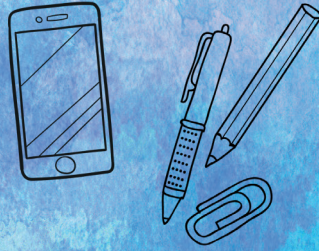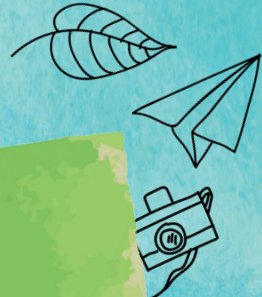# SciGirls

pbskids.org/scigirls

SciGirls Strategies: How to Engage Girls in STEM

Welcome to SciGirls

Every Girl Can Be a SciGirl!

The bold goal of **SciGirls** is to change how girls see science, technology, engineering, and math (STEM) and how the world sees girls. Research shows that, for a variety of reasons, some girls begin to lose interest (and confidence in their abilities) in STEM in middle school. **SciGirls** engages girls between 8 and 13 years old, helping them through these challenging years to arrive in high school with a positive attitude toward STEM studies and careers.

We know our recipe works: **SciGirls** grew from our successful outreach program, established in 2005. Today we partner with museums, schools, universities, and afterschool programs, offering training, media, and multilingual activities. The **SciGirls** model is flexible. Partner organizations tailor these offerings specifically for the girls (and boys) in their communities.

What makes a SciGirl? **SciGirls** work together, make a difference, ask questions and explore, are creative and unique, aren't afraid to make mistakes, motivate others, and use STEM to change the world. SciGirls find STEM in their backyards, on the beach, or on their bicycles, because they know that STEM isn't just serious business, it's also everyday fun.

Most importantly, every girl can be a SciGirl. **SciGirls** is not only for girls who already "get" STEM, but also for those who are reluctant to dive in. A background in STEM teaches important problem-solving skills and a way to think that is transferable to any field and any career. All girls can be confident, capable explorers of all things STEM. It's the **SciGirls** way!

What about the boys?

When you hear the name **SciGirls**, you might think, "I work in a mixed gender setting, is **SciGirls** for me?" The answer is YES! Everyone benefits from a gender equitable approach to STEM.

Table of Contents

Our National Girls Collaborative Project Partners

Thank you for your interest in engaging girls in STEM. Did you know there's an extensive network of organizations and individuals committed to pursuing this common goal? The National Girls Collaborative Project brings together these groups through local collaboratives and The Connectory, which helps organizations and individuals network, share resources, find programs, and collaborate on STEM-related projects. You can list your program at **theconnectory.org**. All programs in The Connectory are also featured on the **SciGirls** website at **pbskids.org/ scigirls/clubs.**

Program Overview

ON TV

SciGirls airs nationally on PBS, the most trusted media brand for children. Each half-hour **SciGirls** episode follows a different group of enthusiastic, real girls and their mentor, as they collaborate, communicate, engineer, and discover. They're accompanied by two animated characters, a determined SciGirl named Izzie and her best friend Jake, who tie the series together with their ongoing adventures.

The backbone of each **SciGirls** episode is the science, technology, engineering, and math (STEM) that drive each project. Every experiment may not turn out perfectly, but each episode showcases important characteristics of a STEM project: teamwork, challenges, problem solving, freedom to express ideas, and support from a mentor. The SciGirls also model important practices like brainstorming, questioning, predicting, observing, measuring, classifying, investigating, recording, interpreting, graphing, and communicating. These practices are at the heart of the scientific and engineering design processes.

ONLINE

The **SciGirls** website is hosted on **pbskids.org**, one of the premier educational destinations for young people on the Web. This site is a unique space where girls can connect, create personal profiles, play games, and watch every episode. Check us out at **pbskids.org/scigirls**.

