SciGirls CONNECT2 Research Report

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Summary

Our goal for this research study was to determine the role of the SciGirls gender-equitable strategies on participating youths' STEM identity changes in 16 participating SciGirls' programs across the nation. The definition of STEM identity was based on Eccles (2007), Carlone and Johnson (2007) and Calabrese Barton and colleagues (2013). According to these researchers, individuals must have a positive STEM identity in order to persist in STEM careers. This positive STEM identity is affected by an individual's expectations of success in STEM and the value they see in STEM and STEM careers (Eccles, 2007). Once students develop an interest in STEM, they must have opportunities to perform their STEM understanding and be recognized by individuals that they view as experts in the field (Carlone & Johnson, 2007). STEM identity development is both a reflection of how one perceives, positions, and aligns oneself within STEM, and how one is perceived and recognized by meaningful others (Carlone & Johnson, 2007). Calabrese Barton and colleagues' (2013) work indicates that young women's varying experiences over time ultimately result in an identity trajectory progression towards or away from STEM. A positive trajectory towards STEM is interpreted as movement toward more central participation in the STEM community of practice, which includes choosing a STEM major in college and pursuing the necessary courses and requirements that lead to a STEM career (Lave & Wenger, 1991).

The research question guiding this project is: What effect does participation in SciGirls programs have on participants' STEM identity? To study STEM identity development we utilized a mixed methods approach that included the following data collection methods: (1) pre/post survey data of youth at 16 study sites that measures STEM identity; (2) observations of program components in three site-based case studies; (3) interviews with educators and parents from case study sites; and (4) interviews with students at case study sites. The study was approved by Florida State University's Human Subjects Internal Review Board. We provide a summary of the quantitative and qualitative findings here before unpacking a more descriptive account of each of these summaries.

Quantitative Summary

The quantitative portion of the study focused on STEM Identity and STEM Self-Efficacy[1] changes from pre to post for 148 youth in fourth through ninth grade. Overall, students' STEM Identity significantly increased, which was largely driven by participant perceptions of how others recognized them as STEM people. Results from the regression analyses indicated no differential effects for race, ethnicity, gender, STEM capital, or enrollment in honors or advanced classes. However, as students get older, they are less likely to see increases in STEM Identity as a result of participating in one of the programs in the study. This is similar to findings from other studies (Jayaratne et al., 2003; Roberts & Hughes, 2019).

To determine if there were differences in STEM Identity changes based on type of program (afterschool or summer camp), we ran independent samples t-tests comparing changes in STEM Identity and STEM Self-Efficacy of summer camps compared to after school programs. The results indicated that after school programs saw larger gains in STEM Identity than summer camps, but the difference was not statistically significant. There were only minimal differences in STEM Self-Efficacy growth between after school programs and summer camps, and these differences were also not statistically significant. We planned to compare

[1] Note we use capital Identity and Self-Efficacy when referring to our survey metric categories

changes in STEM Identity and STEM Self-Efficacy across all 16 sites, however, the small sample size resulted in a lack of statistical power and precluded this analysis.

Qualitative Summary

The qualitative portion of the study focused on three case study sites (i.e., Mote Marine Lab, Project Scientist, and Texas Girls Collaborative Project) to determine what aspects of the SciGirls umbrella concepts (i.e., culturally responsive teaching (CRT) and safe and supportive learning environments) and strategies (i.e., connections, opportunities, growth mindset, stereotypes, collaboration, and role models) impacted participating girls' STEM identity. This part of the study supported the value of recognition that was highlighted by the quantitative portion. In our qualitative comparative case study data we found that recognition of both STEM (Carlone & Johnson, 2007) and non-STEM identity performances created a supportive and inclusive learning environment wherein girls felt safe and confident to try STEM activities and struggle through concepts in ways that might not be feasible in formal K-12 settings. While we found our three case study sites to be effective in providing a safe and supportive learning environment, we did not identify CRT strategies to be present. Using references in the interviews by educators we were able to identify that educators did not fully understand CRT and how to use the construct.

We used the teacher interviews as well as interviews with girls and the observations of all activities to highlight when the SciGirls strategies were used successfully – to impact change in STEM identity. No one activity incorporated all of the strategies. However, all three sites incorporated most of the strategies over the course of their programs. This finding suggests that informal STEM education programs need to have multiple days or activities to fully integrate the SciGirls strategies. Mote Marine Lab and Project Scientist employed connections the most during their program. Texas Girls Collaborative Project's most highly used strategy was collaboration. All three programs introduced role models in multiple and varied ways and collaboration was a consistent strategy used across the camps. Stereotypes and growth mindset were the two strategies used the least.

