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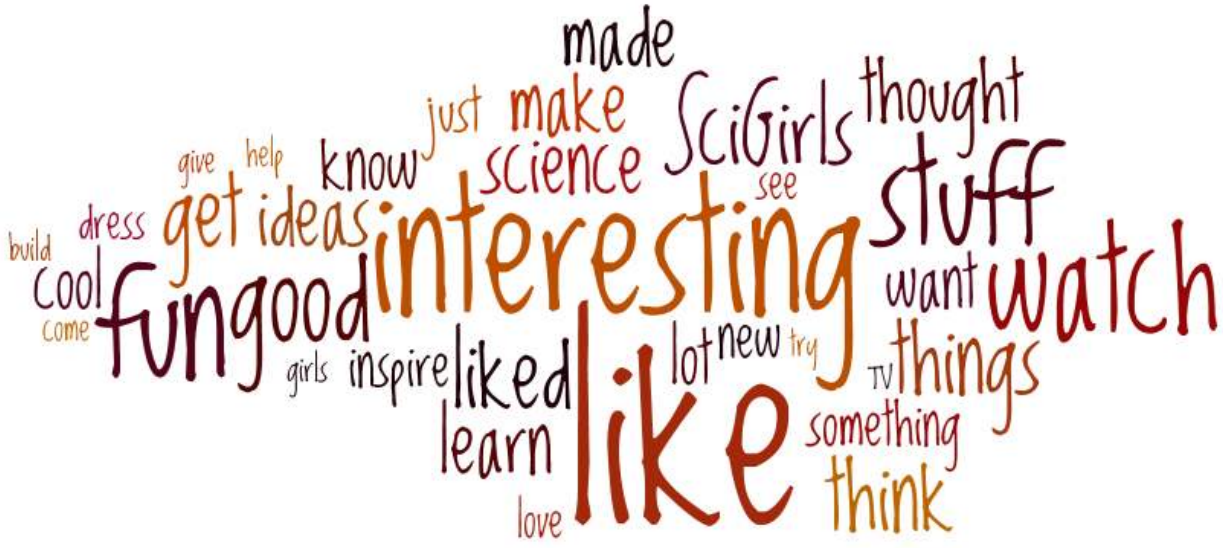
Summative Evaluation of *SciGirls* Television Series Season One



Report for Twin Cities Public Television
by Barbara N. Flagg, Ed.D., Director

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EXECUTIVE SUMMARY
SUMMATIVE EVALUATION OF *SCIGIRLS* TELEVISION SERIES SEASON ONE
MULTIMEDIA RESEARCH • NOVEMBER 2010

SciGirls is a new weekly public television series produced by Twin Cities Public Television and supported by the National Science Foundation. Twelve half-hour animated and live action shows are accompanied by web and outreach activities in the fields of science, technology and engineering (STEM). Multimedia Research, an independent evaluation group, implemented a summative evaluation of *SciGirls* television programming with a rigorous randomized controlled trial design comparing treatment and control groups. Girls entering fifth grade were assigned randomly either to a treatment group (n = 42) that viewed four *SciGirls* engineering episodes focused on design and build projects or to a control group (n = 42) that viewed four episodes of *Wishbone*, a reading literacy series. Girls viewed programs at home over two weeks, two per week, and completed brief written appeal questionnaires immediately after viewing. Face-to-face interviews about engagement, understanding and confidence followed in the third week. The experimental design permitted assessment of a cause-effect relationship between the *SciGirls* series and its planned outcomes of high engagement, better understanding of the engineering design process, and higher confidence in participating in design and build projects.

Engagement

SciGirls viewers rated the episodes as highly appealing, at a level comparable to that obtained by evaluations of other age-appropriate NSF-funded STEM programming. Three-quarters liked all four episodes; 95% liked *High Tech Fashion* and *Puppet Power*; 85% liked *Going Green*; and 83% liked *Blowin' in the Wind.* All viewers voiced a desire to watch more *SciGirls* shows, because the series was interesting and fun and viewers felt inspired to by the show content. The series is effective in attracting and holding the attention of tween girls.

A review of research literature as to effective strategies that engage girls in STEM in educational settings led the producers to apply a number of these strategies within the *SciGirls* television series: The onscreen real girls and their mentors are shown as "role models" who "collaborate" and "apply their creativity" to "personally relevant and meaningful" projects. Nine in ten (90%) *SciGirls* viewers noted at least one of these four strategies in their open-ended appeal responses, confirming that translating these evidence-based strategies into a television series successfully engages girl viewers. Viewers appreciated that the design projects were important or relevant to their own interests. They liked how the real girls used their creativity and talent to solve problems and complete their engineering projects. The viewers enjoyed the teamwork and constructive interactions of the real girls and identified with the onscreen girls as role models.

SciGirls viewers liked that the animated stories of Izzie and Jake, which frame the live action stories, paralleled the stories of the real girls and that Izzie visited their stories to obtain help with her own problem. Viewers thought the animated stories of Izzie and Jake were funny, valued that Izzie tried to do something meaningful with her projects and particularly enjoyed her creative problem solutions. Viewers enjoyed when Izzie and Jake worked together but did not always appreciate some of the negative comedic interactions between two characters.

Understanding the Engineering Design Process. The evaluation focused on a subset of four *SciGirls* programs in which the onscreen teams create projects that model, implicitly and in varying degrees, the six steps of the engineering design process [i.e., identify the problem; research and brainstorm ideas; sketch and plan; prototype or model; test and redesign; share solution]. In the post-viewing interview, all girls were given a hypothetical project to design and build a bridge over a creek, and the *SciGirls* viewers revealed a significantly better understanding of the engineering design process than the control group. *SciGirls* viewers successfully transferred their learning of steps of engineering design to the new problem of bridge building.

