do not themselves speak Spanish. Not only does this potentially create barriers to parent involvement in such programs (and possibly a contributing reason that parent involvement was not part of this program's design), but also explains why some of the Spanish language *SciGirls* videos were ineffective and hard for some participants to understand.

Case Study: Children's Museum of Houston

Program Description

While this program was officially led and staffed by the Children's Museum of Houston, the venue for the experience was within a local school as an afterschool program with several field trips.

Title: SciGirls

Type: Afterschool Program

Duration: Tues & Thurs each week (February to May) for 1 hour each session (20 total contact hours)

Size: 18 girls, grades 6 to 8, from urban middle school, 4 girls and their parents participated in the case study

Setting: School science lab classroom, with field trips to parks, museum, local university

Content Focus: STEM broadly with a focus on making STEM fun, purportedly took girls' preferences into account

Leadership: Mixed across the program depending on the content each week, and included museum staff, a mentor for the water quality project, a research associate in the Cornell lab of ornithology, an undergraduate student and mother, and others.

Educational Activities Included: The program included a mix of activities that involved skill building (e.g. 3D printing, chemistry, caring for the turtle pond, etc.). A combination of structured and unstructured learning opportunities organized by learning clusters and/or activity stations designed to promote participant autonomy (rather than competition), participant choice, and leadership development among participants.

Parent Involvement: No parents were involved until the final day for the share-a-thon event, or '*SciGirls* Family Fiesta.'

1. Participant Experiences

A. STEM-Related Self-Appraisals, Reflected Self-Appraisals, and STEM Commitment

The cohort of girls in the case study for this site included three who entered the program with self-appraisals of high STEM-related identity. One of the girls entered the program with a moderate self-appraisal for STEM-related identity.

Additionally, two girls entered the program with high reflected self-appraisals (their perceptions of how others see them) for STEM-related identity, while one reported low (others would not see me as a "STEM-person") and one with moderate levels of reflected self-appraisals for STEM-related identity (some would see me as a "STEM-person").

For the girls with prior self-appraisals of high STEM-related identity, the experience did not result in dramatic changes to their self-perceptions regarding STEM. However, for the girl with moderate initial self-appraisal for STEM-related identity, the experience enhanced it:

> *This program made me realize that I like science and learning about nature, like when I helped with the turtle pond.*
>
> Josefina

Through the program, Josefina in particular seemed to make the personal discovery that learning about nature was in fact the prime directive of science. When she made this connection, her prior existing interest in nature translated into the realization that she liked science. Her hands-on activities in the turtle pond seemed to be involved in this discovery. Indeed, the turtle pond was mentioned prominently by all of the girls. Their activities with the turtle pond included observations, feeding, and maintaining the turtle pond with dip netting during the City Nature Challenge component of the program.

> *We did many things these months …we did lava lamps, and DNA and visited the University and some labs. We also cleaned up the turtle pond and cleaned the school gardens that needed urgent care.*
>
> Alicia

The three girls reporting high initial self-appraisals for STEM-related identity experienced no changes in their perceived abilities to understand and participate in STEM after the program. However, once again, the girl with moderate initial self-appraisal for STEM-related identity reported an increase in her perceived ability to understand STEM.

Among all the girls, there was ample evidence that the program experience resulted in validation or reinforcement of their existing interest in and/or commitment to STEM, including increased resolve to pursue STEM.

> *I'm an only child and my mom is very proud and supportive that I attend this class. … Last year I got interested in NASA programs and now I'm in this STEM class, I like doing STEM related activities.*
>
> Josefina

> *After Latina SciGirls I am determined to study harder in science. … I want to come back next year and help with the turtle pond. I want to learn more about STEM.*
>
> Amalia

> *I learned lots of cool things about science that I already knew but it was still fun.*
>
> Kiara

> *They taught us about cool things. We chose what we wanted to do most times, messing up in the maker room with the help of [the leaders]. [They] took us on a field trip to the science museum and I really enjoyed that. Going to the museum made me feel a bit anxious because I realized how little I know of everything. I think I need to study harder.*
>
> Amalia

For this cohort, it seems the impacts on their STEM self-appraisals, interest in STEM, and commitment to STEM were universally positive, even where validation and reinforcement of existing positive STEM-related identities, rather than perceived growth, dominated their experiences.

B. Role Models

Once again with this cohort, the concept of role models was not intuitive nor obvious to the girls. However, once explained in terms of influencers in the context of STEM learning, the evidence points to this program having successfully designed STEM role model interactions into the experiences – even if the recognized role models were the program leaders and staff themselves in some instances.

For example, Josefina answered the role model questions quite differently pre-post program:

[Pre – "Who are your role models?"]
I don't have one.

[Post] Meeting some of the scientists and educators at the museum was inspiring. They showed us the museum and did activities with us.
Josefina

Three themes emerged from the participants regarding role models in this case study. The first was the importance of **active engagement with the program's intended role models**. Rather than simply introducing STEM role models, explaining what they do, or even sharing stories about how they think and feel about what they do, several girls indicated excitement and value at actually *working* with the STEM role models on activities during the program:

We met women scientists and [program leader] made sure they were all women. We visited their labs and did activities with them. It was very cool, they looked like they love what they do.
Alicia

[The role models] were great in helping us with the activities we chose. … I decided to learn the 3D printer and did a bracelet! I also did DNA work with a scientist who came to show us and we made pendants. I can carry mine with me. It's so cool!
Josefina

They were awesome. They wanted to teach us many things and they were smart and caring.
Amalia

The second theme that emerged regarding role models was **agency-lending**, similar to that observed at the Puerto Rico site. Once again, we have framed the effect of agency-lending as the development of a sense of agency for a new capacity -- in this case for STEM learning and STEM work. This effect seems due to the protégé perceiving a high level of personal similarity with the role model combined with depth of their interaction in terms of contact hours, frequency and/or meaningfulness to the protégé – hence the importance of experiencing activities in active collaboration with the intended role models.

Therefore, where agency-lending occurred primarily through storytelling at the Puerto Rico site, here we see the effect resulting primarily from working on program activities together, linking this theme with the first one. This was evident in the girls' descriptions of the program's intended role models. When asked about this, the girls often answered in terms of activities they did together combined with perceived similarities and/or aspirations to personal similarities:

I enjoyed working with the chemist. She was shy like me but very smart. Her activities were hands on and fun.

Amalia

In one instance, a participant commented on our *Latina SciGirls* researcher herself as a role model in the program, given her frequent presence and interaction with the girls:

I love [the program leader] and it's been great to meet you [the Latina SciGirls researcher]. You are so inspiring and cool. I'd like to have the confidence you have because I'm super shy.

Alicia

The third role model theme that emerged at this site was the successful **integration of the *SciGirls* videos** within the program. This included the use of the videos for contextualizing what the girls were doing in the program activities and especially for effective role modeling. Leaders used the videos to provide context for the girls on program-specific learning objectives, working within a team, and reflection over the entire learning experience. The videos were also used explicitly as a model for how engagement between adult leaders and participants could play out across all program interactions. In this respect, the videos reinforced a participant-driven experience in which adult leaders facilitated and supported their efforts – which is how the program was intentionally designed.

Unlike the other two sites, several girls mentioned the videos in positive terms. Among the practices that differed regarding the videos, the program leaders here ensured frequent and consistent viewing of *SciGirls* video as an anchor activity throughout the program:

["Please describe how the program introduced you to STEM role models."]
We saw a lot of Latina SciGirls videos. I liked the videos a lot, they were inspiring and fun.

Kiara

Also unlike the other two sites, participants mentioned the importance of seeing girls like themselves in the videos – harkening back to agency-lending once again. For example:

I liked the Latina SciGirls videos. Those were cool. I watch them all the time. I wish there were Spanish videos. I like seeing Latina students that like STEM like me.

Josefina

This example also indicates that the Spanish language *SciGirls* videos were not used or not available to this participant, although they do indeed exist.