The three camps provided girls the opportunity to perform STEM competence and be recognized for that competence. However, there were moments when girls were not equally recognized. For instance, some girls were called on for answers, while others were not. Additionally, when role models and educators chose to engage in a scientific conversation with some girls and not others. These varying forms of recognition led girls to see certain members of the program as STEM people worthy of having a conversation with experts and others as not-STEM people because they were not encouraged to participate in conversations. These results highlight the need for future researchers to pay attention to how each girl is recognized by the various educators and by the mentors present.

Overall, our findings indicate that the informal STEM education programs in this study, position girls to explore and build on their multiple identities in ways that allowed them to see how STEM is relevant and valuable to their lives and a part of who they are. Additionally, the programs examined here provided girls with opportunities to develop their non-STEM identities, which we surmise is an essential element needed to create a supportive and inclusive learning environment, as well as a crucial component in helping girls develop their personal and STEM identities. Further, the results suggest that incorporating the SciGirls strategies in varying ways across the entirety of a camp can support these improved STEM identities, but that care needs to be taken in how these strategies are employed to provide girls opportunities to perform and be acknowledge for those performances. In the following pages we provide more detailed descriptions of these quantitative and qualitative findings.

Quantitative Description

Of the 16 participating sites in SciGirls Connect2, eleven sites provided complete sets of student data (pre-survey, post-survey, consent form, and assent form) in year one and two for a total student sample of 148 youth. Participating sites had a mixture of summer camp and after school activities, all of which utilized the SciGirls strategies. Demographic information of the 148 participants including race, ethnicity, gender, grade in school, and honors course enrollment were all self-reported by students and are presented in Table 1.

Table 1. Participant Demographics

Demographic Characteristics	n	Percent
Race and Ethnicity*		
Asian	13	8.8%
Black or African American	35	23.6%
Hispanic or Latino/a	25	16.9%
White	70	47.3%
Other Race or Ethnicity	15	10.1%
Would Rather Not Respond	8	5.4%
Gender		
Male	5	3.4%
Female	141	95.9%
Other	1	0.7%
Grade		
5^{th}	29	20.1%
6^{th}	36	25.0%
7^{th}	52	36.1%
8^{th}	21	14.6%
9^{th}	6	4.2%
Enrolled in Honors or Advanced Classes		
Yes	86	59.3%
No	59	39.9%

*Students were able to select multiple races and ethnicities, so percents will not add up to 100.

The overall metrics of interest for the quantitative component of the research project were STEM Self-Efficacy and STEM Identity, which are further broken down into subscales. These scales were developed based on the Aschbacher and colleagues' (2010) survey tool along with the Assessing Women in Engineering (AWE, 2008) survey tool (see Table 2).

Table 2. Scales and Items

Scale	Subscale	Items
STEM Identity (α=0.922)	Self-Perception (α=0.832)	• Science is something I rarely even think about. (Reverse Coded) • I would feel a loss if I were forced to give up doing science. • I really don't have any clear feelings about science. (Reverse Coded)

		• Science is an important part of who I am. • Being a scientist is an important part of my identity. • No one would really be surprised if I just stopped doing science. (Reverse Coded)
	External Perception (α=0.91)	• I am likely to choose a career in science. • I spend much of my time doing science related activities. • Many people think of me in terms of being a scientist. • Other people think doing science is important to me. • It is important to my friends and relatives that I continue as a scientist. • Many of the people that I know expect me to continue as a scientist.
STEM Self-Efficacy (α=0.90)	Self Confidence (α=0.84)	• I can understand difficult ideas in school. • I can explain science to my friends to help them understand. • I can get good grades in science. • I can effectively lead a team to design and build a hands-on project. • In lab activities, I can use what I have learned to design a solution. • I can teach myself to use new technologies. • I can use what I know to design and build something mechanical that works.
	Openness to Challenge (α=0.77)	• I look forward to math class in school. • I am capable of getting straight A's. • I like classes that are easy for me more than classes that challenge me. (Reverse Coded) • When an assignment turns out to be harder than I expected, I usually don't complete it. (Reverse Coded) • I can get good grades in math. • I can explain math to my friends to help them understand. • When I see a new math problem, I can use what I have learned to solve the problem.
	Willingness to Learn (α=0.79)	• I look forward to science classes in school. • I like learning how things work. • I can learn new ideas quickly in school. • I am good at learning new things in school. • School is easy for me. • I can get good grades in science.