Confidence Related to Engineering Design Process. The evaluation looked at confidence as it pertains to a belief in one's ability to succeed in specific situations –that is a belief in "self-efficacy." The measurement instrument put the *SciGirls* series to a stringent and challenging test by looking at confidence in doing engineering design steps, not for projects that were presented in the four shows, but for two new hypothetical projects. The *SciGirls* viewing group included significantly more girls than the *Wishbone* group who rated themselves "definitely" able to carry out the design steps of *brainstorming* and *testing*. The difference between groups also favored the *SciGirls* viewers for the design tasks of *modeling* and *presenting*, but statistical significance was not obtained for these two tasks.

In conclusion, the summative evaluation of *SciGirls* reveals that the television series succeeds in attracting and engaging girls by incorporating evidence-based engagement strategies into the programs; effectively uses winning fictional and factual narrative stories and characters to improve viewers' understanding of the engineering design process; and provides vicarious experiences through which viewers increase their confidence in their ability to execute the steps of the design process.

INTRODUCTION

Produced by Twin Cities Public Television, St. Paul, MN, and sponsored by the National Science Foundation (NSF) with additional support from ExxonMobil, *SciGirls* is a new weekly public television series of 12 half-hour animated and live action shows accompanied by web and outreach activities in the fields of science, technology and engineering (STEM).[1] The overall goals of the multimedia project are to 1) to foster a greater interest and confidence in STEM among girls ages 8 to 13 and their parents; 2) to deepen understanding of the most effective ways to engage girls in STEM activities and encourage them to pursue STEM careers; and 3) to connect girls to existing quality STEM education opportunities in their communities.

Each half-hour episode of the *SciGirls* television series follows a different group of enthusiastic, *real* middle school SciGirls who collaborate, communicate, engineer and discover. They are accompanied by two animated characters – a plucky SciGirl named Izzie and her best friend Jake, who tie the series together with their ongoing adventures. Each episode begins with a story in which Izzie and Jake discover they have some problem that science can solve. Crying "SciGirls, I need you!," Izzie surfs the *SciGirls* website, finds a science or engineering problem related to her own, and jumps literally into a live action video in which the real girls model the science inquiry process or engineering design process to solve their own real-life problem. Each episode closes with Izzie presenting to Jake her personal solution to her problem, based on what she learned from observing the SciGirls' experiences.

Supported by the NSF grant (#0813519), Multimedia Research, an independent evaluation group, implemented a summative evaluation of *SciGirls* television programming during the summer of 2010. In a departure from the typical pre-post studies of children's programming, this summative evaluation employed the more rigorous randomized controlled trial design of comparing treatment and control groups. Girls entering fifth grade were assigned randomly either to a treatment group that viewed four *SciGirls* engineering episodes focused on design and build projects or to a control group that viewed four episodes of *Wishbone*, a reading literacy series. The experimental design permitted assessment of a cause-effect relationship between the *SciGirls* series and its planned outcomes with respect to STEM of high engagement, better understanding of the engineering design process, and higher confidence in participating in the design and build steps.

[1] See http://pbskids.org/scigirls/

GOALS OF SUMMATIVE EVALUATION

Engagement. While shaping the *SciGirls* project, the development team reviewed current research on factors that create effective STEM experiences for girls. The team identified seven evidence-based strategies to engage girls in STEM, as listed below:

1. *Girls are motivated by projects they find personally relevant and meaningful*
2. *Girls are motivated when they can approach projects in their own way, applying their creativity, unique talents and preferred learning styles*
3. *Girls benefit from collaboration, especially when they can participate and communicate fairly*
4. *Girls benefit from relationships with role models and mentors*
5. *Girls enjoy hands-on, open-ended projects, and investigations*
6. *Girls build trust in their own reasoning when encouraged to think critically*
7. *Girls' confidence and performance improves in response to specific, positive feedback on things they can control – such as effort, strategies and behaviors*

These strategies were applied as appropriate to each medium in developing the various components (i.e., TV, Web, Outreach) of the *SciGirls* overall project. The project component that concerns us for this summative evaluation is the television series. For the *SciGirls* television series, the producers attempted to engage viewers by presenting girls conducting activities in a way that mirrors the first four strategies listed above. The remaining three strategies (open-ended activities, critical thinking, positive feedback) describe approaches that educators should apply in outreach settings. While the latter three strategies influenced the producers' thinking, they were not deliberately modeled in the TV series. The producers applied the first four strategies within the television series by showing the onscreen girls and their mentors as "role models" (strategy 4) who "collaborate" (strategy 3) and "apply their creativity" (strategy 2) to "personally relevant and meaningful" (strategy 1) projects. One goal of this summative evaluation was to examine whether these four production strategies were seen by *SciGirls* viewers as appealing and engaging, as intended by the producers and as suggested by gender-specific research literature.

Understanding. The *SciGirls* television series as a whole showcases the *process* of STEM and includes a wide variety of projects, incorporating both scientific inquiry and engineering design. The summative evaluation focuses on a subset of the STEM process by exposing viewers to four episodes in which the *SciGirls* onscreen teams create projects that model six steps of the engineering design and build process:

1. *Identify the problem*
2. *Generate ideas by looking at other relevant designs, consulting experts or a mentor, consulting non-human sources, and brainstorming*
3. *Plan by sketching, drawing a detailed design*
4. *Create by building a prototype or model*
5. *Test, evaluate and redesign*
6. *Share solution*

The four programs model the engineering process to varying degrees. Some steps are presented more completely and explicitly than others depending upon the program. The programs do not treat the steps didactically; instead the process steps are embedded in the actions and dialogue supporting the development and implementation of each engineering project. A second goal of this summative evaluation was to explore to what extent exposure to four programs gave *SciGirls* viewers a better understanding of the engineering design and build process when compared with those who did not view the programs.

