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SciGirls Strategies

Note: A bug in the current version of WordPress prevents us from listing the authors in the correct order above. The correct order is: Rita Karl, Bradley McLain, and Alicia Santiago.

SciGirls Strategies is a National Science Foundation–funded project led by Twin Cities PBS (TPT) 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 three-year initiative aims to increase the number of high school girls recruited to and retained in fields where females are traditionally underrepresented: technical science, engineering, technology, and math (STEM) pathways. We seek to accomplish this goal by providing career and technical education (CTE) teachers with professional development focused on gender-equitable teaching strategies and role modeling.

In the United States, women remain significantly underrepresented in the STEM workforce, particularly in CTE fields such as engineering, manufacturing, and computer science. In 2012, in Minnesota's Twin Cities metropolitan region, only 1.1% of postsecondary degrees were awarded to women in technology and engineering fields, and none in manufacturing and trade. Although CTE is widely available across Minnesota (in middle and high schools, career centers, community and technical colleges, and other postsecondary institutions), young women make

up fewer than one in four students in CTE programs, fewer than one in six students in manufacturing and construction-related CTE programs, and fewer than one in 10 students in transportation and logistics CTE programs (Mueller 2014). CTE can give women the knowledge and skills required to enter higher-paying “nontraditional” occupations for women, which are legally defined as those in which less than 25% of the workforce are women (DOL 2008). These include occupations such as computer science; mechanical, electrical, and materials engineering; automotive repair; architecture; construction; manufacturing; aviation; and firefighting, among others. To encourage more girls and minorities to pursue STEM careers, the Minnesota Department of Education recommends connecting course work to students’ lives, improving teaching through professional development, and providing students with internships, mentoring, and hands-on training in CTE-related STEM jobs. This echoes the Perkins Act, which aims to increase the quality of technical education and recommends that states collaborate with industry to enable CTE faculty to consistently refresh their industry knowledge and instructional practices, including gender equity.

SciGirls Strategies’ activities include:

1. developing and delivering a professional development short course for CTE educators on gender equitable strategies,
2. delivering and evaluating role model training for female STEM professionals,
3. creating and disseminating role model videos featuring diverse female STEM professionals, and
4. completing a research study that investigates how using gender-equitable strategies and female role models impacts girls’ STEM identity.

SciGirls Strategies is based on *SciGirls*, a PBS media educational program anchored by two decades of research about what engages girls in STEM learning and careers. *SciGirls*’ gender-equitable strategies have encouraged girls’ authentic collaboration, self-reflection, and STEM participation, and they have been proven to increase girls’ interest in STEM and improve their attitudes toward these fields (Flagg 2012, 2016; Knight-Williams 2008, 2014).

SciGirls Strategies is designed to address barriers that prevent many girls from fully participating in technical STEM career tracks. These barriers include limited exposure to female role models, stereotypes about girls’ lack of STEM ability and interest, commonly held misperceptions about STEM fields being “unfeminine”; low STEM self-esteem, and a lack of knowledge about or misunderstanding of STEM fields. Additionally*, SciGirls Strategies* uses digital narratives and media-making to help faculty explore and employ gender-equitable instructional strategies and help girls develop positive STEM identities.

With the overall goal of retaining more girls and women in nontraditional CTE-STEM pathways, our theory of action contends that if educators use more gender-equitable strategies and resources, more girls will be recruited and retained in technical STEM studies and careers. We are exploring the impact of providing students with a gender-equitable STEM classroom in three ways:

1. preparing educators to employ gender-equitable teaching strategies;
2. exposing girls to female STEM role models; and
3. considering outcomes that reach beyond students’ scores and academic performance to include STEM-related attitudes, beliefs, personal relevance, meaning-making, and

sense of self.

Behind this theory resides the question of whether this integrated approach can help girls generate more positive STEM-related identities, and ultimately pursue STEM studies and careers.

Enhancing Teaching Practices: Course Content and Year 1 Evaluative Data

During year 1 of *SciGirls Strategies*, TPT developed and piloted the course with eight educators from three Twin Cities–area schools. Over the next two years, we will engage an additional 48 educators, reaching more than 400 girls. Educators participate in a hybrid (face-to-face and online) course on gender-equitable teaching strategies. The course is comprised of six three-hour sessions of professional development, plus one hour per week of online reflection.

Course participants learn the "*SciGirls* Seven," a set of research-based strategies that encourage the use of collaborative, meaningful, creative, and open-ended activities; promote a growth mindset and critical thinking; and emphasize the use of female STEM role models (TPT 2013). Each strategy aligns with general practices in technology and engineering fields. CTE educators can find close alignment between the skills required for STEM career success and the *SciGirls* Seven strategies (Figure 1).