It seems clear that while certainly not as impactful as interactions with in-person role models, the *SciGirls* videos were used effectively to present peers engaged in STEM learning. The combination of girls' active engagement with in-person role models on program activities and the *SciGirls* videos appears to have generated agency-lending and demonstrated a potentially useful video integration strategy beyond how the other two sites embedded the SciGirls videos into their programs.

C. Conceptions of Science or STEM
While there was evidence that the participants experienced a validation of their interest and motivation to learn about STEM, there was little evidence that their conceptualizations of science or STEM changed during the program.

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The exception to this was Josefina, who established a new connection between nature and STEM learning. Not only did this personal discovery expand her concept of science, it also enhanced her interest and motivation in STEM.

D. Participant Program Reflections

Two themes emerged when girls were asked to reflect upon the program overall. First was how much **fun** it was.

> *Yes. I learned a lot, it was fun. I wanted to come to class.*
>
> Kiara

> *[What was fun about the program?] They taught us about everything from clouds to weather stations and rain gauges and birds and technology and building bridges with gummy bears and satellite, cooking and making lip balms.*
>
> Carmen

> *Hands on is the way to learn. I like it that even in beauty products like the lip gloss is science. I am excited to share with my friends who like fashion.*
>
> Valeria

The 'fun-factor' was also noted by the parents and the on-site researcher, who recognized **fun** as the predominant element of the program (as discussed below).

Second, once again, was the theme of **personal relevance through social engagement**. Social engagement through friendships in this program was enhanced by the fact that the program was largely delivered in small-group formats with an emphasis on both individual and small-group-based independent work.

> *We work independently and [the program leader] and our two facilitators help us figure out some activities. … It's hard sometimes but I enjoy figuring things out on my own.*
>
> Josefina

As seen in the Puerto Rico site, the combination of personally relevant content with social learning effectively created opportunities for the girls to bond, sometimes with friends they already knew prior to the program and other times with new friends. Both enhanced their experiences:

> *[I liked it …] because I was with my friends doing something good for my future*
>
> Josefina

> *[I liked it …] because it was at my school with my friends and with [project leader, a teacher at the school] and I like it here. …We are a tight group of friends and support each other through thick and thin.*
>
> Alicia

> *I learned about chemistry and made new friends. We worked together. It's fun to learn with friends. We visited labs and the university and met chemists and engineers. … My friends were important to me. I like to learn with my friends and to talk about what we learned.*
>
> Amalia

> *[I loved ...] that I made new friends and we hang out together learning and doing STEM activities. ...*
> *jitterbug with a CD, a LAVA lamp and a DNA necklace.*
>
> Kiara

Worth noting as well, one participant made a point to comment on the one time parents were involved in the program, which was during an end-of-program celebration – the share-a-thon event which served as the recommended *SciGirls* Family Fiesta.

> *[on the highlights of the experience]... especially the celebration and my parents here to see what I learned and teach them. Also for my parents to meet [the program leader], you [the Latina SciGirls researcher] and my friends.*
>
> Amalia

This comment yet again suggests the link between personal relevance and family/parental involvement as an added value to the STEM-related learning experience for participants as it related to personal relevance.

Criticisms of the program from the participants were again quite limited. Among them were reports of occasional boredom with non-interactive elements and tiredness at the end of the day:

> *I did [like the program] for the most part. Some other times it was a bit boring. ... Another challenge to me is that I get bored easily so hands on activities are best for me.*
>
> Amalia

> *I was tired at the time of the class after school. I did not like to have to walk around campus.*
>
> Kiara

2. Parent Experiences

Parent engagement for this site was limited to the family celebration at the end of the program. Otherwise, as an afterschool program located at the school, parents were not expected nor invited to participate.

This cohort of parents included one mother with a high STEM-related identity who considered herself to be a STEM professional (a seamstress who worked with technology and calculations everyday), one father with a high STEM-related identity who considered himself a STEM person but was not a STEM professional, and two mothers with neutral to slightly negative STEM-related identities who did not consider themselves to be STEM persons in any way, but supported STEM for their daughters nevertheless. The following themes emerged among the parents:

A. Importance of the Program Leader

This theme emerged with three of the four parents and was reflected with all of the girls as well. The program leader, who was also a teacher in the school and known by the participants and parents alike, was a central figure in the program and in many cases was the reason parents signed their girls up:

I think it was great. [The program leader] is a beloved leader and she is caring and brings great experiences to all the students. [The program leader] is very knowledgeable and knows how to get the girls excited.

Carolina

[The program leader] is very committed and I think she puts all her heart in supporting the girls. They love her. ... We all love and respect [the program leader].

Noa

Clearly, a trusted and charismatic educator as the leader was a tremendous asset to the success of the program. It also set the program leader up as an important role model for participants and parents alike, as someone who is excited about STEM -- but not a STEM professional herself. The other intended role models in the program were perceived differently from the program leader, who held such a vaunted status among the families.

B. Role Models

Parents' awareness of their daughters' interactions with intended STEM role models during the program ranged from almost none to quite a lot:

["Did your daughter interaction with STEM role models during the program?"]: I don't know, I think so.

Noa

Yes. [The program leader] planned for field trips where the girls met scientists and did hands on activities with them.

Carolina

As in the other cases, the parents were more familiar with the term 'role model' than their daughters were. In many instances, parents knew quite a few details about these encounters:

A chemist from the museum came to help facilitate a program and Josefina liked meeting and working with her.

Amy

She met several scientists but was most impressed by the scientist chemist I think who came to teach them DNA.

Pablo

These instances clearly show that the girls were reporting these experiences to their parents in detail, emphasizing the that fact that the role models did activities and worked side-by side with the participants. However, curiously, there was an absence in the parents' accounts of any of the other role modelling details that appeared in the girls' reporting. For example, there was no mention of indicators relating to agency-lending nor the program's successful integration of the *SciGirls* videos, as important outcomes of STEM role model interactions, as reported by the girls. In fact, the parents did not indicate any knowledge of the use of the *SciGirls* videos within the program, although this was clearly a strength of the program according to the girls.

Since the parents were not present during the program and relied solely on what their daughters shared with them post-facto, there are three possibilities for this. Either the girls did not share those

elements as part of their story-telling to their parents about their program experiences, or their parents did not ask deeper questions about the impacts of their work with scientists during the program (perhaps being satisfied with simply knowing what activities they did), or both. In any case, it is interesting that participants had quite a lot to say regarding their STEM role model interaction impacts when prompted to do so, but evidently very little of that detailed information was related to parents as part of the value of STEM role models in the program.

It is worth noting that there was one parent who volunteered a telling fact as she summed up her daughter's experience:

> *Kiara loved [the program], thank you. She watches Latina SciGirls videos all the time.*
>
> Noa

Apart from the successful integration of the SciGirls videos into the program, as described above, this girl apparently viewed the *SciGirls* episodes outside of the program as well (perhaps as a result of the program). But since the *SciGirls* videos are fundamentally based on the portrayal of different kinds of role model interactions, this off-hand comment seemed to indicate an overall program success in this respect.

C. Parent Involvement

Since parents were not expected nor invited to participate in the weekly running of the program, all the direct parent involvement occurred during the final family celebration event. The parents were overwhelmingly positive in their descriptions of it in terms of **parent-child engagement**:

> *It's been great to have my daughter show me what she learned.*
>
> Pablo

Additionally, there were several indicators that the event evoked a sense of community among the girls and parents alike, as in this example:

> *She has also been very excited for this family celebration and sharing with other parents and you [referring to the Latina SciGirls interviewer].*
>
> Carolina

As well, the event afforded parents the opportunity to see their daughters in a new light, and in this respect – a new identity:

> *I don't know how teachers teach STEM but seeing the girls interacting and demonstrating their experiments is very impressive. I'm happy to see Alecia so engaged and happy. She looks like a scientist to me.*
>
> Pablo

At least in one instance, parent involvement extended beyond the girls sharing stories of their program experiences or attending the final celebration event together, to enter into family life – in this case a birthday celebration:

> *Kiara did a Lava lamp [at camp] and gave it to me on my birthday. She did lots of activities and went on a field trip to the museum.*
>
> Noa

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This example points to the fact that for most children this age, the psychological presence of parents – even in the absence of their physical presence -- is a powerful influence on the experience of an informal learning program like *SciGirls*. And one that can be structured into the intentional design of such programs, and indeed may have been here.