Additionally, we were interested in the role that STEM capital played in developing STEM Self-Efficacy and STEM Identity. For the purposes of this project, STEM capital was measured based on the work by Archer and colleagues (2015). Items included in the measure of STEM capital are:

- One or both of my parents sign me up to activities outside of school time (e.g. dance, music, clubs)
- One or both of my parents expect me to go to college
- One or both of my parents think science is very interesting
- One or both of my parents think it is important for me to learn science
- One or both of my parents has explained to me that science is useful for my future
- One or both of my parents knows a lot about science
- How often do you do the following things outside of school? - Read books or magazines about science
- How often do you do the following things outside of school? - Go online to find out more about science (e.g. YouTube, science websites, science games)
- How often do you do the following thing when you are NOT in school? - Go to a science center, science museum, planetarium
- How often do you do the following thing when you are NOT in school? - Visit a zoo or aquarium
- How often do you do the following thing when you are NOT in school? - Do experiments or use science kits
- How often do you do the following thing when you are NOT in school? - Fix or build things
- How often do you do the following thing when you are NOT in school? - Program computers
- How often do you do the following things when you are IN school? - Go to an after-school science, technology, engineering, or math club
- How often do you do the following things when you are IN school? - Attend a science presentation or talk
- How often do you do the following things when you are IN school? - Take a STEM-related school trip
- How often do you do the following things when you are IN school? - Take a school trip to a museum
- I have learned a lot about science from museums

All scales and subscales remained the same or increased in average score from pre to post program. To test for overall significant changes, we ran paired samples t-tests for each of the scales and subscales. Of the seven scales, three had statistically significant differences: STEM Identity, External Perception, and Self Confidence. Table 3 presents the results of these analyses.

Table 3. Paired Samples T-Test Results for Scales and Subscales

	Mean Pre	Pre SD	Mean Post	Post SD	*d*	p

STEM Self-Efficacy	4.1	0.51	4.1	0.56	0.07	0.139
Self Confidence	3.9	0.66	4.0	0.66	0.10	0.049
Openness to Challenge	4.0	0.65	4.0	0.65	0.03	0.559
Willingness to Learn	4.3	0.52	4.3	0.59	0.00	0.937
STEM Identity	3.5	0.87	3.6	0.87	0.14	0.015
Self-Perception	3.8	0.84	3.8	0.86	0.20	0.001
External Perception	3.3	0.99	3.5	0.96	0.02	0.701

Overall, students' STEM Identity significantly increased, largely driven by their responses to the External Perception subscale, indicating that this change in students' STEM Identity was largely driven by their changes in their perceptions of how others recognized them as STEM people. In practice, this means that students' perceptions of themselves as a "STEM person" did not change, but they felt that others perceived them more as a "STEM person" after participating in the program.

To examine whether or not student demographic characteristics, including race, ethnicity, gender, grade in school, enrollment in honors courses, and STEM capital had any differential effects on pre- to post-program changes, we ran linear regression analyses on each of two larger scales, including all demographic characteristics listed above as covariates.

Self-Efficacy results from the regression analyses indicated no differential effects for race, ethnicity, gender, STEM capital, or enrollment in honors or advanced classes (Table 4 and 5). This indicates that students of different races, ethnicities, genders, or enrollment/non-enrollment in advanced classes were equally likely to see changes in STEM Identity and Self-Efficacy from pre- to post-program. There were no differential effects for grade in school on STEM self-efficacy, but there were significant differential effects for STEM Identity (Table 5, β=-0.121, p=0.014). The negative beta indicates that as students get older, they are less likely to see increases in STEM identity as a result of participating in one of the programs in the study. This is similar to findings from other studies (Jayaratne et al., 2003; Roberts & Hughes, 2019).

Self-EfficacyTable 4. Regression Results for STEM Self-Efficacy

	β	Standard Error	*p*
Gender	0.169	0.131	0.200
Asian	-0.026	0.091	0.774
Black or African American	-0.013	0.073	0.859
White or Caucasian	-0.085	0.063	0.178
Hispanic or Latino/a	-0.113	0.072	0.121
STEM Capital	0.001	0.002	0.799
Honors Enrollment	-0.003	0.053	0.951
Grade	0.007	0.024	0.786

Table 5. Regression Results for STEM Identity

	β	Standard Error	*p*
Gender	-0.171	0.260	0.510
Asian	0.130	0.236	0.583
Black or African American	-0.007	0.155	0.966
White or Caucasian	-0.023	0.134	0.866
Hispanic or Latino/a	0.165	0.147	0.265
STEM Capital	-0.002	0.005	0.734
Honors Enrollment	-0.021	0.111	0.853
Grade	-0.121	0.049	0.014

The overall results suggested a change in students' STEM Identity over the course of these programs. In order to begin parsing out what elements of the programs were most impactful on students' identity development, we conducted analyses on the role of program type (summer camp or after school program) and examined changes at individual sites. To test for differences in program type, we ran independent samples t-tests comparing changes in STEM Identity and STEM Self-Efficacy of summer camps compared to after school programs.