Figure 1

The course underscores the importance of role models, student-focused instruction, cultural awareness, and relevant learning experiences, and it provides strategies that promote creativity and critical thinking, a growth mindset, and respectful communication (Figure 2). Upon course completion, participants are expected to integrate the strategies into their teaching and counseling practices throughout the following semester.

The course format consists of direct instruction, small-group discussions, reflection, and activities. Course content includes gender equity and cultural competency resources; opportunities for participants to discuss, view, and create video reflections on the use of strategies; short-form videos showing ethnically diverse female STEM role models; and autobiographical videos created by girls describing their STEM experiences.

During year 1, evaluative data was collected via observations, surveys, and interviews. Educators reported that the course impacted their perceptions of what girls need for CTE/STEM classroom success. Participants reported increased and specific use of the *SciGirls* Seven strategies, confirmed by post-training classroom observations. Educators also reported observing changes in their female students' behavior, including increased classroom participation and confidence. Year 1 provided valuable insight into educators' needs, which will help the project team improve and refine content and course delivery.

Figure 2

Credit: ©TPT

Digital Media Narratives: Educator-Created Videos and Role Model Videos

SciGirls Strategies' multiple digital narrative resources include: *educator-created videos* that portray teachers discussing STEM and gender equity and *student-created videos*, in which girls share autobiographical stories about their STEM experiences. *Role model videos* feature female professionals in nontraditional STEM fields discussing their work and lives.

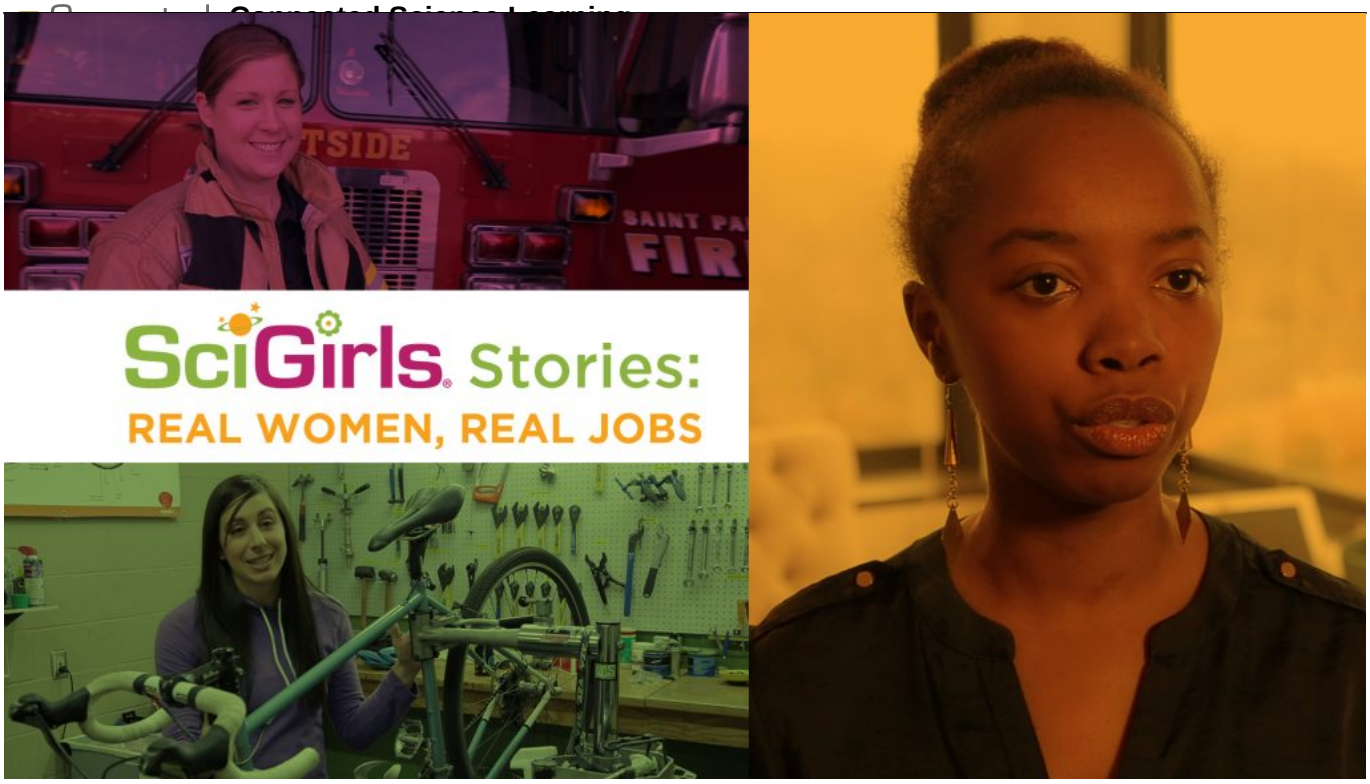
http://csl.nsta.org/wp-content/uploads/2017/01/SciGirls-PSA-2015-Final-Project-1.mp4