D. Parent Program Reflections

Finally, parents were asked to reflect on the overall program design and implementation. Three themes emerged. First, even without direct participant STEM-related identity impacts, as noted above, the parents were universally **positive about their daughters' program experiences, their learning gains, and their enhanced motivation to pursue STEM:**

I think it was good. Josefina learned a lot, she says. I always asked her how it went and she would share. I noticed she liked it.

Amy

I thinks she loves STEM much more now. She has asked to be enroll again in the program again next year.

Pablo

The second theme, as seen in the other sites as well, was **personal relevance through social engagement** aspect of the program – although at this site the social engagement was with existing friends.

Josefina enjoyed meeting her friends after school to do STEM.

Amy

It was important for Alexia to be with her friends.

Pablo

Seeing and working with her friends and [the project leader] every week was good.

Carolina

This last example yet again highlights the earlier observed importance of the program leader to the success of the program and its impacts on parents and girls alike. Combined with the value placed on learning with existing friends (as opposed to the need to make new friends – as seen at the other sites), this degree of personal familiarity provided a feeling of security and confidence for the parents regarding their daughters' participation.

The third theme was the **informal learning nature of the program** itself. Although the weekly meetings were held within a school and led by a formal classroom educator with support of the Museum, the mode of the program was informal STEM learning. This not only contributed greatly to the 'fun factor' reported by the girls as well as the important social learning aspects, it was also not lost on the parents as a valuable element:

Amalia enjoyed learning in this environment. I think that learning without grades was a good thing because she stresses when she knows there is an expectation on her learning.

Carolina

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Lastly, and unique among the case studies, at this site there were no criticisms of any kind regarding the program design or delivery from the parents.

3. Summary and Researchers' Notes

Case study analysis of the Houston program revealed a highly intentional program design across a broad swath of STEM learning domains, with an emphasis on hands-on activities and quality interactions with STEM role models. The experience served to enhance the personal relevance of STEM for participants and to validate (if not grow) their STEM-related identities directly. Although parents were not included in the design of the week-to-week program, the final celebration event served to facilitate important parent-child interactions and presented some indications of a sense of community forming around STEM learning in this context.

Our on-site researcher made several key program observations:

- Strong positive relationships including staff, peer and families. There was a sense of trust and satisfaction.

- Rich content-based activities that were fun, including a mix of activities that build skills (i.e. 3D-printing, chemistry, etc.).

- Effective learning and mastery-oriented content delivery strategies. All activities at the summary celebration event provided structured and unstructured learning opportunities, which promoted participant autonomy (not competition), choice, and leadership.

- Effective program leadership. The program obviously provided high quality relationships and activities designed and facilitated by an experienced and qualified staff. All staff had been working with the program leader for over three years and it's obvious that they have been trained and given planning time and assistance with lesson plans and work environment.

- Small group program configuration. Experiences were presented in a "per cluster/station" learning format.

- Effective use of available resources. Meetings were held in a lab-like classroom with large tables/work spaces. The classroom was equipped with plenty of materials (but looked very messy and unorganized).

- Family Engagement. Families were very engaged and happy to free up their hectic schedules to come support and celebrate with their daughters and other families at the final celebration event. All families were acquainted with each other and the staff. They understood what the program entailed and understood the program goals and objectives – indicating effective communication on the part of program leadership.

- Bilingual program delivery and facilitation. It was great to see the students perform hands-on in a bilingual format, always choosing to use cognates as a best way to communicate with parents (notable during the Family Fiesta). The girls were switching back and forth between English and Spanish for their parents and thereby mixing their personal lives (how they communicate with their parents) with their academic learning using both languages easily and comfortably.

In fact, language was mentioned by several participants and parents alike as an issue, but for different reasons:

["Is language an issue for you in this program?"]
Yes it is. I sometimes do not understand STEM vocabulary and have to ask for help.

Josefina (participant)

A Houston participant who did not speak Spanish, reflecting a similar situation as seen at the Waco site:

I was born here and I don't speak Spanish but consider myself a Latina

Alicia

Finally, this parent observation was typical of many of the parents of participants in terms of affecting their involvement/engagement in the program or more generally in their daughters' academics:

["Are language/cultural barriers an obstacle for your parental academic involvement in your daughter's learning?"]
Yes. I mostly spend time with my community.

Amy (parent)

In light of these widely varying conditions and needs regarding language, it is clear that a bilingual design was critical for both the girls and their parents in order for the program to be successful.

Finally, the challenges of the program centered on funding and sustainability, including a primary concern to forge additional and renewable external funding partnerships (aside of *Latina SciGirls* and the Science Museum).

Cross-Case Analysis & Discussion

From the review of these three site-based case studies, we have seen that the experiences of these girls as part of the *Latina SciGirls Strategies* program was the result of a vast combination of program design, implementation strategies, content, the use of the *SciGirls* materials and instructional philosophy, and of course the programs leaders, parents, and participants themselves. Looking across these programs we are, to some extent, comparing apples and oranges in the details of each. However, given the common program leader training, *SciGirls* video episodes and role model videos, and other educational materials and strategies provided by tpt and the *Latina SciGirls* project team, this cross-case analysis considers some of the different ways those elements were utilized – and to what effect -- in service to promoting young Latinas in STEM learning.

With this in mind, presented here is an exploration of the notable similarities and differences of the cases, including important emergent themes, in terms of the first three research questions of the study:

1. How does the experience of participating in Latina SciGirls impact Hispanic girls' STEM-related identity development (if it does)?
2. What are the impacts of the project's role models?
3. What are the impacts of parents, family or friends?

1. Cross-Case: Participant STEM-Related Self-Appraisals, Reflected Self-Appraisals, and STEM Commitment

In line with the research model employed for this investigation, an identity-based STEM self-concept (and interview questions about that) were rooted in four primary self-assessments:

*   Self-appraisals in relation to STEM, including thinking of oneself as a "STEM Person" or "not a STEM Person," and a the degree of integration of STEM into one's overall sense-of-self
*   Perceptions of one's capacity to understand STEM-related concepts and also to participate in STEM-related activities. This is also related to participants' conceptions of STEM itself.
*   Reflected self-appraisals in relation to STEM; or one's perceptions of how others see them in relation to STEM.
*   STEM commitment

For most of the girls across the cases in the study, they entered their respective programs with moderate to high STEM self-appraisals. This is likely an effect of selection bias in that girls already interested and personally validated in STEM are more likely to sign up for such programs. As a result, we do not see nor expect dramatic changes in STEM self-appraisals in those girls. What we do see, however, is a strong reinforcement of their existing positive STEM identities in terms of interest, motivation, and especially emotional connection.

In fact, emotional connection to STEM was found to be a dominant theme across cases and was reflected in the quantitative results of the study. Within the case studies, emotional connection to STEM was closely tied to social bonding opportunities and personal relevance – which were in turn tied to small group, student-driven experiential activities centered on content important and/or interesting to the participants. Bilingualism was also seen to be important for establishing personal relevancy in those programs where it was available. Notably, these characteristics of program design are hallmarks of quality informal STEM learning designs and often harder to achieve in formal

learning environments. We suspect these aspects of the informal learning programs directly gave rise to the findings related to enhancing participants emotional connections to STEM.

Across the cases, we did not see direct evidence of growth in participants' perceived capacities to either understand STEM-related concepts or to participate in STEM-related activities. Again, this is very likely related to the selection bias. While participants did report learning "new things" or "cool things" in every program case, we also do not see much evidence of growth in participants' conceptualization of science or STEM itself from their experiences. This tracks with little or no changes in perceived abilities to understand and participate in STEM. The major exception to this was the Puerto Rico site, in which we saw a broadening of participants' (and parents) conceptualizations of STEM as part of the recovery effort in the wake of hurricane Maria, which had struck the island just months prior. And in one notable instance in Houston, we did witness a personal discovery linking STEM to the participant's love of nature for the first time, effectively increasing her perceived personal relevance and excitement for STEM. This particular girl entered the program with a moderate STEM self-appraisal, which translated into a higher STEM self-appraisal by the end of the program.