Confidence. The attitude variable of interest in this evaluation is that of "self-efficacy," which is a theoretical construct of the social cognitive psychologist Albert Bandura, referring to belief in one's ability to succeed in specific situations. Self-efficacy is a concern of the *SciGirls* team because research has shown that science self-efficacy is predictive of science achievement among middle school students. Bandura proposed four sources by which we form our self-efficacy beliefs: mastery experience, social persuasion, physiological states and vicarious experience. Regarding the latter source, Bandura writes that "seeing people similar to oneself succeed by sustained effort raises observers' beliefs that they too possess the capabilities to master comparable activities required to succeed."[2] The *SciGirls* television series provides vicarious experience by presenting the onscreen girls successfully modeling the design and build process in a variety of applications. A third goal of this summative evaluation is to look at what extent viewing of same-sex models in the four engineering design shows influenced viewers' self-efficacy beliefs (or more colloquially – their confidence) that they have the ability to do various steps of the design and build process.

[2] Bandura, A. (1994). Self-efficacy. In V. S. Ramachaudran (Ed.), Encyclopedia of Human Behavior (Vol. 4, pp. 71-81). New York: Academic Press.

Impacts and Indicators. The evaluation randomly assigned girls to a *SciGirls* viewing treatment group and a *Wishbone* viewing control group. Both groups answered paper-based appeal questions after viewing each of four shows at home and were interviewed individually after viewing all four shows. With these data, the study addresses the hypotheses (impact indicators) as presented in Table 1.

Table 1. Impacts and Indicators

Impact categories and statements	Impact indicators
Engagement	
Treatment group will express high engagement with the *SciGirls* videos.	Treatment group will rate *SciGirls* videos as highly appealing and note one or more of four evidence-based production strategies in their open-ended responses as to what they like about the videos.
Understanding	
Treatment group will demonstrate better understanding of the design and build process than Control group.	Given a hypothetical design and build project, Treatment group will be able to describe more design and build steps compared with the Control group.
Confidence	
Treatment group will report greater self-efficacy (confidence) with respect to their ability to participate in design and build activities than the Control Group.	Compared with the Control group, Treatment group will rate themselves higher in self-efficacy with respect to their ability to participate in the steps of a design and build project.

To provide formative feedback for the series, the evaluation also collected data about the appeal of the animated characters, Izzie and Jake, particularly as they appear in the scenes at the beginning and end of each program that frame the stories of the real girls.

METHOD

Sample

Girls entering fifth grade were recruited around nine national sites, including Miami, FL; rural DE; Long Island, NY; Boston, MA; Austin, TX; St. Louis, MO; Chicago, IL; Sacramento, CA; and Corvallis, OR. The recruitment process applied a set of background filter questions to recruit girls who felt they had an interest and ability in science but had not yet engaged in science beyond school requirements. The goal was to work with those who were not already committed to science but who might be open to the models and strategies employed in the *SciGirls* series.

The written permission letter inviting parents and children to participate asked questions relative to the recruitment criteria, including parallel questions about both science and reading to camouflage the study's interest in science in particular. To obtain a sample of girls who were interested and able in science but who were not active in science outside of school, we excluded girls who had completed an optional school science fair project or attended a science club or camp inside or outside of school, since these activities reflect an already higher commitment to science. We included girls who said they were interested in science "a lot," "somewhat," or "a little" and excluded those who were "not at all" interested in science. We included girls who perceived themselves as performing "really well" or "pretty good" in school science and excluded those who thought they performed "okay" or "not so good." We also excluded those whose favorite school subject was science. Also eliminated from the recruited sample were girls who had already seen *SciGirls* shows and any who "sometimes watched" *Fetch!* or *Design Squad*, which are age-appropriate PBS series about STEM process.

The recruited girls were randomly distributed into the Treatment and Control Groups, stratified by ethnic status (white, minority) to equalize representation in the groups. After viewing the four assigned shows, ten girls (5 Treatment; 5 Control) were dropped from the data set to improve study validity, because they reported in post-viewing interviews that they had watched one or more broadcasted *Fetch!*, *Design Squad* or *SciGirls* shows during the study period.

Table 2 on the next page summarizes the background characteristics of the 84 girls comprising the Treatment and Control groups. Chi-square statistics confirm that the two groups are equivalent on all measured background characteristics.

Table 2. Background Characteristics

	Treatment: *SciGirls* N = 42	Control: *Wishbone* N = 42
Interest in Science		
What is your favorite subject in school? (top 4 answers from open-ended responses)		
Math	41%	24%
Social Studies/History	24%	14%
Art	17%	19%
Reading/Language Arts	14%	19%
How interested are you in science?		
A lot	14%	24%
Somewhat	71%	52%
A little	14%	24%
Not at all	0%	0%
Self-Assessed Performance in School Science		
How well do you feel you perform in science in school?		
Really well	88%	86%
Pretty good	12%	14%
Okay	0%	0%
Not so good	0%	0%
Viewing Experience of *Fetch!, Design Squad, SciGirls*		
Do you ever watch the PBS series entitled *Fetch!?*		
I turn on and watch *Fetch!* sometimes	0%	0%
I have seen the show	24%	14%
I have never watched *Fetch!*	76%	86%
Do you ever watch the PBS series entitled *Design Squad?*		
I turn on and watch *Design Squad* sometimes	0%	0%
I have seen the show	5%	9%
I have never watched *Design Squad*	95%	91%
Do you ever watch the PBS series entitled *SciGirls?*		
I turn on and watch *SciGirls* sometimes	0%	0%
I have seen the show	0%	0%
I have never watched *SciGirls*	100%	100%
[after viewing DVDs] During the last two weeks, did you watch any PBS shows of *Fetch!* or *Design Squad* or *SciGirls* [not on DVD]?	0%	0%
Ethnicity		
White	79%	81%
Minority	21%	19%

Procedure

The evaluation assessed a cause-effect relationship between the *SciGirls* series and its planned outcomes with a Two-Group Posttest-Only Randomized Experimental Design. The evaluation did not include pre-viewing measures because true random assignment of girls suffices to ensure the probabilistic equivalence of the groups prior to viewing, as confirmed in Table 2. Also, with the absence of a pretest, we avoid sensitizing girls about our research issues and influencing their viewing.