The following two educator-created samples help our evaluators and researchers explore how girls create meaning around STEM. They were intended for use with students, or as a way for educators to reflect upon gender equity.

- Bonnie Larson: "I created a video to attract girls to engineering. I specifically chose engineering since it is the least-represented by women in the STEM fields.

- Lauris Grundmanis: "I 'interviewed' my mother, who was one of three women in a class of 100 admitted to the University of Minnesota Dental School in 1950."

The 12 role model videos portray ethnically diverse women in nontraditional technical fields describing their career trajectories and lives. The women represent many diverse and underrepresented professions including firefighter, pilot, welder, carpenter, architectural estimator, technology manager, software engineer, web developer, bicycle engineer, biomedical engineer, product engineer, and traffic engineer. The videos' appealing storylines help girls invest in and relate to the characters. Provided on a flash drive for ease of use, the videos help faculty spark discussion about CTE/STEM professions.



Role Model Training of Female CTE Professionals

SciGirls Strategies is investigating the extent to which exposure to female STEM role models, a widely accepted best practice for STEM engagement, impacts girls' CTE studies or career paths. To this end, 25 CTE-related industry role models from technical fields, such as technology, engineering, and the trades, attended a web-based training based on two *SciGirls* publications: *SciGirls Seven: How to Engage Girls in STEM* and *SciGirls Role Model Strategies: Encouraging Girls to Consider STEM Careers*. The women represented nontraditionally female professions in engineering, technology, manufacturing, and trade (e.g., auto mechanic, aviation instructor, software engineer, web developer, process engineer, machine design engineer, safety engineer, apprentice plumber, crane operator). The training was highly rated, with participants reporting increased skill in relating to students, sparking girls' STEM interest, and articulating their educational and career paths. Post-training, a Role Model Meet & Greet evening was held with all role models and educators. Participants watched role model videos and networked with each other. Role models were encouraged to host workplace visits (field trips), visit schools, and offer mentoring opportunities to educators participating in *SciGirls Strategies*.

STEM Identity Research Study: Student-Created Videos to Examine STEM Identity Construction

SciGirls Strategies' research examines girls' experiences with equitable strategies embedded into classroom teaching and explores how these experiences contribute to their STEM-related identity construction. *STEM identity* is defined as the degree to which a person integrates STEM into his or her sense of self. It can be represented as a continuum from a negative STEM identity, characterized as STEM disinterest, avoidance, or even phobia, to a positive STEM

identity, characterized as STEM interest, affiliation, and ownership (McLain 2012). Our research questions are:

1. How does the experience of participating in all of the *SciGirls Strategies* project components impact girls' STEM identity construction?
2. What are the impacts of the project's individual components: classroom instruction, role model activities and videos, and autobiographical story sharing?
3. What modifications to the STEM identity framework are indicated by the findings?

The study employs short-form autobiographical videos, journals, and interviews as part of a case-study approach that illuminates selected girls' experiences. Video production combined with other research methods enable the researcher to explore how girls connect STEM learning to their lives.

Research points to STEM identity formation as playing a major role in STEM literacy and continued STEM interest and persistence, particularly for minorities (Carlone and Johnson 2007; Tan et al. 2013). Identity development is a powerful strategy to address the STEM barriers facing young girls because it integrates self-concept, sense of agency, importance of role models, attitudes, personal relevance, motivation, and ultimately choices, behaviors, and persistence.

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Figure 3

Our research focus is on the girls in the study (shown in the center of Figure 3) and their relation to the *SciGirls Strategies* project deliverables. The model articulates different areas of personal growth and learning (cognitive and noncognitive) as *science identity construction zones* (CZ, in orange in Figure 3). These are:

- agency (or belief in one's capabilities),
- content confidence (with the STEM content in the project),
- emotional connection, and
- personal relevance.

These zones are based on prior research demonstrating their importance in leading to outcomes considered indicators of positive science identity.