ON THE GROUND

SciGirls offers parents and educators resources in English and Spanish to support girls, start **SciGirls** clubs, or enhance existing educational program. Since 2011, the **SciGirls** outreach program has worked with partner organizations in 35 states and the territory of Puerto Rico to build programs that inspire girls to pursue STEM studies and careers. During that time, **SciGirls** staff and Certified Trainers have trained over 3,300 informal and formal educators to incorporate the research-based **SciGirls Strategies** into their STEM programs. For more information about becoming a **SciGirls** partner visit **scigirlsconnect.org**.
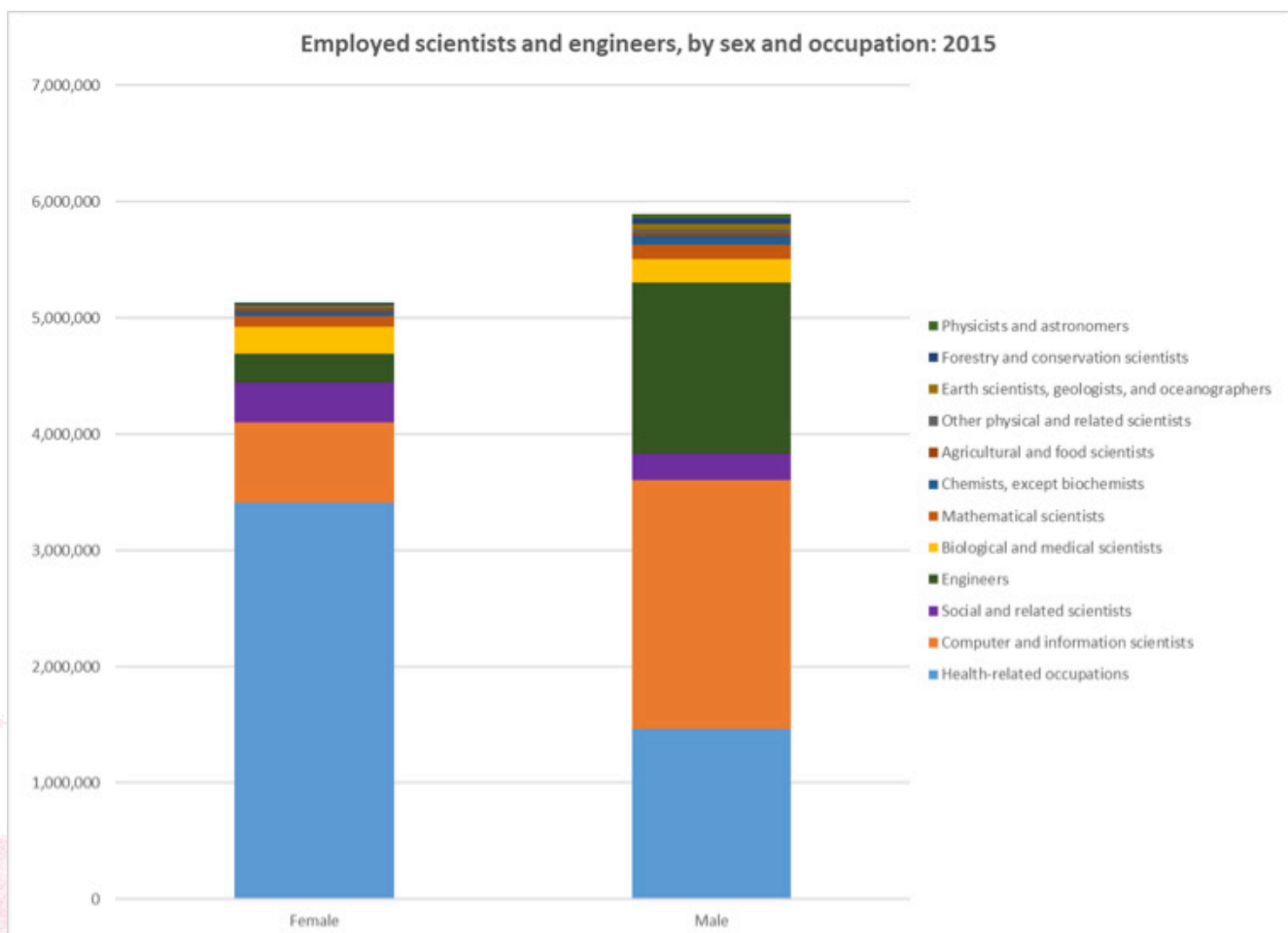
The Big Idea