Interestingly, most girls entered their programs with only moderate reflected STEM self-appraisals – even those who held high STEM self-appraisals. Across the cases we saw some evidence of growth in reflected STEM self-appraisals *within* the group of participants as new friendships formed and/or existing friendships were enjoyed in the context of their STEM learning. For two girls, they expressed their initial shyness and how they went on to become more active and visible in their programs – largely due to the social elements and working with role models (discussed below). However, participants did not report growth in terms of reflected STEM self-appraisals regarding people *outside* of the program.

Finally, there is ample evidence across all cases that STEM commitment, or more accurately intended STEM commitment, was enhanced. STEM commitment is measured in terms of both the number of social bonds one has connected to STEM and time spent engaged in STEM-related activities. In those terms, participants expressed intentions to maintain relationships with other girls in the programs (in one case parents even starting a WhatsApp group), and desires to spend more time doing STEM or signing up for the same program next year. These expressed intentions were interpreted as enhancements to STEM commitment and therefore represent an important indicators of STEM-related identity enhancement along with the other indicators.

Importantly, both sites using small group learning designs and more effective role modeling strategies correspondingly generated more salient positive results for enhancing participant identity-based STEM self-concept. These were Puerto Rico and Houston. The zoo-based Waco program still generated some positive results in these areas, but mostly associated with animal interactions rather than people-interactions or designed learning activities.

2. Cross-Case: Role Models

Across the case programs, the girls initially had difficulty naming role models and were unfamiliar with the concept of role modelling in general. Even when the idea of role modelling was explained in terms of positive influencers in their lives (related to STEM or not), the girls had difficulty naming any, with the exception of a few girls mentioning their parents.

This changed however post-program for two of the program sites. In both Puerto Rico and Houston, strong women role models were integrated into the program design in effective – but notably different ways.

The girls (and parents) participating in the Puerto Rico program reported the powerful impacts of hearing the **role models personal narratives**, revealing two different themes:

- The successful **integration of STEM within female gender identities**, which had the effect of expanding the girls' schemas for whom a STEM professional can be and what a STEM professional does – importantly including life beyond STEM, and
- **Agency-lending --** the idea that 'because I see and/or know someone who is like me doing something that I have not yet done, I develop a sense of agency for the same activity – a sense that I too can do it.' Agency-lending appears to be based both on: (1) The protégé perceiving a high level of personal similarity with the exemplar and on; (2) The depth of their interaction in terms of contact hours, frequency and/or meaningfulness to the protégé. Both of these components of agency-lending are variants of personal relevancy.

Importantly, these responses indicate that role models can impact girls in a variety of ways related to gender and ethnicity… beyond simply modeling STEM jobs or interest in STEM alone. Personal relevancy through story-telling seemed to be a successful strategy for the Puerto Rico program.

Notably, however, these positive impacts did not seem to translate from video-based role models embedded within the *SciGirls* videos. Although the Puerto Rico Program used the *SciGirls* video episodes and role model videos throughout their program, none of the participants mentioned those videos in reference to role model experiences. This may be due to a lack of recognition by the participants of video-based characters as potential role models (even portrayed peers), a lack of impact of video-based role models, and/or may have to do with the manner in which the videos were introduced and "framed up" within the larger context of the program. By contrast, the Houston site made more effective use of the *SciGirls* videos.

The Houston site integrated role modelling in their design through active engagement among participants and role models – they did activities together, solved problems together, and experienced close one-on-one and small group collaboration together. This strategy revealed three themes:

- The importance of **active engagement with the program's intended role models**. Beyond introducing STEM role models, explaining what they do, or even sharing stories about how they think and feel about what they do.
- **Agency-lending** (again), similar to that observed at the Puerto Rico site, stemming from the protégé perceiving a high level of personal similarity with the role model combined with depth of their interaction in terms of contact hours, frequency and/or meaningfulness to the protégé. Where agency-lending occurred primarily through storytelling at the Puerto Rico site, here we see the effect resulting primarily from working on program activities together, linking this theme with the first one.
- The successful **integration of the *SciGirls* videos** within the program, including the use of the videos for contextualizing program-specific learning objectives, working within a team, reflection over the entire learning experience, and modelling for how engagement between adult leaders and participants could play out. The videos reinforced a participant-driven experience in which adult leaders facilitated and supported their efforts.

Houston's program leaders ensured frequent and consistent viewing of *SciGirls* video as an anchor activity throughout the program. Also, participants mentioned the importance of seeing girls like themselves in the videos (agency-lending once again). The resulting combination of girls' active engagement with in-person role models on program activities and the *SciGirls* videos appears to have generated agency-lending and demonstrated a winning strategy for video integration.

Taken together, the Puerto Rico and Houston sites' successful use of role modelling strategies demonstrates that the monolithic concept of "STEM role model" portraying the successful performance of a STEM role in society is unnecessarily limiting, and inadequate to describe the program experience of girls and the potential impacts of these influencers in more nuanced ways. It seems clear, that role models in a STEM learning context can influence young minds through stories of their personal journeys, exploring the integration of both STEM and gender identities in terms of being a STEM professional and a woman and still having "a life" beyond STEM, and in terms of close personal interactions and relationship-building with STEM role models that results in powerful agency-lending outcomes for participants. In these ways, STEM role models in such programs have a surprisingly wide range of potential impacts their presence can instantiate within the design.

Finally, the Waco site serves as an example, by contrast, in how role modelling is less successful. No participants reported any explicit role modelling experiences, whether with in-person or video-based. There was no evidence of the benefits of intentional role modeling designed into the program (e.g. motivation, agency-lending, inspiration). Despite the inclusion of daily viewings of *SciGirls* videos, the girls did not identify any of the people in these videos (adults or peers) as perceived STEM role models. Additionally, the videos were presented as fillers between activities and displayed on a small screen outside and in hot weather. This made it hard for the participants to hear (due to ambient zoo noise) and hard to focus in general. Further, there was little framing or debriefing to contextualize how videos were relevant to the program or to participants. Overall, it becomes a lesson in how *not* to utilize such video resources.

3. Cross-Case: Parent Involvement

Parents were involved in each of the programs in different ways, providing us with an excellent opportunity to compare and contrast. Parents involvement in the Puerto Rico program was optional but universally accepted and by all the girls mothers. Parent involvement in the Houston program occurred at the culminating celebration – Family Fiesta event. Parent involvement in the Waco program was minimal and not part of the design, therefore limited to pick and drop off and any conversations they had with the girls in transit or at home.

In two of the three cases, Puerto Rico and Houston, the impacts the girls perceived because of the presence of their parents was overwhelmingly positive. Most poignantly was the integration of mothers with their daughters in the Puerto Rico program. In this case, parents were delighted to become participants themselves (not mere observers) and often surprised at how much they themselves learned from the experience. The impacts on the girls in that program included child-parent bonding within a STEM learning context, support and reassurance for shyer girls to help them engage and acquire a sense of belonging, and the formation of a sense of community around the program for all, with the potential for extending that community beyond the time of the *Latina SciGirls* experience. With such interactions, we see the development of new STEM-related identity building from and overlapping with the girls' established identities as daughters. Combined with the social bonding occurring among the girls in the program and with program leaders and role models, the program successfully created a rich and supportive environment for developing strong social identities within the STEM learning context.