The results indicated that after school programs saw larger gains in STEM Identity than summer camps, but the difference was not statistically significant (Table 6). There were only minimal differences in STEM self-efficacy growth between after school programs and summer camps, and this difference was also not statistically significant.

Table 6. Changes in STEM Identity and Self-Efficacy by Program Type

	After School Programs		Summer Camps		
	Mean	SD	Mean	SD	*p*
Change in STEM Self-Efficacy	0.02	0.32	0.04	0.24	0.770
Change in STEM Identity	0.26	0.75	0.08	0.48	0.264

To further drill down potential differences based on programs, we examined pre- and post-program means for all seven scales and subscales at each site, and conducted paired sample t-tests to examine changes from pre- to post-program at each site. Results of these analyses are presented in Table 7 and indicate changes in both STEM Self-Efficacy and STEM Identity were relatively stable across sites. Only one site had a change that stood out from the rest in terms of statistical significance. The Texas Girls Collaborative Project's summer camp saw statistically significant increases in STEM Self-Efficacy from pre to post. Other sites had larger changes in means for either scale from pre to post, but lacked a large enough sample size to ensure enough statistical power to accurately calculate p-values.

Table 7. Individual Program Comparisons

	Site Type	Mean STEM Capital	SD	STEM Self-Efficacy Pre	SD	STEM Self -Efficacy Post	SD	*d*	*p*	STEM Identity Pre	SD	STEM Identity Post	SD	*d*	*p*
4-H Hennepin County	After School	2.4	14.65	3.8	0.74	3.8	0.65	0.00	0.608	3.3	1.01	3.1	0.95	-0.20	0.459
Texas Girls Collaborative Project	Camp	5.2	11.27	4.1	0.56	4.2	0.58	0.18	0.019	3.3	0.89	3.3	0.76	0.00	0.453
Project Scientist	Camp	4.8	7.96	3.8	0.73	3.9	0.57	0.15	0.575	3.1	0.73	3.1	0.62	0.00	0.923
Girls, Inc	After School	-9.3	20.74	3.6	0.63	3.7	1.24	0.10	0.784	2.2	1.25	3.1	1.80	0.58	0.311
MagLab	Camp	15.3	8.57	4.3	0.43	4.4	0.49	0.22	0.148	4.0	0.67	4.0	0.81	0.00	0.653
Marion P. Thomas Charter School	After School	0.0	9.98	3.8	0.58	3.8	0.54	0.00	0.574	2.8	0.83	3.2	0.88	0.47	0.217
Mote Marine Lab	Camp	11.1	9.13	4.1	0.43	4.1	0.45	0.00	0.391	3.8	0.63	4.1	0.77	0.43	0.238
New Mexico PBS	After School	8.5	10.92	3.6	0.51	4.2	0.57	1.11	0.898	3.5	0.38	3.8	0.65	0.56	0.262
SELF International	After School	-5.8	13.46	3.9	0.32	4.2	0.08	1.29	0.305	3.0	0.60	3.1	0.89	0.13	0.943
SpectrUM*	Camp	-5.5	14.85	-	-	-	-	-	-	4.1	0.94	4.0	0.24	-0.15	0.895
WSKG	Camp	-9.1	7.75	4.1	0.81	3.6	1.02	-0.54	0.084	2.9	1.14	3.4	0.55	0.56	0.213

*This site only had an n=1 for STEM Self-Efficacy scales, so the results were not reported to protect anonymity.

Rows highlighted in blue indicate our three case study sites

Qualitative Description

We conducted full case study research analysis on three sites[2]: Mote Marine Lab, Sarasota, FL; Project Scientist, Charlotte, NC; Texas Girls Collaborative Project, Austin, TX. The literature review team as well as the evaluation team drove our framework for observations and informed our understanding of each site.