What the Research Shows

Despite the number of women in science and engineering (S&E) occupations or with S&E degrees increasing steadily over the past two decades, a gender gap continues to persist in the United States. Women of all racial and ethnic groups, especially Hispanic and Asian women, are reflected in these increases; however, women from groups historically underrepresented in STEM continue to be significantly underrepresented in the STEM workforce[1].

Although they make up half of the U.S. college-educated workforce, women hold less than 30% of STEM jobs[1]. Women who are employed in S&E occupations are concentrated in different areas than men, with relatively low proportions in engineering, physical sciences, and computer and mathematical sciences[1]. Minority women comprise fewer than 1 in 10 employed scientists and engineers[2]. The graph below shows the comparison of women and men in STEM professions in 2015.

National Science Foundation, National Center for Science and Engineering Statistics, National Survey of College Graduates (NSCG) (2015), https://www.nsf.gov/statistics/srvygrads/.

For the United States to remain competitive in STEM fields and to prepare our girls for the future workforce, we must close the gap. It is important to recognize that girls and boys do not display a significant difference in their abilities in mathematics and science; rather, the cause for the gender gap in STEM is social and environmental[3, 4, 5, 6, 7]. Research shows that girls start losing interest and confidence in STEM during middle school and this decline often continues as they get older[6, 8].

This is where **SciGirls** can help. It is important to spark and strengthen girls' interest and confidence in STEM subjects before high school, when girls are deciding what kind of person they want to be[4, 9]. The **SciGirls** videos, combined with our girl-centered, inquiry-based activities and a community-focused website, can foster girls' interest in STEM and shape their attitudes toward these fields. **SciGirls** welcomes girls from all experiences. We do not discriminate based on gender identity, gender expression, or sex assigned at birth. **SciGirls** resources, which are culturally relevant to all girls can advance gender sensitivity among educators. With this awareness, educators can recognize and avoid the unconscious behaviors that often contribute to climates unfavorable for youth in STEM classrooms or activities.

Meeting the Challenge

SciGirls empowers you to create a more gender equitable and culturally responsive learning environment that inspires, engages, and helps girls thrive in STEM. We know that eliminating the gender gap is challenging work; even convincing administrators, parents, or fellow staff of the importance of this mission can be hard. For help beyond the research outlined here, please see our suggested readings on page 17. Your efforts will not only help girls, but will improve the general climate in your educational setting and level the playing field for all learners. For more information on the importance of STEM encouragement and for tips on how you can help, please see **scigirlsconnect.org**.

Developing a STEM Identity: I see myself as a science person!

Research suggests that developing a STEM identity is an important factor in girls choosing to participate in STEM courses, activities, and potentially careers. STEM identity refers to a person's sense of who they are, want to be, and what they believe they are capable of in relation to STEM. Girls' STEM identity development is dependent upon factors like interest, knowledge, self-confidence, performance, and recognition[10, 11, 12, 13, 14, 32].

SciGirls Strategies are designed to instill confidence and persistence, and to motivate girls to develop a STEM identity during a crucial time in their academic and personal growth. The middle school years are when girls are deciding "what kind of girl to be" and figuring out desired versions of their future selves[4, 9]. This is when educators can help girls overcome barriers and push against stereotypical views to develop strong STEM identities. The identities girls develop are shaped by how they see themselves and how others see them in multiple spaces including in-school and out-of-school, social, and home/family[9, 15, 16, 17, 18, 19] across intersecting cultural characteristics including gender, race, ethnicity, and class[20], and in relationship to concepts of femininity that are congruent with ideas of warmth, sensitivity, cooperation, and the need for belonging[4, 5]. When a girl sees STEM as something that represents her interests, she has confidence in her abilities, and can embrace and celebrate the differences which make her competitive in STEM[8, 9, 21, 22].