As outlined in Table 3, both Treatment and Control Groups viewed at home at their convenience four half-hour television shows on DVD, watching two shows per week. The DVD menus indicated an order to viewing the four shows. The four *SciGirls* shows for the Treatment Group focused on engineering design projects.[3] The Control Group viewed four shows of *Wishbone*, a PBS reading literacy show popular in the 1990s. During recruitment, the names of the series were not mentioned because random group assignment had not yet occurred.

Immediately after viewing each show, girls in both the Treatment and Control groups completed short written questionnaires about appeal. After viewing all four shows, all girls were interviewed individually about their understanding of the design and build process and their feelings of self-efficacy related to components of that process (see Measures section).

Table 3. Two-Group Posttest-Only Randomized Experimental Design

	Treatment Group N = 42	Control Group N = 42	Measures for both groups
Week 1	View at home two half-hour *SciGirls* shows on DVD	View at home two half-hour *Wishbone* shows on DVD	Ratings and open-ended written questions about appeal after each show
Week 2	View at home two half-hour *SciGirls* shows on DVD	View at home two half-hour *Wishbone* shows on DVD	Ratings and open-ended written questions about appeal after each show
Week 3			Individual interview about understanding the design and build process and about self-efficacy attitudes related to the steps of the design and build process. *SciGirls* viewers alone were asked about engagement with the shows.

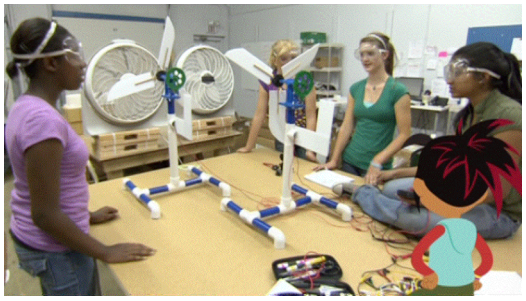
[3] 'Engineering' in the evaluation instruments is represented by the phrase 'design and build.'

Shows

Each *SciGirls* show has two intertwined and related stories. One is an animated story of Izzie and her friend Jake (illustrated to the right) in which Izzie has a problem that only the real SciGirls can fix. The other is a live action story of real girls implementing an engineering design project, which helps Izzie to solve her problem. The four shows incorporate four of the SciGirls seven strategies (noted on p. 2) to engage girls with STEM and also present in varying degrees the six steps of the design and build process (noted on p. 2). The *SciGirls* shows in order of viewing include:

- *Puppet Power*: Anna and her friends engineer a giant pig puppet for a May Day parade, complete with blinking eyes and a twirling tail. In the parallel animated story, Izzie builds a puppet to make herself appear taller for her class election campaign.

- *Blowin' in the Wind*: Izzie's off the grid with Hannah and her friends, who design and build their own working miniature wind farm. The still frame shows how Izzie appears in the real girls' stories to comment occasionally and learn from their design and build process. Izzie figures out how to power her computer with Jake's bicycling energy.



- *High Tech Fashion*: With Project Runway fashion designer Diana Eng as mentor, Hallie and her friends wire up an electrifying gown, while Izzie designs a high tech triathlon suit for a fundraiser to help the ducks.

- *Going Green*: Izzie joins forces with Mackenzie and friends, putting a lid on school trash by inventing a new use for non-recyclable containers. The real girls recycle yogurt cups as seed starting kits, and Izzie recycles snack cups to make Jake a winning costume.

The *Wishbone* series was chosen for the control group viewing because it is a similarly structured show focusing on literacy in a different school discipline: reading. Like the *SciGirls* series, *Wishbone* presents two intertwined and related stories with the dog Wishbone as protagonist in both – one real story is about adventures of the dog's family [Joe and his parents, Steven and Ellen] and Joe's friends [David, Samantha] and the other is a fictional book story in which Wishbone plays a character. The *Wishbone* shows in order of viewing include:

- *Shakespaw:* The school is putting on a production of Shakespeare's The Tempest, with David directing, Joe working as Stage Manager, and Samantha as Miranda. Meanwhile, in the fantasy sequences, Wishbone portrays Ariel in the same play.
- *Digging up the Past:* Joe, Ellen and Wishbone meet a woman who lived in their home over 40 years ago, who comes to see the house and find the treasures she left behind as a kid. Wishbone imagines himself as Rip Van Winkle who falls asleep for 20 years and and can't get anyone to believe who he is.
- *Viva Wishbone!:* Ellen befriends a young man who has recently lost his own mother, which causes Joe to wrestle with his jealousy. To help him, Senora Julia, an old friend who is like a second mother to him, tells him the story of Juan Diego (played by Wishbone) and Our Lady of Guadalupe.
- *The Impawssible Dream:* Joe tries to set a world record for shooting baskets which inspires Wishbone to recall the story of Don Quixote. Wishbone plays the part of Sancho Panza.[4]

Measures

Engagement. Engagement with the *SciGirls* overall format and individual shows was addressed with both written questions answered immediately after viewing each show and with individual interviews after all four shows were viewed. The written questions asked for a quantitative appeal rating of each show and qualitative open-ended responses about what was liked and not liked about the animated stories of Izzie and Jake and about the stories of the real girls. The interview similarly asked open-ended questions about the two story formats. A parallel set of written and interview questions were asked about *Wishbone*, but these data were not analyzed because we were not interested in relative engagement levels.