1. The literature review team outlined the importance of cultural responsive teaching (CRT – Gay, 2013) along with a safe and supportive learning environment as the umbrella under which the SciGirls strategies need to occur to improve STEM identity. We did not observe CRT being used in any of our three sites. Educators informed the evaluation team that they did not fully understand what CRT is or how to use it in their programs. This highlights the need for a CRT training for SciGirls educators. We did observe structures of learning environments that made girls feel comfortable and willing to share multiple identities which we will highlight for each case.
2. We focused on activities at each of the three sites and summarized which strategies were used during each activity. We broke the camp into activities which we identified as having a clear start and stop time. For example, in the Mote Marine Lab camp the getting to know you activities started at the beginning of the day at 9 am. The teachers would usually end them by inviting the girls back to their seat. The next activity would begin as the teachers introduced the concept for the day with a PowerPoint and sometimes a demo. This would end when the girls were given a challenge – an activity that had them work in groups to solve a problem or answer a question. The strategies developed by the literature review team are:

    - Connect STEM experiences to girls' lives (Connections): moments where connections were made between science activity and the girls' lives
    - Support girls as they investigate questions and solve problems using STEM practices (Opportunities): moments where girls were able to think like scientists/engineers and experience a community of science
    - Empower girls to embrace struggle, overcome challenges, and increase self confidence in STEM (Growth mindset): moments where girls struggled or were encouraged to struggle productively
    - Encourage girls to identify and challenge STEM stereotypes (Confronting stereotypes): moments where girls or educators confront stereotypes related to science
    - Emphasize that STEM is collaborative, social, and community-oriented (Collaboration): moments where girls collectively engage with each other and potentially other scientists.
    - Provide opportunities for girls to interact with and learn from diverse STEM role models (Role models): moments where girls meet and/or interact with role models

3. In addition, we were focused on moments within the activities where girls had opportunities to perform STEM competence and be recognized for this competence

[2] Our original fourth site were not able to meet the 10-camper criteria and could not hold their program. We planned to use our MagLab SciGirls camp, however, the video footage during this camp was significantly different from the three other sites making it difficult to do the study we had planned. At the three main sites, the camera was positioned in one location so as to capture the entire room for the entire camp. In the MagLab program, girls could video each other but we were not able to observe all activities across the camp.

(Carlone & Johnson, 2007). What we noticed is that girls were also given time to perform other identities (e.g., art or creative portions, and athletics) as well as be recognized for these. These general identity opportunities allowed the girls to feel safe and valued in their respective learning environments and were important to STEM identity development, so we included general identity and general recognition moments as well, which we refer to as non-STEM identity.

Our qualitative comparative case study data indicate that recognition of both STEM and non-STEM identity performance leads girls to feel safe and confident to try STEM activities and struggle through concepts in ways that might not be feasible in formal K-12 settings. Informal science education programs allow girls to explore ways in which they can combine and build on their multiple identities in ways that allow them to see how STEM is relevant and valuable to their lives and a part of who they are. Educators need to pay attention to how each girl is recognized by the various educators and by the mentors present. There are moments where girls are not called on for answers or where role models and educators choose to engage in a scientific conversation with some girls and not others. These varying forms of recognition lead girls to see certain members of the program as STEM people worthy of having a conversation with experts and others as not-STEM people because they were not able to participate in conversations.

For the SciGirls strategies, we observed that no one activity incorporated all of the strategies. However, all three sites were able to incorporate most of them over the course of multiple days (See Table 8). This finding indicates that informal STEM education programs need to have multiple days or activities to fully integrate the SciGirls strategies. Mote Marine Lab and Project Scientist utilized "connections" the most during their program. Texas Girls Collaborative Project's most identified strategy was collaboration, while stereotypes was not used at all during this camp. Growth mindset was one of the other strategies used the least across all camps, however, educators and girls identified activities with this strategy to be among their favorites because they provided opportunities to struggle and overcome that struggle. All three programs employed role models and engaged girls in collaboration throughout the day as well as gave girls the opportunity to perform STEM competence and be recognized for that STEM competence.

Table 8. Average Use of SciGirls Strategies by Day for Each Case

	Mote Marine Lab	Texas Girls Collaborative Project	Project Scientist
Number of activities	13.8	15.5	12.8
Connections	5.8	5.5	6
Opportunities	2	4.5	2.3
Growth Mindset	1	3.5	1.3
Stereotypes	2	0	0.5
Collaboration	3	6.5	4.3
Role Models	3.6	6	2.3
Performance of STEM Competence	2.6	10.5	7.3
Performance of non-STEM Competence	1.4	2.5	3
Recognition of STEM Competence	3.4	7	3.5

Recognition non-STEM Competence	1.2	1	0.25

The use of strategies and identity components may be dependent on the length of the program. For instance, Texas Girls Collaborative Project was only 2 days so the girls might not have had enough time to encounter and dispel stereotypes or make connections to the girls' lives since the educators did not have time to get to know the girls. Confronting stereotypes and developing a growth mindset were both highlighted by the evaluation team as strategies that the educators had difficulty incorporating across all programs. The results of the qualitative portion indicate that opportunities to perform non-STEM identities and be recognized for these aspects of one's identity were important for creating a learning environment wherein the youth felt like their contributions were valued. This led them to feel empowered and supported to try new things and make mistakes. Project Scientist gave the girls the most opportunities to perform general (non-STEM) identity but the recognition was not always provided. Texas Girls Collaborative Project and Mote Marine Labs provided more opportunities for educators and peers to recognize and value these non-STEM identities. This indicates that all three programs gave girls opportunities to share their multiple identities.