Framework for the SciGirls Strategies

In addition to the **SciGirls Strategies** themselves, research and practice highlight the need for educators to consider the learning environment and to utilize culturally responsive practices to engage and effectively serve all girls in STEM, especially girls of color and girls from marginalized communities. Both the learning environment and culturally responsive practices are important in helping foster a STEM identity.

Create a STEM for ALL learning environment

For the **SciGirls Strategies** to be as effective as possible, it is critical to provide a supportive space and learning environment that fosters mutual respect, looks and feels inviting, and allows girls to feel that they belong[23, 24]. Research shows that a learning environment that is comfortable, personally meaningful, collegial, and supportive can positively impact girls' interest and motivation in STEM and positively influence girls' STEM identities[15, 22, 25]. The learning environment must also be culturally responsive, one that recognizes, reflects, and validates the history, cultures, and world-views of youth. In such an environment, diversity is valued as an asset, which leads to effective teaching and learning.

Tips to create a STEM for ALL learning environment

- *Create a warm and welcoming space that is accessible to all and fosters cooperation and acceptance.* Create an organized space where everyone can move easily and safely and work in a collaborative way.

- *Learn about your youths' needs.* The tools to make the environment accessible and welcoming vary depending on individuals' needs (vision or hearing impairments, sensitivity to light, etc).

- *Practice and encourage active listening.* Active listening includes orienting your body to the speaker, maintaining eye contact, nodding your head, using facial expressions (e.g., smile, frown) and verbal cues (e.g., "That is interesting").

- *Create an atmosphere of mutual respect.* Shared expectations help develop a sense of community and encourage positive interactions.

- *Use icebreakers so youth can introduce themselves in a non-threatening manner.* This activity allows your youth to relate to each other and share and appreciate differences among them.

- *Provide opportunities for youth to voice their opinions and feel accepted.* Encourage active participation by all youth and structure tasks that have multiple paths to a solution.

- *Form meaningful connections with youth.* Take some time to view everyone as an individual—encourage them to share their own lives and interests—and show them that you believe in their abilities.

Adopt Culturally Responsive Practices

Embrace diversity

The population of the United States is becoming increasingly diverse and this diversity is reflected in our K-12 schools. By 2044, half of all Americans are projected to belong to a minority group resulting in a significantly more ethnically and culturally diverse population. For example, one in four female students in public schools across the nation is Latina; by 2060 that number will increase to one in three[26]. Therefore, the youth you work with may differ from you and each other in ethnicity, race, language, and socio-economic background. To truly engage diverse youth in STEM, it is critical to reach out to them in ways that are culturally responsive and appropriate.

Culturally responsive practices (CRP) support student achievement by providing effective teaching and learning in a culturally supported environment that is student-centered. In these environments, educators identify, nurture, and use the strengths that students bring to the learning space to facilitate and promote student achievement[27]. Geneva Gay, a professor in multicultural education, describes *CRP* as teaching to and through the strengths of students who are culturally, ethnically, and linguistically diverse. She defines *culturally responsive teaching (CRT)* as a process of using cultural knowledge, prior experiences, and performance styles of diverse students to make learning more appropriate and effective for students[28].

CRP empowers youth by respecting and incorporating their interests, identities, cultures, backgrounds, and experiences as central to the learning process[24, 29, 30]. *Culturally responsive practices* are particularly effective in motivating and engaging girls of color in STEM studies and careers as they recognize girls' culture as an important strength upon which to construct the STEM learning experience[31 ,32].

Getting started on your journey to cultural responsiveness
A culturally responsive educator is someone with the knowledge, attitudes, and skills to work effectively with and successfully engage youth from different cultures. Cultural responsiveness is a sensibility that we acquire throughout our life. Here are a few tips on how to become more culturally responsive.