Understanding. To obtain the interest and cooperation of the control group girls in answering questions unrelated to the *Wishbone* shows they watched, the girls were told that "*the television producers want to develop a show about how girls can carry out interesting design and build projects. They'd like your help in developing the series, so I have some questions to ask you that are not related to the Wishbone series*." An open-ended question asked all treatment and control participants to explain how they would design and build a bridge:

> *I'd like you to think about this problem: You and your girlfriends want to get to school faster but that means crossing a creek. You decide that you need a bridge to cross the creek. Assuming that you could get any materials and tools that you need, describe for me the steps you would take to design and build a bridge to cross the creek. Let me read the problem again. …*

General follow-up prompts were used to encourage more detail:

> *I would like a bit more detail about the steps. What is the very first thing you would do in the project of designing and building a bridge to cross the creek?…What would you do after that? …Would you do anything else to design and build the bridge?*

[4] All *Wishbone* show descriptions are pulled from www.imbd.com, Internet Movie Database.

Confidence. To assess self-efficacy with respect to the girls' perception of their abilities to participate in the steps of a design and build project, two additional projects were proposed in the interview with follow-up questions about confidence:

Now imagine that you have a new neighbor who uses a wheel chair. You and your girlfriends team up to design, build and test a device that she can use to grasp cups and glasses in kitchen cupboards above her head.

Now imagine that your school principal puts you on a team of girls to design, build and test some kind of house for bats to put up around the school. This will attract more bats, and since bats eat mosquitoes, there will be fewer mosquitoes on the playground.

To control for order effects, the order of presentation of the two projects was reversed for a randomly chosen half of each of the groups.

After presenting the project description, participants were asked to rate on a five-point scale how confident they were about doing each step in the design and build process and to explain why they felt confident or not; for example, the question for step 1 for the grabbing device project was:

You are assigned the task of doing some background research on grabbing devices. How confident are you that you could do the background research?

I definitely could do it
I maybe could do it
I'm not sure that I could do it
Maybe I could not do it
I definitely could not do it

Why do you think you [could/could not] do background research?

The remaining questions asked "How confident are you that you could…":

…contribute to the brainstorming of ideas about designing, building and testing the device
…work on a design sketch or drawing of the device
…help build a prototype or model of the device
…test and evaluate the model of the device
…present the team's decisions about the device to your neighbor

A parallel set of questions were used for the bat house project.

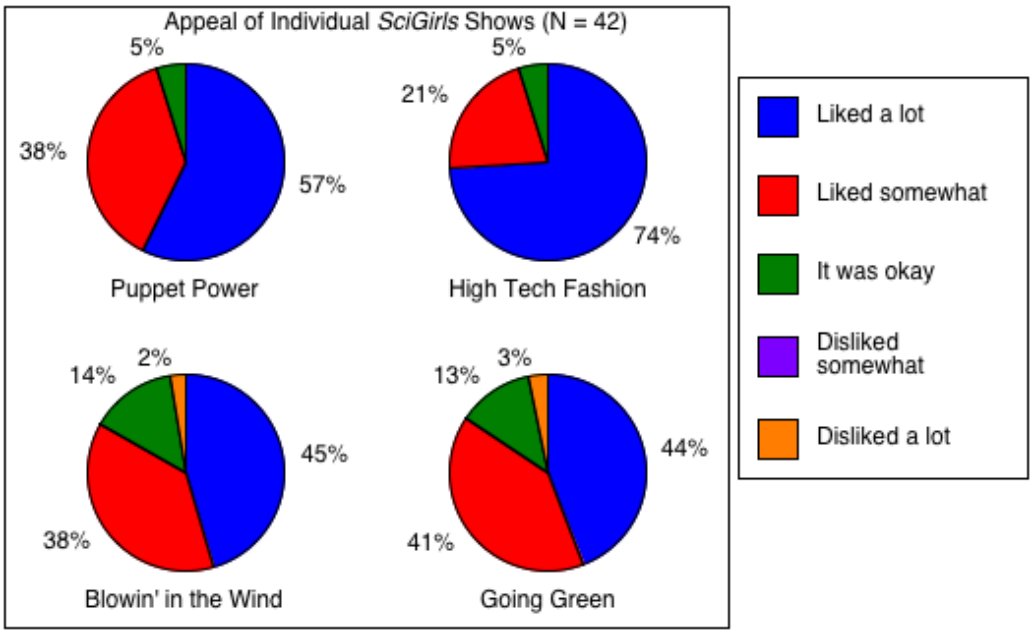
ENGAGEMENT

Immediately after viewing each *SciGirls* and *Wishbone* show, viewers rated the show appeal on a five-point scale and explained what they liked or did not like about the real and the fictional stories. To assess engagement, only the *SciGirls* data were analyzed.

How Appealing Were *SciGirls* Engineering Design Shows?

Viewers rated the *SciGirls* episodes as highly appealing. Three-quarters (74%) liked all four episodes. All viewers voiced a desire to watch more shows, because the series was interesting and fun and viewers felt inspired to do things.

Three-quarters (74%) of *SciGirls* viewers rated all four episodes as "liked a lot" or "liked somewhat." As indicated in the chart below, 95% liked *High Tech Fashion* and *Puppet Power*, 85% liked *Going Green* and 83% liked *Blowin' in the Wind*. These results compare favorably with appeal of other age-appropriate STEM series: 70% to 87% liked each of five Season 3 episodes of *Fetch!*[5] and 81% liked the *Design Squad* series after watching four Season 1 episodes.[6]



[5] Goodman Research Group, Inc. (2010) Summative Evaluation of FETCH Season III: Executive Summary.
[6] Goodman Research Group, Inc. (2007) Design Squad: Final Evaluation Report Executive Summary.

All our *SciGirls* viewers reported that they would like to watch more *SciGirls* shows, when asked at the close of the interview. They gave the following reasons in support of their intention:

- 38% felt the series was ***interesting***.

