Seven Strategies to Engage Girls in STEM

**Program Type:** Training  
**Audience Type:** Adult

**Goals:**
- Participants will engage in a hands-on engineering challenge.
- Participants will learn about the engineering design process.
- Participants will discuss the SciGirls 7: Strategies to engage girls in STEM (Science, Technology, Engineering, and Math).

**Topics:**
Engineering, strategies to facilitate science-related activities

**TIME REQUIRED**

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<tr>
<th>Advance Preparation</th>
<th>Set Up</th>
<th>Activity</th>
<th>Clean Up</th>
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<tr>
<td>60 min</td>
<td>10 min</td>
<td>60–120 min</td>
<td>5 min</td>
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**SITE REQUIREMENTS**
- Projector and screen for showing the PowerPoint presentation.
- Tables and chairs for the participants.
- A raised area from which to drop parachutes (i.e. a stage, step stool, sturdy chair, or balcony).
### Supplies

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<tr>
<th>Supplies</th>
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<tr>
<td>Projector, computer, and screen</td>
<td>1</td>
<td>For displaying PowerPoint</td>
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<tr>
<td>“SciGirls Seven” printouts</td>
<td>1/person</td>
<td>See Appendix</td>
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<tr>
<td>Mixed paper</td>
<td>3-4</td>
<td>Use any variety of papers, such as tissue paper, paper napkins, printer paper, cardstock, or newspaper</td>
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<td>Mixed paper</td>
<td>sheets/group</td>
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<tr>
<td>String</td>
<td>48”/group</td>
<td>Embroidery floss, heavy duty sewing thread, or even dental floss can work</td>
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<td>Masking tape</td>
<td>12”/group</td>
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<td>Scissors</td>
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<tr>
<td>Washers</td>
<td>1/group</td>
<td>If washers are unavailable, substitute any other small weight, like beads or paper clips</td>
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<tr>
<td>Step stool or sturdy chair</td>
<td>1</td>
<td>(Optional) For testing parachutes</td>
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<tr>
<td>Stopwatch</td>
<td>1</td>
<td>(Optional) Can also use timer app on any mobile device</td>
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<tr>
<td>Scratch paper</td>
<td>1/group</td>
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<td>Pens/pencils</td>
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INTRODUCTION

- This document is meant to guide professionals in delivering trainings/workshops for educators and caregivers.
- The content and length of the training can be adapted to fit the needs of the participants and the facilitator’s personal presentation style.
- It is important to approach the topic with sensitivity; participants may have strong opinions and emotions regarding the topics of education, parenting, and gender.
- Making space for personal reflection and small-group discussion may encourage participants to engage more deeply.
- You can download the PowerPoint presentation by going to http://www.omsi.edu/educator-resources and searching “Designing Our World.”
- A suggested script for the facilitator appears below. The facilitator should become familiar with the content and present it in a way that works for them and the groups.

AGENDA

This agenda is meant to be used as a guide to organize the content of your session. Feel free to adapt it to meet the needs of your session/group. The times listed at the top of each section are approximate. Some discussions can take longer due to the group’s background/interests.

- Welcome group (location of restrooms, introductions, nametags, etc.) – 5-10 minutes
- Hands-on activity: “Paper Parachutes” – 15-30 minutes
- The engineering design process – 10-15 minutes
- Strategies to engage girls in engineering and science-related activities
  - Small group discussion – 5-10 minutes
  - Large group discussion – 20-30 minutes
- Closure/questions - 5 minutes
## Gender Equity in STEM

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| **1** | *Welcome participants*  
*Introductions*  
*Housekeeping details (restrooms, breaks, etc.)* |
| **2** | *Go over agenda*  
- Introductions  
- Hands-on engineering challenge  
- The Engineering Design Process  
- SciGirls 7  
- Small and large group discussion  
- Closing and debrief |
| **3** | *Introduce engineering challenge:*  
Because this is a program about engineering, it’s appropriate that we would try out an engineering challenge ourselves! For this challenge, you will be working with small groups to build a device that will allow a weight (hold up a washer, or whatever weight you have provided for this challenge) to drop from a height to the ground as *slowly* as possible.  

You can use the supplies in any way you like. When you are ready to test your design, bring it to the testing area. One group member will... |
*CAREFULLY* step up on the step stool (or sturdy chair, or stage, or balcony), hold the washer (and whatever device you’ve created) up high and drop it. Another group member will use the stopwatch (or phone) to time how long it took for the weight to hit the ground. Remember, the goal is to take as long as possible.

Help participants break into small groups of 2-4. Provide paper, string, masking tape, scissors, and one washer to each group. Groups will likely create parachutes or similar devices, but encourage any creative use of the supplies!