In terms of STEM performances, girls had multiple ways in which to perform STEM competencies, typically through answering questions directed by educators, asking questions of educators and role models, and taking lead roles in group activities. As the program progressed in our three case studies, it became clear that those girls who were recognized by the educators and role models (e.g. being called on and having a longer follow up with their questions) participated more actively in the program and saw themselves as STEM people (Carlone & Johnson, 2007).

Mote Marine Lab, Sarasota, FL

Learning Environment. The Mote Marine Lab SciGirls Camp met daily from 9 am to 4 pm. There were two main educators who worked with the girls daily, a senior level educator who worked with the girls a couple of hours during the first two days and an intern who was present for the entire camp. Twenty girls participated in the program, all of whom were from Sarasota and the surrounding areas. Each morning the doors opened at 8:30. Girls who were dropped off before 9 am could come in and sit at tables and watch episodes of SciGirls that related to the science theme of the day. The camp officially started at 9 am each day. The first 30-40 minutes of each day was a getting to know you or **team building activity – times when girls could perform and be recognized for non-STEM related identities**. The entire camp was focused on marine science, but each day engaged the girls in activities and with mentors related to a specific focus within marine science: Day 1 Geology, Day 2 Chemistry, Day 3 Marine Biology, Day 4 Physics, and Day 5 Communication. The teachers would introduce concepts with a short PowerPoint and then facilitate a concept related activity where the girls engaged at their tables. The girls would meet one to two mentors from Mote each day to ask questions and learn about their careers. Often those mentors would spend an hour more with the girls to engage in an activity with them. The **question and answer (Q&A)** sessions during the PowerPoint presentations and during the mentor talks became **moments for girls to perform their STEM competence and be recognized by educators and role models** (e.g. experts). Time was set aside for the girls to **draft questions for mentors** and **answer reflection questions on camera**

through flipgrid. These were moments for girls to **perform general competence as well as STEM competence.** The teachers never directed the girls. The girls always had an opportunity to engage and were encouraged by the teachers to try new things. Throughout the day, girls were encouraged to write a “SciGirls shout-out” on a piece of paper and put it in the shout-out jar. The educators would read the shout-outs at the end of the day. These **shout-outs** became moments for girls to be **recognized** for multiple non-STEM (e.g. artist, helper, swimmer, leader) and STEM identities. The learning environment created within the Mote space allowed girls to perform multiple identities that were valued by educators and peers as evidenced by shout-outs. This sense of support translated into girls trying new things (e.g. kayaking, calculating speed of waves, and sharing their ideas and hypotheses) that allowed their STEM identity to evolve.

Strategies. We broke the camp into activities which we identified as having a clear start and stop time. For example, the getting to know you activities started at the beginning of the day at 9 am. The teachers would usually end them by inviting the girls back to their seat. The next activity would begin as the teachers introduced the concept for the day with a PowerPoint and sometimes a demo. This would end when the girls were given a challenge – an activity that had them work in groups to solve a problem or answer a question. In the Mote program, the number of activities ranged from 12-18 per day (See Table 9). All 6 strategies were covered over the course of the week. Each day there was at least one activity that provided an opportunity for girls to perform their STEM identity as well as their non-STEM identity and be recognized for it.

Table 9. Occurrences of SciGirls Strategies and Performance and Recognition of STEM and non-STEM Competencies across the Five Day Mote Marine Lab Camp

	Day 1	**Day 2**	**Day 3**	**Day 4**	**Day 5**
Number of activities	**18**	**14**	**12**	**13**	**12**
Connections	7	3	6	7	6
Opportunities	2	2	3	1	2
Growth Mindset	0	0	1	1	3
Stereotypes	1	3	2	2	2
Collaboration	3	3	4	1	4
Role Models	5	3	3	4	3
Performance of STEM Competence	2	3	4	1	3
Performance of non-STEM Competence	2	1	1	2	1
Recognition of STEM Competence	4	3	4	2	4
Recognition non-STEM Competence	1	1	1	1	2