- 31% felt ***inspired*** by the shows to do things; for example:
  They were creative, and I really liked how they could inspire me to do different things.
  I would love to watch more SciGirls because I think they made me want to become a SciGirl and do more science projects. And it kind of inspired me to do more and do new things. They inspired me.
  They give me ideas about how I can make a good impression on the environment and what I can make. They inspire me.
  They give me ideas of like what I might wanna do.
  It helps me come up with fun ideas to do my own stuff with my friends.

- 26% described the series as ***fun to watch*** or ***funny***.

- 21% asserted that they ***learned*** from the shows; for example:
  Because I'm not that into science that much, but the shows really help me understand science, even though it's not my favorite thing in school.
  You get to learn about something new and how they make it, and every time you learn about science with them.
  I learned a lot from them.

And intriguingly, a few girls noted spontaneously that their family also enjoyed the series:
  It's about girls, but boys can also watch it, because they can relate to it sometimes. My brother couldn't take his eyes off the TV. He's 12.
  My mom likes them, and there are not many good shows that I am allowed to watch. They are pretty fun to watch.
  Even my mom, she was sitting there [while I was watching the show], *and I'm like "Mom, it's time to leave now. You're going to be late." And she was like "Hold on one second." She learned stuff she didn't know too.*

Did Evidence-Based Strategies Engage *SciGirls* Viewers?

Production of the *SciGirls* segments of real girls doing real projects is rooted in four strategies that previous research has revealed engages girls in STEM in educational settings. The project raises the question whether translating these research-based strategies into a TV series produces comparable levels of engagement. A prime indicator of success in engaging the tween girl viewer of *SciGirls* is whether or not these production strategies are reflected in open-ended responses of what viewers "*liked*" about the real girls segments. Viewers' appeal responses - written after watching each program and oral in the final interview - were coded for the appearance or not of each of the four strategies, as illustrated below with quotes. The quotes are verbatim with corrected spelling but not corrected for grammar.

> Nine in ten (90%) viewers noted at least one of four evidence-based production strategies in their open-ended responses as to what they liked about the videos.

1) Girls are motivated by projects they find personally relevant and meaningful.
Girls become motivated when they feel that what they are doing is important and can make a difference and when topics are relevant to their own lives and interests. Viewers were coded into this category when their appeal responses voiced a personal interest in the project topic (e.g., *I really like fashion* or *I like art)* or when their responses described the project as meaningful using key words like *help*, *save*, *care, important*. Some responses did not contain either personal interest or key words but still fit the theme of appreciating the importance of the girls' onscreen activity (e.g., *I liked how the girls gave the money they earned to a cause instead of keeping it for themselves.)*

More than half (55%) of the *SciGirls* viewers liked that the projects were important or relevant to their personal interests; for example, five girls commented about the series and individual shows as follows:

They wanted to help stuff too. They helped things – they recycled and made something that did not use energy. [response about series]. *I liked how they made something big to help the planet. They actually made sure it would work* [response about program *Blowin' in the Wind*]. *I liked that they did something in fashion because I really like fashion* [response about program *High Tech Fashion*].

I liked how they liked to save the earth and how they liked to save people from doing electricity a lot and use wind power to do things and puppet power [series]. *Loved the song, liked how they wanted to use wind power to help people get electricity* [*Blowin' in the Wind*]. *How they wanted to save the earth by recycling* [*Going Green*].

I liked how they showed us how to make the pig puppet. I like art so it was interesting to me [*Puppet Power*]. *I really like fashion and sewing so I liked this one the best* [*High Tech Fashion*].

I love fashion so I thought the theme was awesome [*High Tech Fashion*]. *I was glad they cared so much about the earth* [*Going Green*].

I loved that I actually learned science that I can use and I liked that it was ALL green [*Blowin' in the Wind*]. *I loved that it showed how you should recycle and what you can do about trash. It was my favorite one ever! I really enjoyed watching it.* [*Going Green*].

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

Girls enjoy being able to express their personality through their projects and thus gain a sense of pride and ownership in the outcomes. The television series feeds into this strategy by showing how the onscreen girls generated their own creative ideas drawing on their talent and abilities. Viewers were coded into this category when their appeal responses revealed an appreciation for the onscreen girls' abilities (e.g., *They used their imagination to make a dress)* or an appreciation for their project ideas (e.g. *I liked how they would have a bunch of good ideas).* Key words used to describe the project *ideas* included *amazing, cool, creative, different*, *funny*, *good, great*.

Half (50%) of *SciGirls* viewers pointed out that they liked how the real girls used their own creative ideas and talents to solve problems and complete the projects; for example, four girls commented about the series and individual shows as follows;

> *I like how smart they were and how they knew what they were doing with all of the technical stuff* [series]. *I liked that they had the talent to make a moving pig for the parade* [*Puppet Power*]. *I liked their amazing ideas.* [*High Tech Fashion*]. *They had great ideas* [*Going Green*].

> *I liked that they always had really good ideas and stuff* [series]. *What I enjoyed was that they had the idea for smoke coming out of the pig's nostrils* [*Puppet Power*]. *I thought it was really cool that they thought to power a bird bath using wind mills* [*Blowin' in the Wind*].

> *The stories of the real girls I really liked because they were very creative in what they did and how they did it and when they did it. And they showed why they did, and it was very fun to watch them do things* [series]. *They were creative and smart* [*Puppet Power*].

> *They thought of really good ideas. One specific one was in the "High Tech Fashion" show, they were making a dress and they made the bottom of the dress out of a purple plastic table cover, and I liked that.* [series]. *They thought of good ideas* [*Puppet Power*]. *They tried different ideas* [*Blowin' in the Wind*]. *I like that the girls came up with good designs.* [*High Tech Fashion*]. *I like that the girls came up with all those ideas of what they can do with the yogurt cups, and also that they were going to use the yogurt cups for a flower pot* [*Going Green*].

3) Girls benefit from collaboration, especially when they can participate and communicate fairly.