Help facilitate testing, as necessary.

As groups work, observe and ask questions, as it feels appropriate. For example:

- Why did you decide to make your parachute the size/shape you did?
- I notice that as the parachute falls, it collapses on itself instead of staying open. Any ideas about how to fix that?
- I notice that the strings get twisted and tangled. Any ideas about how to fix that?

After 15-30 minutes of testing, prompt groups to clean up their supplies and make their way back to their seats. If you feel there is time, you can invite small groups to share their designs with the larger group, explaining what worked, what didn’t, and how slow they were able to make their descent.
What you all just experienced is just a small taste of what we call The Engineering Design Process. There are 5 basic steps: Ask, Imagine, Plan, Create, and Improve. Of course, engineers don’t always do these exact steps in this exact order—and your students won’t either. It is very common to create something, test it, find a problem, and then go back to an earlier step to make a modification or change to the design. This way of working is called **iteration**.

Let's discuss how we used these steps in the paper parachute challenge we just did.

**Ask** – The first step is to ask, “What is the problem?” *Invite participants to answer. (The problem is we want to slow down the weight as much as possible).* We might also ask ourselves, “What are the constraints?” “How have others approached this problem?”

**Imagine** – When you first heard the challenge and saw the supplies, you probably immediately started imagining how you could put those supplies together to build a parachute—or perhaps some other creative device! Maybe you even had multiple different ideas.

**Plan** – You probably discussed your ideas with your group, or even drew some sketches, got feedback, and decided on a plan. In a more formal engineering situation, the planning process might be very rigorous, and utilize blueprints, computer models, etc.

**Create** – The next step is to follow your plan and create something. Then test it out!

**Improve** – Chances are, your first creation wasn’t
perfect. Testing revealed new problems. What new problems did your groups discover after your first test? *Invite participants to answer.* These problems invited you to ask, “How improve our parachute in a way that addresses this problem?” which brings us back to the beginning of the cycle.

We have tried a simple engineering activity and explored the engineering design process. Now we’re going to talk about how we can better engage students—and girls in particular—in engineering.

The approach we're using comes from SciGirls, a partnership between PBS, the National Science Foundation, the National Girls Collaborative Project, and other key partners. It’s based on decades of published research on the factors that have limited girls’ involvement in science and, conversely, the factors that *encourage* girls to engage in science.

And, it should be said, while these strategies have been shown to benefit girls especially, they aren’t at all detrimental to boys. In fact, these strategies have been shown to benefit all students!

There are 7 research-based strategies in the SciGirls approach. We are going to address each one. To start out, you’ll work in small groups, with each group reading and discussing one of the seven strategies.

*Pass out “SciGirls Seven” printout.*
With your small group you will:

- Read the strategy out loud
- Discuss: How (if at all) was this strategy applied in the paper parachutes activity?
- Discuss: How could you change, re-frame, modify, or add to the paper parachutes activity so that it does utilize this strategy?
- Or in other words, how would you re-engineer this engineering activity to make it more engaging to girls?

I'll give you 5-7 minutes to discuss with your small groups, and then we will go through the strategies one by one and hear your thoughts. You may want to have one or more members of your group take notes so you can report back to the larger group.

- Help participants break into small groups of 2-4 (can be same groups that did parachute challenge). There should be at least 7 groups.
- Assign each group one of the seven strategies to discuss. If there are more than 7 groups, that’s okay; more than one group can discuss each strategy.
- Pass out scratch paper and pens/pencils.
- Invite small groups to begin discussion. Roam around the room observing and encouraging.

Ask the participants who had Strategy 1 to share what they discussed.
Thank you for sharing your ideas. Here are some other tips that we can practice to encourage collaboration among girls when doing engineering/science-related activities.

**Create an atmosphere that is open and positive.** Start with activities to “break the ice” involving communication and teamwork.

**Encourage working in small groups.** Use various methods for forming groups, keeping in mind that kids should be grouped with different members from time to time.

**Speak up promptly if a girl makes a distasteful remark, even jokingly.** Set the rules at the start: no teasing or unfriendly talk. Explain why a comment is offensive or insensitive. If conflicts arise, resolve them through group (or pair) dynamics in which each person voices what they think happened and how it made them feel. Then work on agreement and resolution.
Ask the participants who had **Strategy 2** to share what they discussed.

Thank you for sharing your ideas. Here are some other tips that we can practice to encourage personal connections when doing engineering/science-related activities.

**Look for ways to connect the material to the girls’ lives.** How is the activity connected to the girls’ lives? Thinking about the Paper Parachutes challenge, you might ask, Have you ever seen a parachute? When might you need to use one?