- *Understand your own culture and how it affects others*. Engage in self-reflection regarding how your values, attitudes, experiences, and social context shapes your instruction and how it might be improved.

- *Get to know your youth and build on their life experiences.* Provide opportunities for youth to share their interests and personal experiences and connect them to STEM.

- *Demonstrate caring.* Develop meaningful relationships with youth by engaging them personally and getting to know what they like and value.

- *Communicate high expectations for behavior and performance.* Communicate clear and specific expectations, and let youth know that you believe in their capabilities. This can increase their confidence and their motivation to tackle challenging problems.

- *Provide opportunities to belong.* Foster a sense of belonging with youth by listening to their ideas and letting them make real-world connections to the activities they participate in.

- *Embrace participants' home language.* Validate youth's bilingual abilities to leverage learning and make youth feel welcome and accepted.

Go to the **scigirlsconnect.org** website and watch the **SciGirls Snapshots** for more information about culturally responsive teaching and becoming a culturally responsive educator.

The SciGirls Strategies

Proven Strategies for Engaging Girls in STEM

The **SciGirls** approach is rooted in research about how to engage girls in STEM. A quarter of a century of studies have converged on a set of common strategies that work, and they have become the framework for **SciGirls**. The original set of strategies, created in 2010, were updated in 2019 to reflect current research.

1 **Connect STEM experiences to girls' lives.**
(Boucher et al., 2017; Sammet et al., 2016; Bonner & Dornerich, 2016; Erete et al., 2016; Stewart-Gardiner et al., 2013; Civil, 2016; Verdin et al., 2016; Cervantes-Soon, 2016).

Make STEM real and meaningful by engaging girls in activities that draw on their interests, knowledge, skills, culture, and lived experiences. This helps girls develop a STEM identity and increases their sense of belonging in STEM.

2 **Support girls as they investigate questions and solve problems using STEM practices.**
(Buckholz et al., 2014; Kim, 2016; Scott & White, 2013; Farland-Smith, 2016; Munley & Rossiter, 2013; Civil, 2016; Riedinger et al., 2016)

Engage girls in hands-on, inquiry-based STEM experiences that incorporate practices used by STEM professionals. Let girls take ownership of their own STEM learning and engage in meaningful STEM work to positively impact their identities and re-define how they see STEM.

3 **Empower girls to embrace struggle, overcome challenges, and increase self-confidence in STEM.**
(Blackwell et al., 2007; Dweck, 2000; Halpern et al., 2007; Kim et al., 2007; Mueller & Dweck, 1998)

Help girls focus on and value the process of learning by supporting their strategies for problem solving and letting them know their skills can improve through practice. Support girls to develop a growth mindset—the belief that intelligence can develop with effort and learning.

4 **Encourage girls to identify and challenge STEM stereotypes.**
(Allen et al., 2017; Carli et al., 2016; Cheryan et al 2015; Robnett, 2016; Allen et al., 2017; Carlone et al., 2015; Sammet et al., 2016, Scott et al., 2014; Tan et al., 2013; Dasgupta et al., 2014; Verdin et al., 2016; Civil, 2016; Boucher et al., 2017)

Support girls in pushing against existing stereotypes and the need to conform to gender roles. Helping girls make connections between their unique cultural and social backgrounds and STEM disciplines will negate potential stereotype barriers.

5 **Emphasize that STEM is collaborative, social, and community-oriented.**
(Capobianco et al., 2015; Diekman et al., 2015; Leaper, 2015; Riedinger et al., 2016; Robnett, 2013; Parker & Rennie, 2002; Scantlebury & Baker, 2007; Werner & Denner, 2009; Cakir et al., 2017; Sammet et al., 2016; Boucher et al., 2017; Clark et al., 2016; Leaper, 2015)

Highlight the social nature of STEM to increase interest and motivation and change the stereotypical perception that STEM jobs require people to work alone. Girls benefit from a supportive environment that offers opportunities to build relationships and form a collective identity.