Girls are energized by the social part of science – working and learning together in a respectful and inclusive manner. Viewers were coded into this category when their appeal responses described how the girls worked together (e.g., *I liked how they all worked together).* Key phrases and key words included *worked together, nice to each other, listened to each other, team, friends, share*.

Almost half (45%) of the *SciGirls* viewers found most appealing the teamwork and constructive interactions of the real girls in the shows; for example:

> *They were all like best friends. They all, you know, all were teens, and like the teamwork, and very single time they managed to pull it off even if they got off to a rough start* [series]. *I liked the fact that they were from different cultures, they were all best friends, they worked together and they listened to each other when they had different ideas* [*Puppet Power*]. *The girls all worked well together. It was a really fun episode* [*High Tech Fashion*].

In every episode, they were all trying to work together to build things [series]. *I liked how they all worked on the puppet as a team* [*Puppet Power*]. *I liked that the girls saved energy by working together* [*Blowin' in the Wind*]. *I liked that they worked together on making an eco-friendly project* [*Going Green*].

They all worked together as a team and thought of really good ideas, and they were nice to each other [series]. *That they worked together as a team.* [*Puppet Power*]. *That they worked together like a team by agreeing with each other and trying different ideas* [*Blowin' in the Wind*]. *They worked together as a team to make sure the positive and negative wires didn't touch each other. I liked everything!* [*High Tech Fashion*].

I really liked the Puppet Power that they worked together to make that huge puppet, and I really liked how they worked together, and the end was just awesome because I thought it was going to be one of those hand-held puppets, but then I was like: "Wow!" [series]. *I liked how the girls worked together to make the puppet.* [*Puppet Power*]. *I liked how they all worked together to make 15 wind turbines* [*Blowin' in the Wind*].

4) Girls benefit from relationships with role models and mentors.

Seeing girls and women who have succeeded in STEM helps inspire and motivate viewers, especially when they can relate to these role models as "real" people. Viewers were coded into this category when their appeal responses described how the viewer identified herself with the onscreen girls (e.g., *I think that it's really cool that girls like me could make something like that)* or when the viewer noted the role of the onscreen mentors (e.g. *If they had a question, they'd ask whoever was helping them build).*

In the appeal responses, 31% of *SciGirls* viewers identified the onscreen girls as role models for themselves and/or noted the help of the onscreen mentors in the real girls' projects.

I liked watching the everyday girls like me doing a big project kind of thing. [series]. *I liked that the creator of Project Runway was in the episode* [*High Tech Fashion*].

I liked that they were just like real girls, like they wouldn't do anything that we probably wouldn't be able to do. They could do anything that we could do too [series].

I liked it when Diana first showed the girls the LED lights. It was cool how the colors went on and off. [*High Tech Fashion*]. *I liked how the girls went to the wind farms for help* [*Blowin' in the Wind*].

I liked how they brought experts in [*Going Green*].

One production feature that attempted to increase viewer identification with the onscreen girls as role models were the short video stories about their backgrounds and personalities. This feature was not asked about directly; but a small portion (12%) of viewers commented that they liked learning more about the onscreen girls through this feature, whereas a similarly small portion (14%) felt the videos distracted from the project story; for example*I liked the parts where they tell a little bit about themselves. It helped me figure out what their personalities was* [series].

I like the little clips about them. I thought that was good [series]. *In the short clips that explained about them, it explained about the stuff they liked, their cultures, their awards and much more* [*Blowin' in the Wind*].

I also liked when they told about themselves by making videos. It was funny [*Puppet Power*].

They should say a little bit less about the girls because it takes more time and takes away from the show and I really like the show [series].

I didn't like the short segments of the individual girls. It didn't have to do with the work they were doing on the show, and it didn't teach anything that I should know about them [*Puppet Power*].

I didn't like when it kept stopping in the middle of the story to show what they did because sometimes I forgot [about the project] and had to rewind a little bit [series]. *I didn't like when the girls were telling about the hobby* [*Blowin' in the Wind*].

What was Not Appealing about the Real Girls' Stories?

Almost half (45%) of the *SciGirls* viewers liked everything about the real girls stories in each individual show and the series as a whole. A few concerns arose related to production values across shows:

- 14% did not like the interstitial videos that explained the interests of the onscreen girls (as noted above).
- 14% were confused by some of the vocabulary (e.g., *science words that I don't know yet*) in *High Tech Fashion* and *Blowin' in the Wind*.

Other issues related to personal discomfort with specific parts of specific shows:

- 19% critiqued the look of the dress design in *High Tech Fashion*.
- 12% did not like the emergency with the pig's "smoke" during the parade in *Pig Power*.
- 7% were uncomfortable that the girls dug through trash in *Going Green*

What was Appealing and Not Appealing about the Izzie and Jake Animated Stories?

SciGirls viewers thought the animated stories of Izzie and Jake were funny, valued that Izzie tried to do something meaningful with her projects and particularly enjoyed her problem solutions. Viewers liked that the animated stories paralleled the stories of the real girls and that Izzie visited their stories to obtain help with her own problem. Viewers did not appreciate negative interactions between the two characters when Jake was rude or not supportive or when Izzie misused Jake for one of her projects.

Viewers were asked what they liked and did not like about the animated stories of Izzie and Jake in the written questionnaire immediately after viewing each *SciGirls* episode and also in the verbal interview after seeing all four shows. The major themes are described below:

- 71% of viewers liked the solutions presented at the end of the animated stories; for example,
  I liked how in the end [of Blowin' in the Wind], *Jake was on the "energy" bike to get energy for Izzie's computer. I liked how she made a technology type suit for the triathlon. I liked how Izzie got Jake into the show with the cans.*
  I liked how Izzie made her own puppet tall. I liked how she thought to make her computer work by using the bike. I like how Izzie made her own outfit. I like how they made the outfit out of recycled potato munch containers.
  I liked when she made her puppet to try to win the election. I liked that she made a outfit so she would not have to change outfits. I liked that they made a helmet and outfit out of the containers.
  I liked Izzie's puppet. I liked how she thought of a bike instead of a windmill. I liked how she made the floaties pop out of her sleeves. I liked how they made the recycled costume.