**Use real-life examples.** Show how this engineering innovation could be used in a meaningful, even an unexpected, way. For example, a company called Zipline uses drones to deliver life-saving medical supplies in third-world countries. The drone drops the supplies from the air, and a parachute allows them to safely descend to the ground without breaking. How cool is that?

**Create a “need to know.”** As you are preparing activities, ask yourself why would kids/girls need to know about this topic. Ask girls to prepare a table of their thoughts, including: what they know, want to know, have learned, and how they can learn more. Use this in groups or individually as a tool for tapping into prior knowledge and encouraging personal reflection.

**Use follow-up questions** that focus kids’
attention on ideas or assumptions embedded in their first answers. These questions can help girls explore and express what they know even when they aren't sure they know it. For example: Tell me more. Then what? Could you give me an example?

Ask the participants who had **Strategy 3** to share what they discussed.

Facilitator: Thank you for sharing your ideas. Here are some other tips that we can practice to encourage open-ended projects and investigations.

**Try an activity without step-by-step directions.** Don’t shortchange your girls by assuming they can’t do an investigation without prescribed directions. Rather than giving them specific directions for how to build an origami paper parachute, just tell them, “Build some kind of device that can slow down a falling weight.” Release their inner explorers and let them surprise you!

**Pose questions using “what” or “how.”** Instead of asking “Is noise considered a pollutant?” ask “How can you test whether noise is a pollutant?” Instead of asking “Is this building/structure safe?” ask “How can we test whether this building/structure is safe?”

**Resist answering the question “Is this right?”** Highlight unexpected results and suggest ways for
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<th><strong>14</strong></th>
<th><strong>SciGirls Seven Strategies</strong></th>
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<td><strong>#4</strong></td>
<td>Ask the participants who had <strong>Strategy 4</strong> to share what they discussed.</td>
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<th><strong>15</strong></th>
<th><strong>SciGirls Seven Strategies</strong></th>
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<tbody>
<tr>
<td><strong>#4</strong></td>
<td>Thank you for sharing your ideas. Here are some other tips that we can practice to encourage girls to experiment and be creative when doing engineering/science-related activities.</td>
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**Allow girls to design their own experiments and tests.** Girls can share their plans with you, but your role is as a facilitator rather than as a leader or expert. Emphasize that everyone is learning and discovering together.

**Let girls communicate their findings using a variety of techniques** relevant to their lives: poetry, music, posters, blog post, plays, slideshows, 2D and 3D models, drawings, etc.

**Use your girls' language to reiterate their points.** Use a board, notebook, or large sheet of paper to document participation. Write the idea as you hear it—don’t reword unless you have permission from the child/participant. When meanings are unclear, restate what the girl said in her own words first and then ask her to expand on her thinking with “Tell me more.” or “What makes you think that?”

Girls are motivated when they can approach projects in their own way, applying their creativity, unique talents and preferred learning styles. (Eisenhart & Finkel, 1998, Calabrese Barton, Tan, & Kriet, 2008)

- Allow girls to design their own experiments and tests.
- Let girls communicate their findings using a variety of techniques.
- Use girls’ own language, without rushing to correct.

girls to investigate further by asking “How could we figure that out?” or “What do you think?”
Ask the participants who had **Strategy 5** to share what they discussed.

Thank you for sharing your ideas. Here are some other tips that we can practice to improve confidence among girls when doing engineering/science-related activities.

**Avoid statements such as “You are really good at this!”** It sends the message that success doesn’t require effort or struggle. Instead, praise a specific effort, improvement or accomplishment. “You saw that your parachute strings were getting all tangled, and you figured out a way to fix that!”

**Convey the same level of respect for and confidence in the abilities of all your girls/children.** Make sure you’re acknowledging the specific efforts of each participant, not just the “obvious” ones. Introduce girls to the good work done by their peers/siblings. Share the ideas, knowledge, and accomplishments of individuals with the group/family as a whole.

**Emphasize that working scientists struggle and make mistakes, too.**
Ask the participants who had **Strategy 6** to share what they discussed.

Thank you for sharing your ideas. Here are some other tips that you can practice to encourage girls to gain confidence and trust their own reasoning when doing engineering/science-related activities.

**Support an environment free of “instant answers.”** By working through a problem, girls will experience a sense of achievement and confidence that will increase their motivation to learn. When you simply give kids the solution, you rob them of the chance to think for themselves. Address girls’ anxiety about not getting the answer by refocusing their attention on the problem at hand. Build on what they do know to move forward.