Texas Girls Collaborative Project, Austin, TX

Learning Environment. This camp was a two-day camp. There were four educators who worked with the girls for all activities. Two senior level educators served as the lead instructors for the activities. One of these educators managed the logistics of the camp and was the lead instructor. Another educator served as the main facilitator who presented the task and brought the girls back together at the end of the task. The other two educators were undergraduate engineering students who served the dual purposes of assistant instructors and role models. They helped the girls during tasks, entertained the girls at the start and end of the day, and served as role models during lunch times when they sat with girls and “talked shop” with them. Nineteen girls participated in the research portion of this camp, of which some girls previously knew each. Girls arrived at various times in the morning and they would sit individually, interact socially, or engage in other non-STEM competencies such as singing and dancing. At the start of each day, girls engaged in an activity to break the ice and to further get to know one another. Like, the Mote Marine Lab camp, these experiences served as **team building activities that gave the girls opportunities to perform and be recognized for their non-STEM related identities**. Additionally, lunch and snacks were provided for all the girls. The girls were encouraged to help themselves to snacks whenever they wanted. Lunches were brought in and the assistant educators and other visiting role models sat with the girls and ate with them at their tables during these times. These interactions helped build a collegial atmosphere as the girls and the role models interacted casually, like peers, rather than other more structured activities in which the role models sat in front of the girls and talked about and answered questions about their experiences. During these times, the girls were encouraged to **share the work that they had done (i.e., performance**) **and the role models asked questions about this work (i.e., STEM recognition**). This type of **performance and recognition** also **occurred when the girls were working on activities and the role models would come around and talk with them about their designs**. The camp was centered on **engineering** and all activities were framed as challenges in which the girls worked collaboratively to find solutions, to test out those solutions, and to share the final solution to the problem with the entirety of the camp community.

Strategies. During the engineering challenges, girls were often positioned to struggle – growth mindset - to find solutions and then to share these struggles with their peers at the end of the task. Many of the activities that the girls found most enjoyable were the ones that they identified as being frustrating because of this struggle. The lead instructor recognized this struggle as STEM competence and connected the idea of struggle back to the larger picture of what engineering is and what engineers do. Role models played a large part in this camp and the organizers had role model panels each afternoon, had the role models eat with the girls (rotating around tables to talk with different groups), and had a panel at the parent dinner on the second day. All role models were women engineers at different stages in their careers, which ranged from recent graduates to more senior level positions. Role models shared their experiences and answered girls’ questions, and sometimes stayed and helped girls as they engaged in activities. The end of this camp concluded with the girls being recognized as engineers as they were asked to guide their family members through an engineering challenge. In the Texas Girls Collaborative Project, the number of activities ranged from 8 to 14 per day and all 6 strategies were covered, except for confronting stereotypes. Additionally, girls were provided with at least one activity where they could perform their STEM and non-STEM identities (See Table 10).

Table 10. Occurrences of SciGirls Strategies and Performance and Recognition of STEM and non-STEM Competencies across the Two Day Texas Girls Collaborative Project Camp

	Day 1	**Day 2**
Number of activities	**17**	**14**
Connections	9	2
Opportunities	5	4
Growth Mindset	3	4
Stereotypes	0	0
Collaboration	7	6
Role Models	6	6
Performance of STEM Competence	13	8
Performance of non-STEM Competence	3	2
Recognition of STEM Competence	7	7
Recognition non-STEM Competence	2	0

Project Scientist, Charlotte, NC

Learning Environment. The Project Scientist camp was a multi-week program. We observed one week of the camp which focused on the different types of energy. Nine girls participated in the research portion of the camp for this week. Two educators worked with the girls. One was the lead facilitator and provided directions to the girls for each activity and was often observed joining in with the girls or working side-by-side with the girls on her own project. She most often provided clear step-by-step directions at the start of an activity, but then let the girls work together to complete the tasks. Sometimes, the teacher would hold a whole class discussion, in which she was the director of the conversation, about a type of energy. The second educator was an assistant and floated around the room to help girls with the activities that they were working on. Unlike the other two camps, the ice breaker activity for this camp was an engineering challenge which situated the girls as problem solvers. This was not the first week of the camp and many of the girls already knew each other and had already formed strong bonds. The girls engaged in other **team building activities** such as dance parties where they matched the dance steps of virtual dancers on the overhead projector. In these instances, the girls **performed and were recognized for their non-STEM related identities**. Each day was structured such that girls arrived each morning and played outside before they were introduced to a STEM superstar (including watching SciGirl episodes) who gave a talk about their work as it related to STEM. STEM superstar held a diversity of positions including a chef, an air conditioning employee, and scientists and technicians at Duke Energy (who girls interacted with during their field trip to the Duke Energy Plant off-site). All superstars talked about their positions and highlighted how their jobs overlapped with STEM disciplines. The girls then went upstairs to their classroom and engaged in multiple activities centered on the different types of energy. Like, the Mote camp,