6 **Provide opportunities for girls to interact with and learn from diverse STEM role models.**
(Koch et al., 2015; Leaper, 2015; Adams et al., 2014; Jethwani et al., 2017; Kessels, 2014; O'Brien et al., 2016; Levine et al., 2015; Hughes et al., 2013; Cheryan et al., 2015; Weisgram & Diekman, 2017)

Introduce girls to diverse women role models from varied STEM career pathways to help girls see potential futures and develop resilient STEM identities. Positive role models can increase girls' interests in, positive attitudes toward, and identification with STEM.

Tips for Using the SciGirls Strategies

In the next several pages, we offer practical tips for implementing the **SciGirls Strategies**. You do not need to incorporate *all* the strategies into an activity to improve girls' STEM identities. Practice introducing one or two techniques each time you do an activity and discover what works best for your group.

1 Connect STEM experiences to girls' lives.

- Ask girls about their backgrounds, interests, and community to better understand how to connect STEM to their lives, or have girls choose the topics they want to explore.
- Create experiences that allow girls to explore issues or topics they care about and that impact their lives, families, or communities to help girls see the relevancy of STEM.
- Include posters, materials, and examples that reference girls' communities and experiences; for instance, posters of STEM professionals who mirror the girls.
- Allow time for reflection throughout the activity. You might ask girls to write in a journal or talk with each other about connections to their lives.

STEM identity refers to a person's sense of who they are, want to be, and what they believe they are capable of in relation to STEM. For more information, see page 6.

2 Support girls as they investigate questions and solve problems using STEM practices.

- Provide opportunities for girls to engage in scientific and engineering practices such as asking questions and identifying problems, planning investigations, making predictions, building and testing models or prototypes, analyzing data and constructing explanations, and sharing results and solutions.
- Provide opportunities for girls to engage in hands-on STEM activities that incorporate scientific and engineering practices and that are open-ended (ones that have several right answers and many ways to get to them).
- Provide opportunities for girls to use everyday language to make sense of science terminology. Use their language when you reiterate points.
- Make direct connections between STEM activities and the work of STEM professionals so girls understand they are doing real STEM work. They'll be able to envision themselves as someone who does STEM.

For additional resources on STEM practices look at A Framework for K-12 Science Education from the National Research Council (2012).

For more information go to **scigirlsconnect.org**

3. Empower girls to embrace struggle, overcome challenges, and increase self-confidence in STEM.

- Teach girls that working through problems and having experiments fail is a normal part of the scientific and engineering process.
- Provide time and space for girls to grapple with and process ideas before stepping in to provide support and direction.
- Ask questions that get at the process of learning rather than a finished product (for example, how did you get to that answer? or how did you decide what step to do next? or I like how you connected your learning to this activity).
- Provide feedback on things girls can control—such as process (problem solving, critical thinking, information processing, communicating results), strategies (trying new approaches to solve problems, reverse engineering, switching perspective, collaborations), and behaviors (effort, persistence, challenge seeking).

4. Encourage girls to identify and challenge STEM stereotypes.

- Provide examples of what STEM looks like for professionals. Help girls understand the stereotypical STEM professional (working alone on a computer or in a lab) is not what many people experience in their own work lives.
- Incorporate materials, images, and content that counter stereotypes about who does STEM. For example, display posters of diverse women and highlight those whose work benefits the community.
- Provide opportunities for girls to work together, support each other, and connect with STEM-minded peers.
- Point out that doing STEM and being a STEM person does not contradict how girls see themselves or their aspirations for the future.

Use **SciGirls** episodes and role model videos to showcase peers and adult women who are challenging the STEM stereotype. Visit **scigirlsconnect.org/resource_topic/role-model-profiles/** for access to a wide variety of videos.

5 #5 Emphasize that STEM is collaborative, social, and community-oriented.