**Think like scientists and engineers.** It is okay to make mistakes; there is more than one way to solve a problem. Experimentation may never lead to an answer but rather to new questions. Practice developing alternative explanations for results.

**It’s okay to disagree.** Stress the importance of considering different approaches and viewpoints. When disagreements arise, allow girls to voice their viewpoint while others listen. Remind girls of the importance of using solid evidence when making a claim. Consensus may be difficult and perhaps unnecessary, but listening to one another is important.
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<tr>
<td>20</td>
<td>Ask the participants who had <strong>Strategy 7</strong> to share what they discussed.</td>
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</table>
| 21   | Thank you for sharing your ideas. Here are some other tips that we can practice to encourage relationship building with female engineers and scientists.  

**Invite guest speakers** from all levels, including high school, undergraduate, and graduate students, along with professional scientists. Ask visitors to describe what their work looks like along with how they identify and ask questions, answer them, and share information with others. Remind them to talk about their hobbies, interests, family and life outside of the lab.  

**Spotlight women who work on the subjects you are studying.**  

If you can’t get someone live, show videos of female scientists. (Use SciGirls videos or DragonflyTV’s scientist profiles at scigirlsconnect.org.) |
### 22: Use SciGirls videos to showcase peers as mentors.
The girls in each episode can act as role models for projects.

**Encourage mentor pairings.**

### 23: Invite any final questions and comments.
• **SciGirls** is a PBS Kids show that encourages girls in science, technology, engineering and mathematics or STEM [http://pbskids.org/scigirls/home](http://pbskids.org/scigirls/home)

• **SciGirls Connect** is a set of resources for parents and educators wanting to engage girls in STEM. [http://www.scigirlsconnect.org/](http://www.scigirlsconnect.org/)

• The EngineerGirl website is designed to bring national attention to the exciting opportunities that engineering represents for girls and women [http://www.engineergirl.org/](http://www.engineergirl.org/)
Seven Strategies to Engage Girls in STEM
Appendix
The SciGirls approach—for the TV show, website, and educational materials—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 these have become SciGirls’ foundation. We call these strategies the SciGirls Seven.

1. **Girls benefit from collaboration, especially when they can participate and communicate fairly.** *(Parker & Rennie, 2002; Scantlebury & Baker, 2007; Werner & Denner, 2009)*

   Girls are energized by the social part of science—working and learning together. Provide opportunities for small group work, and encourage girls to talk about their ideas and consider all possibilities before digging in. Make sure discussions remain respectful and inclusive, and that each girl’s contributions are valued. Girls are likely to remember not only what they learned, but also how they felt when they learned it.

> “Whenever you come together with a team, you can find the answer to any question.”
> *Josie, age 12*

2. **Girls are motivated by projects they find personally relevant and meaningful.** *(Liston, Peterson & Ragan, 2008, Lyon & Jafri, 2010; Mosatche, Matloff-Nieves, Kekelis, & Lawner, 2013; Patrick, Mantzicopulos, & Samarapungavan, 2009; Thompson & Windschitl, 2005)*

   Girls become motivated when they feel their project or task is important and can make a difference. Support them using STEM as a tool to explore issues or topics they care about. If they see how STEM is relevant to their own lives and interests, their attraction to these subjects is likely to increase.

3. **Girls enjoy hands-on, open-ended projects and investigations.** *(Chatman, Nielsen, Strauss & Tanner, 2008; Denner & Werner, 2007)*

   SciGirls promotes exploration, imagination, and invention. Encourage your girls to ask questions and find their own paths for investigation.

For more information, go to scigirlsconnect.org
Girls are motivated when they can approach projects in their own way, applying their creativity, unique talents, and preferred learning styles. (Calabrese Barton et al., 2013; Calabrese Barton, Tan, & Rivet, 2008; Eisenhart & Finkel, 1998; Lyon & Jafri, 2010)

Encourage girls to develop their own ways of exploring and sharing knowledge, paying attention to the unique learning styles that motivate your group. You may be surprised by what creative, exciting approaches girls come up with when designing investigations, collecting data, and communicating results.

Girls’ confidence and performance improves in response to specific, positive feedback on things they can control—such as effort, strategies, and behaviors. (Blackwell, Trzesniewski, & Dweck, 2007; Dweck, 2000; Halpern et al., 2007; Kim et al., 2007; Mueller & Dweck, 1998)

Self-confidence can make or break girls’ interest in STEM. Foster their efforts, compliment their strategies for problem solving, and let them know their skills can be improved through practice. Celebrate the struggle. Wrestling with problems and having experiments fail is a normal part of the scientific process!