Additionally, through their embedded participation, parents gained intimate knowledge not only of what their daughters were learning, but also how -- including those intangible emotional elements of excitement, curiosity, wonder, struggle at times, and delight. This understanding is hard to achieve in any other way, and provides parents with a unique window on the nature of their girls' experiences with STEM, as well as to not only support those experiences but also to be part of them. Linking this observation back to the quantitative results, the effect extended to girls' increased emotional connection to STEM and (especially at the Puerto Rico site) interest in all four categories of STEM careers.   Through the lens of social identity theory, STEM careers are role-based identities encouraged and supported by the social identities activated in the program experience. Without parent involvement in this way, it seems likely the effect would not have been as positive or as large.

In the case of Houston, the culminating celebration, or Family Fiesta, was the singular opportunity for parents to engage in the program. However, the opportunity for girls to share their experiences with their parents was powerful for both. Girls expressed pride when sharing their program-related work and knowledge with their parents at the event and parents expressed pride and recognition for their daughters. These expressions and mutual validations represent important experiences that support STEM-related identity as a social identity for the girls. It was also during the Family Fiesta event that parents expressed their appreciation for the informal nature of the program, discussed in more detail in the next section.

The Cameron Park Zoo program in Waco had no provisions for parental involvement. Consequently, participants made no note of parent involvement and parent impressions of the program were somewhat limited. As discussed above, they noted general satisfaction with the program in that they expected it to provide animal interactions for their girls – and it did. They also recognized the importance of the social aspects of the program, as communicated to them by their girls in conversations at home. Recall that the Waco site program design kept the girls in one large group and yet the girls found opportunities to engage in smaller informal groups anyway and reported the value of these social bonding opportunities.

In summary, we have a range of program designs from intensive parental involvement, to one-time parental involvement at the concluding Family Fiesta, to no parental involvement. The results in terms of impact of girls' STEM-related identity development indicators tracks well with parent involvement: the more parent involvement in a well-designed and executed way, the richer the experience, especially in terms of social identity construction related to STEM. In this sense, having no parental involvement could be seen as a missed opportunity – provided the goals of the program include identity-related outcomes.

4. Cross-Case: Program Reflections

Program reflections were gathered from both participants and parents in each program explicitly to collect emergent themes that might otherwise not have been revealed through the identity-specific questions and other identity-based elements of the interviews. From a programmatic perspective, these reflections also provide a large sense of how families perceived the experiences in general, or holistically. Program reflections across cases revealed the following emergent themes:

- The '**Fun Factor:**' Participants across cases discussed how much fun the program experiences were compared to their prior experiences learning STEM in formal education environments. Despite occasional feelings of boredom or complaints of difficult content or long days, participants generally found their program experiences enjoyable. In Puerto Rico, this was

the dominant theme and likely influenced by the highly structured social design of the program (parent involvement included).

- **Personal relevance through social engagement**: This was echoed within other themes already but warranted mention on its own. As informal STEM learning programs, the opportunities for social engagement were greatly valued by participants and parents alike – and as we have seen also played key roles in supporting STEM-related identity development. These social engagement experiences manifested through new and existing friendships, collaboration on personally relevant and interesting projects and activities, and multiple and frequent opportunities for peer-bonding within the STEM learning context. Not surprisingly, the more such social engagement was designed into the programs (small group work, role model interactions, etc.), the greater the impact was. In the case of the Cameron Park Zoo in Waco, where social engagement was not as high a priority as in the other programs, some of this theme was revealed through participant interactions with the animals. In every case, social engagement was closely linked to the fun factor for each program and is likely a major contributor to the findings of the quantitative analysis that enjoyment of science was a significant impact of the aggregate experiences across all programs.

- **The importance of program leaders**: This theme was cited by most of the parents and all of the girls explicitly at the Houston site where the program leader was also a teacher in the school where the program was held (as an afterschool program). She was well known by the participants and parents alike and was, for several families, the reason parents signed their girls up. These observations speak to the importance of trust and familiarity in a well-prepared and highly capable staff for running a quality program. This element was also echoed in the Puerto Rico program in terms of the high caliber and personable staff and visiting role models involved in the program. It was also echoed in the Waco program in the form of a lack of highly qualified staff.

- **The value of the informal learning nature of the program**: Several parents at the Houston site expressed appreciation for the low-pressure, low stakes environment that had no grades and supported a collaborative rather than competitive experience. This is also tied to the fun factor reported by the girls and is a strength of informal STEM learning programs when designed for it. It is also linked to the opportunities for social engagement (which is typically much more limited in formal learning environments) and with familiarity and trust in the project leader. All these elements combine to make participants comfortable and our findings indicate that comfort and personal relevance are key factors in successfully reaching Hispanic girls in particular in the programs we examined.

- **STEM Relevance to the Community:** Lastly, the parents (and some of the girls) at the Puerto Rico site reflected on the relevance of STEM to their community. In the wake of hurricane Maria just a few months prior to the program experience, many parents came to recognize the design of the program as intentionally rooted in the recovery efforts of their community. For most, the idea that STEM and STEM learning was so directly important to their rebuilding of their lives was an eye-opener. We as researchers recognize it as a particularly salient form of personal relevance and emotional connection to STEM. For the program, it provided a powerful social glue and became a very valuable way to design such a STEM learning program.

5. Cross-Case: Researcher Observations of Fear

It is important to recognize a recurrent theme that we as researchers encountered in this entire study regarding the willingness of families to participate. This theme was **Fear**. At the time of this investigation, the U.S. was seeing dramatic increases in deportations of illegal and even legal

immigrants, the separation of children from their parents, and an amplification of threatening fear-based tactics and rhetoric from political leaders and various agencies, as well as a rise in racism, hate-speech, and discrimination in general.

This context permeated all areas of this study; was cited as a concern by parents in survey responses and in interviews and focus groups; and was cited by those declining to participate, resulting in lower response and participation rates.

This fear also permeated the content of responses by both parents and girls. For example, in Waco, when asked about the importance of her family in her school decisions and career interests, one participant jumped immediately to the fear of being separated from them:

> *I love them so much. I don't want to ever lose them. They are very important in my decisions. I tell them everything.*
>
> Clara

For all participants interviewed, when asked about their families' roles in their lives and decision making, there was an overwhelming positive response. With the exception of Puerto Rico's participants, who did not experience the immigrant issues, the importance of family was often coupled with fear of separation.

In fact, Puerto Rico represents a unique situation from all the other sites in the entire project in that their participants where not part of, nor perceived themselves to be, a minority group. In Puerto Rico, the girls and their families were "at home" in every sense. While at the other sites, the young Latinas and their parents very much perceived themselves to be some degree of "other" within their home locations, whether by culture, immigration history or status, or other socio-culturally-linked factors. And it is worth noting that such self-perceptions are certainly identity-affecting across the entire range that impacts a person's overall sense-of-self, and consequently also relevant for any attempts to help Latinas develop more positive STEM-related identities.

Therefore, it is highly probable that the social context of hostility towards immigrants, presenting these and other kinds of barriers, impacted the girls' experiences of the *Latina SciGirls* programs and their self-perceptions within those programs. On the one hand, all the programs were seen by the participants as a very positive and welcome experience. On the other hand, the programs which successfully involved parents and families to a greater degree were perceived as more positive and more impactful by the participants. It is worth considering whether this effect was not due simply to quality family engagement in a STEM learning design, but rather that parental involvement was a critical component for providing a sense of safety and belonging in a social environment where those qualities are increasingly threatened.

Conclusions

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In terms of the study's research questions, the results indicate the following:

1. **How does the experience of participating in Latina SciGirls impact Hispanic girls' STEM-related identity development (if it does)?**

In general, Latina participants do indeed show results towards the development of more positive STEM-related identities according to the framework and research model. The results of both quantitative and qualitative components of this mixed methods study support the growth of STEM-related identity in terms of:

- Emotional connection to STEM
- STEM career interest (reported for all four categories), and
- Perceived personal relevance of STEM (revealed for younger participants)

For most of the girls in the case study sites, their program experiences served to validate and reinforce their pre-existing positive STEM-related identities in terms of enjoyment of STEM, enhanced interest, motivation, and intentions to increase their STEM commitment through increased participation in STEM learning and STEM-related relationships in the future.