- Provide opportunities for girls to collaborate successfully and help them understand the benefits of collaboration.
- Give girls ownership in the process by designing meaningful team roles that are intellectually engaging and provide opportunities for each girl to contribute to the learning process.
- Create a supportive learning environment by helping girls get to know each other, make connections, and feel comfortable sharing their ideas.
- Share examples of how STEM offers opportunities to work with others, help others, and give back to the community.

Icebreaker: Four Corners
Pose a question to the group. (For example: What is your favorite season—winter, spring, summer, or fall?) After asking the question designate one season to each corner of the room and instruct girls to go to the corner representing their answer. Once everyone is settled, invite them to share why they like that season best. Continue the activity by posing additional questions.

"Whenever you come together with a team, you can find the answer to any question."

Josie,
Age 12

For more information go to **scigirlsconnect.org**

Provide opportunities for girls to interact with and learn from diverse STEM role models.

- Incorporate role models who are supportive, engaging, relatable, and who mirror the diversity in your population.
- Invite role models to be guest speakers, host a 'Women in STEM' panel, and provide opportunities for girls to engage in hands-on activities with role models.
- Encourage role models to describe their career path, what their work looks like, and how their work benefits others. Ask them to talk about their personal lives as well, including their hobbies, interests, pets, and families.
- Provide opportunities for girls to engage with different types of role models like STEM professionals, educators, parents, and near peers (high school or college students).

The FabFems directory is a national database of women in STEM professions who are inspiring role models for young women. The directory is accessible to young women, girl-serving programs, and other organizations working to increase career awareness and interest in STEM. Search for role models, or become a FabFem, by visiting **fabfems.org.**

FabFems

Meet a few of the SciGirls Mentors!

Dr. Omayra Ortega,
Professor of math at Arizona
State University

Krystan Wilkinson,
Data Scientist

Alma Stephanie Tapia,
Metallurgical and Materials
Engineer at NASA.

Orietta Verdugo,
Industrial Engineer

Activity Makeover

Apply the SciGirls Strategies

This page shows how to take traditional science or engineering activities and apply the **SciGirls Strategies**, making subtle shifts in how the activities are presented. In these examples, we model incorporating a few strategies at a time. (Refer to pages 12 thru 15 for full explanations of each strategy.) You can do the same with your activities and watch your girls' confidence soar!

Miniature Hovercraft

Supplies for each group

- an empty thread spool
- a 4-inch square of cardboard
- white glue, or a hot-glue gun
- sharpened pencil
- 1 balloon (12 inch, when inflated)

1. Glue the bottom of the empty spool to the center of the cardboard square.

2. Use the sharpened pencil to punch a hole in the cardboard that lines up with the center of the spool.

3. Blow up the balloon. Hold the bottom without tying it.

4. Get your partner to hold the spool for you. While pinching the neck of the balloon, stretch the bottom over the top of the spool, release the neck, and lift off!

5. Experiment with different sizes and shapes of cardboard to get the best hover out of your balloon hovercraft. Give your hovercraft a shove along a smooth tabletop, and see how far it goes.

Strategy 6
Invite a rescue worker who may use hovercrafts or an engineer who designs them.

Strategy 2
Have a table full of additional supplies to promote creative solutions to the hovercraft design: old CDs, water bottle caps of various shapes and sizes, an assortment of tape, scissors, push pins, paperboard cereal boxes, etc.

Strategy 1
Come up and share creative ways to use hovercrafts in their community to rescue families or animals in flooded coastal areas or along rivers.
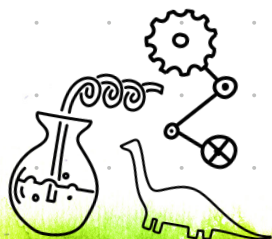
Strategy 3
Once hovercrafts have been constructed and tested, change the focus from "best hover" to fastest craft, farthest hover, or maneuverability/steering through a course. Ask girls to redesign their craft to meet the new challenge.

Let's Get Started

Use this space to record your ideas on how to use the SciGirls Strategies to engage girls in STEM.

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Additional Resources

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