Behavioral outcomes based on the cognitive and noncognitive construction zones are shown around the periphery. They include:

- STEM-related capacity,
- science concept,
- STEM-related attitudes and self-efficacy, and
- future STEM-related choices.

Operationally, our research will determine whether *SciGirls Strategies* impacts these zones and outcomes for participating girls. Our research also examines the impacts of teachers and role models. This framework, and its refinement throughout this study, will serve to further reveal and clarify the processes and markers of STEM-related identity development for girls.

The girls' videos highlight their in- and out-of-school lives, providing the researcher with rich data to examine STEM identity construction (see Figure 2). Girls receive simple guidelines:

1. *You* have to make it.
2. It has to be about *you*—what you think and feel and your experiences and reactions.
3. It should include experiences in STEM, but need not be limited to STEM only.

Girls lead the project, shooting their own video, editing, choosing music, adding narration (or not), and sharing it. Students deliver two versions, one for sharing and a second containing a director's commentary. This commentary is an open-ended self-interview recorded as they watch their videos. Participants are directed to provide "behind-the-scenes" information using prompts about their creative intentions, technical decisions, side stories, and other information that may be relevant for understanding their narrative processes. Researchers then analyze these videos using visual and verbal-linguistic coding, director's commentary analysis, scene-by-scene plot mapping, narrative typing to characterize the stories, and *member checking* (a form of data triangulation in which researchers present preliminary findings to participants for collaborative analysis and interpretation; the intent is to both verify and refine the researchers' own interpretation or to correct it if needed). Finally, video analysis is synthesized with the other data sources.

Aside from being an effective data collection method, participant-created videos are powerful tools for enhancing the depth and meaning of a learning experience. These videos have been shown to elicit a high level of student motivation, creativity, and enjoyment, resulting in authentic engagement and learning. Furman and Calabrese Barton (2006) note that student-created videos about science give students a voice that helps them gain a sense of their own abilities and develop their science identity (Adams et al. 2014; Hartnett, Malzahn, and Goldsmith 2014). O'Neill (2005; 2010) notes that student participation in an informal science video project helped students cultivate a sense of ownership and motivated them to learn science.

Student-Created Videos: Year 1 Video Production

Bradley McLain provided initial technical and video storytelling instruction to case study participants, followed by two months of weekly project support. Due to academic demands and extracurricular activities, several girls dropped out after training, resulting in only two (rather than four) student-created videos being submitted. One girl's video and director's cut is shown below.

Consistent with other projects using this strategy, the girls reported that creating their videos deepened their reflection on their learning and how they have (or have not) integrated STEM into their lives and sense of self. Although much too small of a sample to make any recommendations for use by others, this feedback echoes prior research indicating the value of this approach for instructional practice.

Preliminary analysis indicates:

- the importance of peer groups and social interactions in the learning environment,
- a strong emotional connection to their learning experiences,
- an integration of in-school and out-of-school experiences is important to STEM identity construction, and
- the importance of clear structure and support around video production.

An absence of role model use in the videos is significant. Educators were not required to use a specific number of role models, so due to time restraints, case study educators did not fully employ them. Because we do not provide a “curriculum,” fidelity of implementation is challenging. This is a common issue in efforts to bridge informal methodologies in formal educational practices.

Lessons Learned and Looking Ahead

Year 1 illuminated much about how informal educational programming such as *SciGirls* can be leveraged into a formal classroom environment.

In Year 2, we plan to:

- Increase the number of participating educators and girls in the initial case study pool.
- In particular, increase the sample size of case study girls. As is common in case study research, the initial number of participants is small to permit a “deep dive.” The research plan includes up to four cases to be included in each project year. Together with survey and observation results from non–case study girls and teachers, we hope to formulate an accurate description of the project’s impact and learn which components were more personally relevant in terms of STEM identity construction.
- Provide more incentives for case study participants.
- Continue supporting use of role models. We are excited to report that four Year 1 educators are interested in integrating STEM role models into their classrooms during this academic year. One way we are supporting the use of role models is by ensuring that case study educators have specific contractual plans and support for including role models or role model videos in their instruction.
- Encourage educators to use reflective video production with all students, not just case study participants.
- Increase direct parental communication, providing email, text, and phone messages to increase parents’ understanding and support.
- Create milestones and incentives to improve student-created video production. Beginning earlier and providing a well-timed deadline structure will foster steadier progress.

Participant-created video projects are rapidly becoming part of today’s classrooms (and alternative learning spaces), as they can enhance youths’ motivation, multimodal literacy, problem-solving skills, and content knowledge. Overall, producing videos was a positive experience for girls and allowed them to explore their STEM identities in school and outside school, in meaningful ways.