Additionally, personal relevance and social engagement emerged as the most powerful themes affecting the STEM-related identity impacts of the girls within these informal STEM learning contexts. In terms of programming, those programs that included highly structured and embedded social engagement opportunities as a method of STEM learning combined with content and activities designed to be personal relevant had the greater STEM-related identity impacts for girls. In the three cases examine here, two demonstrated such design elements (although different from each other) while a third one demonstrated fewer such elements and yielded correspondingly fewer and weaker results in terms of STEM-related identity.

Taken together, the results show positive outcomes for the development of STEM-related identities as both social identities (demarking membership and belonging within a social group) and role identities (as seen with increased interest in STEM careers and through the impacts of role models).

2. **What are the impacts of the project's role models?**

The impacts of role models was revealed to be highly variable and complex across the programs in the study. First, as seen in prior work, the concept of role model was largely unknown to the girls in the programs. They were much better understood as personal influencers affecting one's life in a variety of way. Second, each program differed in both the type of role models engaged and the ways they were designed into the experiences. The use of strong and highly qualified and engaging female STEM role models clearly showed advantages over no use. Further, in-person interactions showed advantage over video based exposure to role models, with side-by-side engagement between participants and role models on program activities showing the most powerful impacts in terms of STEM-related identity. Role model personal story sharing (in-person) was also revealed to have strong positive impacts for the girls in the study.

An important theme emerging from role model engagement in the programs was *agency-lending* -- the idea that 'because I see and/or know someone who is like me doing something that I have not yet done, I develop a sense of agency for the same activity – a sense that I too can do it.' Agency-lending appears to be based both on: (1) The protégé perceiving a high level of personal similarity with the exemplar and on; (2) The depth of their interaction in terms of contact hours, frequency and/or meaningfulness to the protégé.

Results suggest that the idea of role modeling within STEM learning contexts can influence young minds in multiple ways beyond introducing STEM-based role identities to participants. These include: Stories of personal STEM-related life trajectories, Exploring the integration of STEM with gender and ethnic identities in terms of being a STEM professional and a Latina and still having "a life" beyond STEM, and; In terms of participants having close personal interactions and relationship-building with STEM role models that results in powerful "agency-lending" outcomes for participants. In these ways, STEM role models in such programs have a surprisingly wide range of potential impacts their presence can instantiate within the design. Unpacking the concept of role models through the lens of multi-modal "identity influencers" may serve to expand the designs of such interactions into STEM-learning programs hoping to impact STEM-related identity development.

3. What are the impacts of parents, family or friends?

The program designs across all cases in this study engaged parents in different ways, providing an excellent basis for comparisons. Programs ranged from intensive parental involvement, to one-time parental involvement at the concluding Family Fiesta, to no parental involvement.

In general, highly structured and intentional parent involvement had a powerful positive influence on the program experiences for girls in terms of amplifying the development of STEM-related identities as social identities. This was seen through enhanced social interactions and development of a sense of community within the program (with indications the community could extend beyond the time of the program in at least one case).

Indeed, overall, the results in terms of impact of girls' STEM-related identity development indicators tracks well with parent involvement: the more parent involvement in a well-designed and executed way, the richer the experience, especially in terms of social identity construction related to STEM. Having no parental involvement could be seen as a missed opportunity in informal STEM learning programs hoping to impact Latina STEM-related identity development.

There are also strong indications that parental involvement was a critical component for providing a sense of safety and belonging in an immigrant-hostile social environment where those qualities are increasingly threatened – which was highly salient to both the participants and parents at two of the three case study sites.

Other family members (e.g. siblings) were not seen to be part of the design of any of the programs in the study. Therefore family engagement was limited to parents.

Regarding the impact of friends on the girls' experiences within their various programs, social engagement was found to be a dominant theme across cases. In terms of identity construction, the tween and the teen years see an increase in the importance of peer-group social ties as personal and social identities are experimented with and later committed to. The programs under investigation here generally made good use of social engagement through friendship building, small-group

collaboration on personally relevant and interesting projects and activities, and multiple and frequent opportunities for peer-bonding within the STEM learning context. Girls entered programs with existing friendships in some cases – which were enhanced through the program; forged new friendships because of the program – often increasing a sense of belonging and commitment (both makers of social identity development within a STEM learning context); or both.

And it was clear that those programs more intentionally and structurally designing for quality social engagement produced better results for their participants on terms of STEM-related identity development. This was also reflected in the results of the quantitative portion of the study showing emotional connection to STEM, enjoyment of STEM, and personal relevance of STEM. The case study analysis shows these to be likely linked outcomes.

4. **What modifications to the STEM Identity framework are indicated by the findings?**
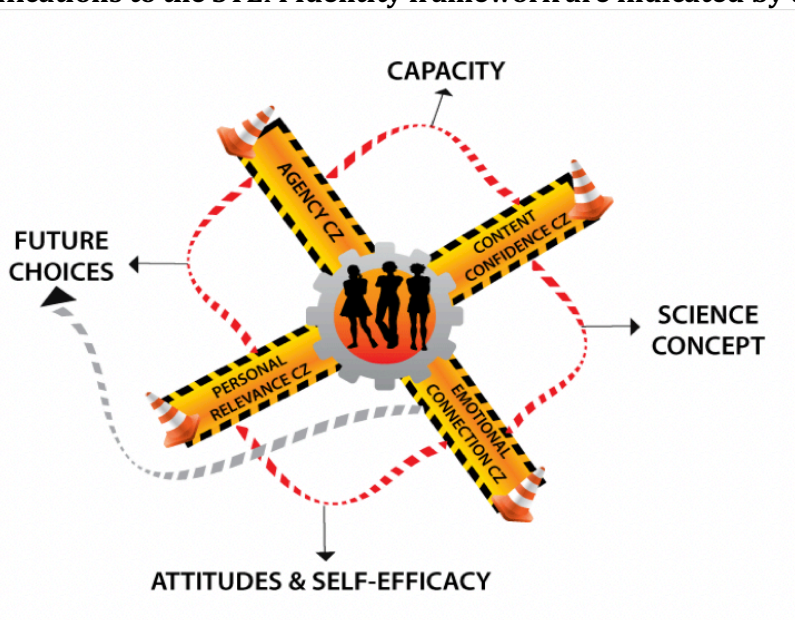
The findings reinforce the importance of personal relevance and emotional connections to STEM, especially as those occur through social engagement designed into programs. These included peer-to-peer interactions, program leader-participant interactions, and parent involvement. Therefore, those elements of the framework as cognitive factors were validated.

Additionally, the role model interactions examined in the study revealed STEM-related agency-lending as an important outcome related to the development of agency, recognized as another cognitive factor in the framework. Conversely, content confidence was the only cognitive factor not revealed in the study as important to the participants' *Latina SciGirls* experiences in terms of STEM-related identity development. This finding tracks with results of the *SciGirls Strategies* research.

The participant outcomes revealed in this study fell within the behavioral categories of Attitudes & Self-Efficacy, and Future Choices (or intentions regarding future choices) of the framework. There were little or no program impacts observed in terms of capacity to understand or participate in STEM (participants entered their programs with high capacities already), or for growth in terms of science concept. Although it should be noted there was at least one example of a girl making a rather dramatic personal discovery connecting her love of nature to STEM – thus considerably broadening and altering her science concept.

As found in the prior SciGirls Strategies research, a useful adjustment to the framework would be to delineate *indicators of* STEM-related identity development from experiential and cognitive *factors involved in the process of* STEM-related identity development. This would significantly change the framework from being one based on differentiating cognitive from behavioral components of STEM-related identity, towards a framework structured by measurable (or describe-able) processes vs. products or outcomes. Such a formulation of the framework would be more applicable to program design and delivery as well as assessment. An updated framework based on these findings and others will be the subject of an upcoming publication by the research team.

Barriers to Latina Engagement in STEM

Finally, revisiting the founding hypothesis of the project -- *The SciGirls model, when augmented to address specific barriers to STEM engagement of Hispanic girls ages 8 to 13 and their parents, will promote the development of positive STEM identities in Hispanic girls* – let's consider the findings of the research study in terms of those barriers.