shout-outs were a form of recognition in which other girls acknowledge the STEM and non-STEM abilities of their peers. On the last day of the week, **the lead educator recognized the competence of the girls as she gave a shout-out of their successes** in front of the girls' parents in an auditorium setting. This shout-out **acknowledged how the girls had struggled and persisted through particularly hard tasks that they were presented with**. At the end of each day, girls either went to Physical Education, Maker Space, or Art. Assistant teachers led these sessions, while the teachers went home for the day. In these spaces, the teachers provided minimal instruction and, instead, they let the girls play with the materials. For instance, one day the girls made twirling ballerinas. Directions were placed on the smartboard but no one directed students' attention to those steps until the girls were unsure of what they were to be doing. In these activities girls were provide autonomy to figure out and complete the task.

Strategies. In the Project Scientist camp, girls were given directions for each activity and the materials to complete that activity, they were provided with space to struggle and work through problems. They were not held to the step-by-step directions that were sometimes presented to them but they were reminded of the task if they veered too far off topic. For the most part, the girls collaborated on activities, but some girls lost interest if a task went on too long or if a problem arouse. In these cases, the girls in some groups recognized the expertise of other "more knowledgeable others" and persisted and pursued help. In other cases, girls moved away from activities and engaged in non-related activities such as singing or dancing. All the strategies were covered across the days of the camp that we observed and the number of activities ranged from 6 to 17 (Table 11). The strategy of confronting stereotypes occurred the least. Like the other two camps, girls were provided with at least one activity where they could perform their STEM and non-STEM identities, except for the day when the girls went on a field trip. On this day, the girls observed many different types of role models and they had a few opportunities to engage in activates that aligned with the strategies, they were, however, not often positioned to perform or be recognized as STEM or non-STEM.

Table 11. Occurrences of SciGirls Strategies and Performance and Recognition of STEM and non-STEM Competencies across the 4 Day Project Scientist Camp

	Day 1	**Day 2**	**Day 3**	**Day 4**
Number of activities	**16**	**12**	**6**	**17**
Connections	7	9	4	4
Opportunities	2	3	1	3
Growth Mindset	0	2	0	2
Stereotypes	1	0	0	1
Collaboration	7	4	2	4
Role Models	1	2	5	1
Performance of STEM Competence	11	7	4	7
Performance of non-STEM Competence	3	3	0	6

Recognition of STEM Competence	2	5	0	7
Recognition non-STEM Competence	1	0	0	0

Conclusion

Our goal for this study was to determine what role the SciGirls Strategies had on participating youth's STEM identity. Both the quantitative and qualitative results support the positive impact of the six strategies as well as the learning environment wherein the strategies occur. Each of our case study sites utilized different strategies more frequently than others, making conclusions as to which strategies are most effective difficult to tell. More research needs to be done to determine how each strategy influences STEM identity development or in what ways the intersections among the strategies influence STEM identity development. An observation rubric to highlight when and how often each strategy is used would be a useful tool for future research on the SciGirls Strategies. We did not see evidence of culturally responsive teaching (CRT) in our observations which supports the evaluation results indicating that teachers need more training on using CRT effectively.

In our study we utilized Carlone and Johnson's (2007) conceptual framework which describes STEM identity development as a process wherein individuals have opportunities to perform their STEM competence and be recognized for that competence by experts. Both the quantitative and qualitative results highlight the importance of recognition (external perception of others as a STEM person) in the development of a STEM identity. In our case study analysis we were able to observe various forms of recognition that occurred. These types of recognition include: call and response from teachers; question and answer time with mentors/role models; group work; and presentations. The value of observing programs over multiple days or activities is that we could see some girls become more confident in raising their hands and participating in dialogue because of the recognition they received, whereas others began participating less as a result of the lack of recognition they received. Future research should study the impact of the various types of recognition that occur to determine how practitioners can improve their strategies in recognizing youth so as to positively impact their STEM identity. Our research indicates that utilizing the SciGirls Strategies in informal STEM education programs improves participating youth's STEM identity. Therefore, the training of informal STEM educators in these strategies is important to address the shortage of women and women of color in STEM fields.

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