Girls gain confidence and trust in their own reasoning when encouraged to think critically. (Chatman, Nielsen, Strauss & Tanner, 2008; Eisenhart & Finkel, 1998; Kim et al., 2007)

Cultivate an environment in which asking questions and creative thinking are a must. Throughout the centuries, this same trust in logic and re-examination of ideas made advances in science, technology, and engineering possible.

Girls benefit from relationships with role models and mentors. (Holmes, Redmond, Thomas, & High, 2012; Liston, Peterson & Ragan, 2008; Lyon & Jafri, 2010; Mosatche et al., 2013; Weber, 2011)

Seeing women who have succeeded in STEM helps inspire and motivate girls, especially when they can relate to these role models as people with lives outside of the lab. Role models and mentors not only broaden girls’ views of who does science, but expand girls’ vision of what’s possible in their own lives.
7 Strategies to Engage Girls in STEM

Designing our World: An Oregon Museum of Science and Industry project, in partnership with Boys and Girls Club, Girls Inc., and Adelante Mujeres

Designing Our World is made possible with funding from the National Science Foundation
Agenda

- Introductions
- Hands-on engineering challenge
- The Engineering Design Process
- SciGirls 7
- Small and large group discussion
- Closing and debrief
Challenge time!

Using the supplies given, build a device that will allow a weight to drop from a height to the ground as slowly as possible.
The Engineering Process

Engineering design cycle adapted by Head Start and Engineering, with permission from the Engineering is Elementary project, Museum of Science, Boston.
SciGirls

A research-based effort to engage girls in STEM

Source for these strategies:
http://pbskids.org/scigirls/home
SciGirls Seven

The SciGirls Seven
Proven Strategies for Engaging Girls in STEM

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

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7. Girls benefit from relationships with role models and mentors.

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SciGirls Seven

With your small group:

- Read the strategy out loud
- Discuss: How (if at all) was this strategy applied in the paper parachutes activity?
- Discuss: How could you change, re-frame, modify, or add to the paper parachutes activity so that it does utilize this strategy?
SciGirls Seven Strategies

#1 Girls benefit from collaboration, especially when they can participate and communicate fairly.

(Parker & Rennie, 2002; Fancsali, 2002)
SciGirls Seven Strategies

#1 How can we promote collaboration in STEM?

- Create a community atmosphere that is open and positive.
- Encourage working in small groups.
- Speak up promptly if a girl makes a distasteful remark, even jokingly.
SciGirls Seven Strategies

#2 Girls are motivated by projects they find personally relevant and meaningful.

How can we make STEM learning personally relevant?

- Highlight connections between the topic and the girls’ lives
- Use real-life examples
- Find out what the girls already know (or don’t)
SciGirls Seven Strategies

#3 Girls enjoy hands-on, open-ended projects and investigations.

(Chatman, Nielsen, Strauss, & Tanner, 2008; Burkam, Lee, & Smerdon, 1997; Fanscali, 2002)
#3 How can we make STEM open-ended?

- Try an activity without step-by-step directions.
- Pose open-ended questions.
- Resist answering the question, “Is this right?”
SciGirls Seven Strategies

#4 Girls are motivated when they can approach projects in their own way, applying their creativity, unique talents and preferred learning styles.

(Eisenhart & Finkel, 1998; Calabrese Barton, Tan, & Rivet, 2008)
#4 How can we tailor STEM to fit girls’ individual interests and skills?

- Allow girls to design their own experiments and tests.
- Let girls communicate their findings using a variety of techniques.
- Use girls’ own language, without rushing to correct.
Girls’ confidence and performance improves in response to specific, positive feedback on things they can control - such as effort, strategies and behaviors.

How can we use specific, positive feedback in STEM?

- Avoid statements such as, “You’re really good at this!”
- Convey confidence in all students.
- Emphasize that working scientists struggle and make mistakes, too.
Girls gain confidence and trust in their own reasoning when encouraged to think critically.

(Chatman, et al., 2008; Eisenhart & Finkel, 1998)
How can we encourage free, yet critical thinking in STEM?

- Support an environment free of “instant answers.”
- Think like scientists and engineers.
- Make sure every girl has a chance to speak/ask questions.
SciGirls Seven Strategies

#7 Girls benefit from relationships with role models and mentors.

(Liston, et al., 2008; Evans, Whigham, & Wang, 1995)
How can we connect girls to STEM role models?

- Invite guests to speak, or help lead an activity.
- Spotlight women who work on the subjects you are studying.
- Show videos of female scientists.
SciGirls Seven Strategies

#7 How can we connect girls to STEM role models? (continued...)

- Use SciGirls videos to showcase peers as mentors.
- Encourage mentor pairings.
7 Strategies to Engage Girls in STEM

Final questions and comments