As discussed on page 7, these barriers notably include:
- Socio-cultural dispositions that don't traditionally include STEM
- Varying degrees of language barriers
- Underrepresentation of Hispanic STEM role models

The case studies revealed that the first item here, referring to the socio-cultural barriers to Latina engagement in STEM, was closely tied to gender. That is, what it means to be a Hispanic female, transitioning from girlhood to adulthood in terms of personal and social identity within the cultural context of the community. As pointed out earlier, the Puerto Rico site differed from other sites in that the cultural context was one of majority Hispanic representation where in other sites the cultural context was one of being part of a minority group – often within an immigrant-hostile climate. However, for both conditions, the case study research revealed that the two more successful programs both intentionally designed environments and participant experiences to combat the notion that a Latina identity is incompatible with a STEM-related identity. This was accomplished by:

- Creating programs involving only Latinas, including leaders, guests, and participants;
- Presenting parents, role models, and program leaders who were all Latinas and supportive of the girls' STEM-related identity development – not only creating a safe place for such identity development but also giving explicit external permission and positive encouragement to explore Latina STEM-related identity;
- Providing social engagement and learning experiences that created a sense of community and belongingness in the context of STEM learning.

By contrast, a third program in the case study made claims to use designs specifically to address barriers to Hispanic girls engagement in STEM, but did not employ the above strategies – nor any strategies identifiable by the research team to explicitly serve this goal. In this case, it would arguably have better not to make such claims unless adequately attended to.

It seems likely that efforts to address the socio-cultural barriers that inhibit young Latina STEM participation need to address this challenge from an intersectional perspective. Specifically, that includes the intersection of Latinas' cultural identity (as part of both the Hispanic community and the larger community in which it sits) with the Latina's gender identity. Both identities present

challenges for STEM engagement. Combined they mutually amplify the challenges. Programs that recognize this and design experiences to address both cultural and gender-based obstacles, as described above, hold more promise than those that do not.

The second barrier, varying degrees of language barriers, was more complex than simply providing bilingual materials or videos. As we have explored, it was often the case that parents and daughters differed greatly in their bilingualism. This enhanced the need for programs to accommodate a range of language challenges. These best performing sites not only used bilingual materials but also conducted their programs in true bilingual fashion, integrating both Spanish and English seamlessly into the delivery. Such an approach signals the integration of Latina identity with STEM-related identity since it occurs in the STEM learning environment. So although participants were not overly passionate about this issue of whether and how their program was bilingual, it seems clear from the researcher perspective that this was an important differentiating factor between programs.

Lastly, the underrepresentation of Hispanic STEM role models was a central theme behind the intention of this project, from the production of the *SciGirls* episodes and role model video to the training, resources, and requirements of the Latina *SciGirls* programs. As we have seen, to properly address this barrier for Latina's in particular, programs need to engage Latina role models in STEM. According to the project evaluation report however, only about half of the STEM professionals engaged as role models across ten sites in this project were Hispanic and bilingual. Additionally, expanding the notion of "role models" to "influencers" serves to broaden the way program leaders think about and design for such interactions – and increases the impact of such influencers across a wider range of identities (both STEM and non-STEM related).

So in terms of the hypothesis once again, is it true that when augmented to address specific barriers to STEM engagement of Hispanic girls, *SciGirls* programs will promote the development of positive STEM identities in Hispanic girls? The answer is that it depends. Recall that there was wide variability across programs in implementation factors, including type of program, duration of program, attendance at online program leader trainings, integration of 'required' program elements, consistent user of *SciGirls* videos and resources, and use of strategies from the *Engaging Latino Families Guide* and incorporation of every *SciGirls Seven* strategy. It seems clear, however, that the *SciGirls Seven* strategies are largely validated with the findings of this report. Further, those sites employing a well-designed synthesis of the *SciGirls Seven* with strategies intended to serve Latinas in ways specifically addressing the above barriers generated several positive indicators of STEM-related identity development over programs that did not. Most of the identity impact was seen in two categories: emotional connection to STEM and enjoyment of STEM. Both of these occurred through the establishment of personal relevance made possible by multiple modes of social engagement (peer-to-peer, role models, parents, leaders) and both critical elements of durable STEM-related identity development.

Recommendations

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Based on the findings in this study, we present the following list of programmatic design recommendations. These should be taken under advisement, as the sample in this study is small. In no way should these recommendations be considered best practices for all Latinas or thought to address the needs of Hispanic girls and their families as a monolithic group. Rather, these recommendations should be considered to inform an identity-based perspective on what kinds of practices may productively contribute towards enhancing Latinas' STEM-related identities.

- **Establish Personal Relevance** in STEM learning. This was THE dominant factor in STEM-related identity development for the girls in this study. Consider the following strategies:
  o Include opportunities to **expand participant perceptions of STEM to their other social identities** in other contexts – as friends, as daughters, as community-members -- and beyond their identities of "program attendees" or students. Effective informal STEM learning programs serve as a forum for social validation of STEM-related identity and forging new social ties around STEM. A sense of belonging promotes STEM commitment and personal relevancy by reinforcing a social identity as a group member. At the very least, don't put STEM-related identity in opposition to other important social identities held by girls.
  o **Create multiple opportunities for social engagement** embedded within the context of STEM learning (as opposed to filler activities or as breaks between STEM learning events). Consider social engagement through three pathways: Peer-to-peer; With role models (including program leaders); With parents and families. Design for small group collaborative work combined with both larger group and individual learning opportunities. Recognize that friendships provide social acceptance of an expressed STEM-related identity in a social context where that is a challenge for many Latinas.
  o **Engage students emotionally**. Emotions held the key to establishing personal relevancy in this study. Successful strategies tied STEM content to important events and topics in the lives of Latinas (hurricane recovery, interactions with animals, engagement with beloved role models, program leaders, and parents). This is a hallmark of participant-centered design (vs. content-centered design) and ties STEM to participants' lives and identities outside of the learning environment. More than the STEM content, the way STEM-related experiences made them feel about themselves had the greatest impact. This is closely tied to social engagement as well.

- **Ensure Bilingualism.** Ideally this includes real-time delivery of the program by program-leaders as well as providing bilingual materials, activities, videos, etc.. Even if the participants are not bilingual themselves, programs intending to reach Latinas need to signal cultural fluency and awareness to parents and families to be successful.

- Get more sophisticated about **Role Models**. Consider unpacking the functional concept of role models into different types of **Influencers**, differentiating role, social, and personal influencers who exhibit traits and behaviors that inform these levels of identity.
  o Have influencers or role models **share their personal stories**, focusing on how their STEM identities and STEM trajectories blended with their other identities and "life beyond STEM" (especially gender identity). This helps dispel notions that STEM careers are incompatible with being a Latina or that choosing a STEM profession presents an either/or options against other important social identities.

- o **Design for agency-lending**. Create opportunities where participants actively work side-by-side with influencers or role models on challenging projects or problems together. Such personal experiences extend beyond hearing from role models to actually working with them, bolstering agency development through agency-lending. Remember that agency-lending depends upon the degree of perceived personal similarity between participants and any influencers combined with the frequency and depth of their interactions. they encounter will determine the impact that intended role models may have.

- **Involve Parents and Families.** Family and community are dominant factors in the lives of Latinas and key components to informal STEM learning programs hoping to better serve them. Successful strategies include:
  - o Create highly structured and intentional design elements that **embed parents (especially mothers) actively in the program** working with their daughters (not treating them as passive observers).
  - o Create opportunities for **parent-to-parent relationship building**. This may include real-time program-based activities, discussions, or even online. All serve to build a sense of community of parents as STEM-identity supporting agents for their daughters.
  - o **Involve parents in some of the programmatic decisions** (to the extent possible or appropriate). This increased ownership, personal investment, and a sense of agency for parents.
  - o Consider **creating concluding events such as Family Fiestas** as ways to engage parents and siblings in lieu of being able to actively embed in the program itself.

- **Be Strategic in the Use of Videos.** Programs that used SciGirls videos as filler material fared less well than those more thoughtful and intentional about their program integration. Consider the following strategies:
  - o Explicitly **link video choices, content, and characters to relevant program elements** occurring at that time. In this way, videos can serve as either framing tools that foreshadow upcoming events or as reflective tools to anchor discussions to conclude activities or events – or both.
  - o **Use or create companion tools to go with videos**. These may include discussion guides, games, or activities related to the videos are the people in them. Don't use videos as stand-alone resources.
  - o Consider **using videos to bolster role model efforts.** Consider videos depicting intended role models as resources to support role modeling or influencer elements – but not as replacements. Programs that explicitly pointed out the video characters as near-peer role models of Latinas doing STEM and engaging with STEM professionals on screen saw valuable outcomes for their participants in terms of making their activities more meaningful. Programs that combined video-based role models with in-person role models fared better than those relying on videos to provide all their role modelling elements.
  - o **Pay attention to presentation design.** This includes the viewing location (seek comfortable venues), larger screen sizes with bright projection or TVs, and audio quality (loud enough and minimizing competing noises if possible). If the viewing experience is sub-standard, it will affect participants' perceptions of it despite the video quality itself.

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Appendix A. Composites and Corresponding Survey Items

<u>Personal Relevance Composite</u>
Response options: Not much like me/Slightly like me/Mostly like me/Extremely like me
  1. Science is important to me.
  2. [Reverse-coded] I actively avoid opportunities to do science-related things.
  3. Science is a big part of who I am and I what I do.

  Omitted sub-item: [Reverse-coded] I spend a lot of my free time doing things that are not related to science.

<u>Agency Composite</u>
Response options: Not much like me/Slightly like me/Mostly like me/Extremely like me
  1. I hope to have a science -related profession one day.
  2. [Reverse-coded] My role models are NOT involved in science.
  3. I admire scientists and people who work in science-related fields.
  4. [Reverse-coded] I see myself having a career that is NOT very much related much to science.

<u>Emotional Connection Composite</u>
Response options: Not much like me/Slightly like me/Mostly like me/Extremely like me
  1. I know most of my friends through my science-related activities.
  2. [Reverse-coded] I do NOT get very excited about doing science.
  3. Other people (family, friends, teachers) know that I like science.
  4. I enjoy or have fun doing science-related activities.

<u>Content Confidence Composite</u>
Response options: Not much like me/Slightly like me/Mostly like me/Extremely like me
  1. [Reverse-coded] I have a difficult time understanding science-related things.
  2. I feel that I can do science-related things quite well.
  3. [Reverse-coded] I rarely talk about science or my science-related activities with others.

<u>Enjoyment of Science</u>
Response options: Not much like me/Slightly like me/Mostly like me/Extremely like me
  1. I like to hear about new discoveries in science.
  2. I enjoy reading about science.
  3. It's fun to do science activities.
  4. I enjoy watching science shows.
  5. I like talking about science topics with others.
  6. I want to understand how things in science and nature work.
Response options: Strongly Disagree/Disagree/Not Sure/Agree/Strongly Agree*
  7. I like to identify things in nature.
  8. It's fun to collect things from outdoors.

*Items using this scale were converted to a 4 point-scale, where "Not Sure" responses were coded to missing

Science Career Interest

Response options: Strongly Disagree/Disagree/Not Sure/Agree/Strongly Agree

1. I am able to do well in activities that involve: (Science)
2. I am able to complete activities that involve: (Science)
3. In my future career, I plan to use: (Science)
4. I will work hard in my classes involving: (Science)
5. It will help me in my future career, if I do well in: (Science)
6. My parents would like it if I choose a career related to: (Science)
7. I'm interested in careers that use: (Science)
8. I like activities that involve: (Science)
9. I have a role model in a career related to: (Science)
10. I would feel comfortable talking to people who work in careers related to: (Science)
11. I know of someone in my family with a career related to: (Science)

Technology Career Interest

Response options: Strongly Disagree/Disagree/Not Sure/Agree/Strongly Agree

1. I am able to do well in activities that involve: (Technology)
2. I am able to complete activities that involve: (Technology)
3. In my future career, I plan to use: (Technology)
4. I will work hard in my classes involving: (Technology)
5. It will help me in my future career, if I do well in: (Technology)
6. My parents would like it if I choose a career related to: (Technology)
7. I'm interested in careers that use: (Technology)
8. I like activities that involve: (Technology)
9. I have a role model in a career related to: (Technology)
10. I would feel comfortable talking to people who work in careers related to: (Technology)
11. I know of someone in my family with a career related to: (Technology)

Engineering Career Interest

Response options: Strongly Disagree/Disagree/Not Sure/Agree/Strongly Agree

1. I am able to do well in activities that involve: (Engineering)
2. I am able to complete activities that involve: (Engineering)
3. In my future career, I plan to use: (Engineering)
4. I will work hard in my classes involving: (Engineering)
5. It will help me in my future career, if I do well in: (Engineering)
6. My parents would like it if I choose a career related to: (Engineering)
7. I'm interested in careers that use: (Engineering)
8. I like activities that involve: (Engineering)
9. I have a role model in a career related to: (Engineering)
10. I would feel comfortable talking to people who work in careers related to: (Engineering)
11. I know of someone in my family with a career related to: (Engineering)

<u>Mathematics Career Interest</u>

Response options: Strongly Disagree/Disagree/Not Sure/Agree/Strongly Agree

1. I am able to do well in activities that involve: (Math)
2. I am able to complete activities that involve: (Math)
3. In my future career, I plan to use: (Math)
4. I will work hard in my classes involving: (Math)
5. It will help me in my future career, if I do well in: (Math)
6. My parents would like it if I choose a career related to: (Math)
7. I'm interested in careers that use: (Math)
8. I like activities that involve: (Math)
9. I have a role model in a career related to: (Math)
10. I would feel comfortable talking to people who work in careers related to: (Math)
11. I know of someone in my family with a career related to: (Math)

Appendix B. Descriptive Statistics for Survey Items

Item		Treatment			
		Not much like me	Slightly like me	Mostly like me	Extremely like me
2. Science is important to me.[3]	Pre	8	17	46	30
	Post	5	18	46	30
3. I hope to have a science-related profession one day.[1,3]	Pre	10	31	38	19
	Post	9	30	33	27
4. I do NOT belong to any science -related groups, clubs, or organizations.[2,4]	Pre	47	22	14	15
	Post	58	24	4	12
5. I know most of my friends through my science-related activities.[3]	Pre	37	34	20	9
	Post	31	33	18	16
6. I do NOT get very excited about doing science.[3]	Pre	50	27	14	9
	Post	60	24	10	5
7. I actively avoid opportunities to do science-related things.[1,4]	Pre	53	33	9	4
	Post	60	22	10	6
8. Science is a big part of who I am and I what I do.[3]	Pre	13	35	37	14
	Post	11	40	30	17
9. I spend a lot of my free time doing things that are not related to science.[4]	Pre	15	35	38	11
	Post	11	30	34	23
10. Other people (family, friends, teachers) know that I like science.[1,4]	Pre	17	26	36	20
	Post	13	26	35	24
11. My role models are NOT involved in science.[1,3]	Pre	28	39	24	9
	Post	32	33	16	17
12. I admire scientists and people who work in science-related fields.[3]	Pre	10	30	36	23
	Post	11	28	31	29
13. I have a difficult time understanding science-related things.[3]	Pre	39	42	15	4
	Post	38	41	18	2
14. I feel that I can do science-related things quite well.[3]	Pre	6	21	42	31
	Post	3	24	45	28
15. I see myself having a career that is NOT very much related much to science.[2,3]	Pre	30	36	26	6
	Post	27	46	17	10
16. I rarely talk about science or my science-related activities with others.[1,3]	Pre	20	45	25	10
	Post	25	37	26	11
17. I enjoy or have fun doing science-related activities.[4]	Pre	3	12	46	39
	Post	1	17	32	48