- 50% of the viewers described the Izzie and Jake animations in the various episodes as funny.

- 40% liked that Izzie was doing something meaningful in saving energy, protecting ducks, and recycling; for example:
  I liked when Izzie tried to go green.
  What I liked was that Izzie was trying to go green. I liked that she was trying to help the ducks.
  I liked how Izzie helped the planet.
  I thought it was great that she used an alternative energy source.
  I liked the fact that Izzie made a fashion statement while saving ducks.
  I liked how she wanted to be green so she made some things to power her computer. I liked how Izzie supported something [the ducks] *that she cared about.*
  Conversely, some (19%) viewers did not like that Jake did not care to recycle:
  I didn't like that Jake didn't care what he was doing to the environment.
  I did not like when Jake wanted to throw away the containers before thinking about recycling them.

- 40% enjoyed how the animated story paralleled the real girls story and liked how Izzie went to the real girls for help, popping into their stories; for example,
  I liked the animated part of the story because I really saw the connection of the real SciGirls with the animated parts.
  I liked how it wasn't the exact same thing as the real girls, but it followed a similar track.
  I liked how Izzie used the Scigirls to like make her own ideas of some things she could do.

I liked how Izzie and Jake could relate to something with the SciGirls, like whenever they had a problem. Every time they had a problem they could just go to the SciGirls and they would have the same exact problem, like the chip containers and the yogurt cups.

I liked how they [Izzie & Jake] *would do something that would have to be included with the SciGirls because they wouldn't know what they were doing, and they would ask the SciGirls for help. I liked how Izzie, whenever she needed help, the computer would take her into the website, and she would climb the stairs and jump down to find a show that might help her.*

I liked how Izzie, like when they did something cool, she would like pop up and try it and see if she could do it.

I loved how Izzie kept popping up in the real girls story and saying comments and stuff about what they were doing.

On the other hand, some (14%) viewers felt that Izzie's popping into the real girls stories was *distracting*.

- 21% of viewers enjoyed the positive interactions between Izzie and Jake when the two worked together or helped each other; for example,

I liked how Izzie helped Jake.

I liked how they worked together and things were always working out.

I liked that they talked to each other on the computer like friends.

On the other hand, 43% of viewers did not like what they perceived as negative interactions between the two characters when Jake was mean, rude or not supportive or when Izzie misused Jake; for example,

Always Jake would be laughing at Izzie for some strange reasons. And Izzie was kind of mean because she made Jake pedal the whole time and they couldn't switch off.

They weren't always getting along, and Jake would sometimes make fun of Izzie.

Jake never believed in Izzie. I didn't like how Jake makes fun of Izzie's hard work.

I did not like that Izzie constantly used Jake, like one time would be okay, but using him over and over. And when Jake made fun of Izzie and laughed when she gave her best.

I did not like how Izzie did not let her friend have a break from pedaling.

I did not like how Jake was rude to Izzie. I didn't like how Izzie made Jake do the ride on the bike to make the computer go because she forced him to do it.

Yet a few (7%) viewers appreciated the humor of Jake's interactions with Izzie; for example,

I thought the shows were really funny because Jake was always annoying Izzie.

I liked how when she was trying to tell him something, he was always talking about something else.

- 17% complained that the animated part of the episodes was too short.

- 10% did not like the animated segments at all:

I don't think the animated part fit it. I am not a big cartoon fan. I think it just should have been the real girls. They should take the animated part out.

I did not really like anything about it. I don't really learn anything.

I don't like cartoons in general because they sometimes get annoying and they're too babyish. I think that it should be the real girls.

Izzie and Jake take up so much time when they could be showing more time with the real girls. I think it would be better without it. I wasn't really focused on them that much because I was focused on the real girls.

UNDERSTANDING THE ENGINEERING DESIGN PROCESS

In the interview after viewing all four shows, both the treatment and control groups were verbally presented with a hypothetical design and build project with a few general follow-up prompts to elicit more detail:

> *I'd like you to think about this problem: You and your girlfriends want to get to school faster but that means crossing a creek. You decide that you need a bridge to cross the creek. Assuming that you could get any materials and tools that you need, describe for me the steps you would take to design and build a bridge to cross the creek. Let me read the problem again.* …[after initial answer] *I would like a bit more detail about the steps. What is the very first thing you would do in the project of designing and building a bridge to cross the creek?…What would you do after that? …Would you do anything else to design and build the bridge?*

Rather than leading the girls with more and more specific prompts, this measure was purposely open-ended to capture how children thought spontaneously about a design and build project. Both treatment and control groups had the same portion of girls who reported that they had some previous experience in building bridges, though the projects were with *toothpicks* or *popsicle sticks* or *clay*.

Given a hypothetical project to design and build a bridge over a creek, the *SciGirls* viewers revealed a significantly better understanding of the engineering design process than the control group.

The open-ended responses to the hypothetical bridge project were coded, blind as to group, for the presence and absence of language reflecting design and build steps that the *SciGirls* teams model in the television series. Response examples are presented below to illustrate the coding for each step.

The first step modeled by the onscreen girls was to *identify the problem*. In answers to the bridge problem, respondent girls typically noted that they need to measure the creek or consider characteristics of the creek; e.g.,

> *We would go to the creek and make sure how long it is and how much of the bridge we need to build.*
> *I'd figure out how deep the creek was.*
> *First, see how long the stream is. See how wide it is.*
> *The first step I would take would see how fast the creek was running.*

The next step involved *generating ideas by looking at other relevant designs, consulting experts or a mentor, consulting non-human sources, and brainstorming*. The response set included all of these possibilities; e.g.,

> *I would see how other bridges are made.*
> *I would probably like ask people like someone who knew a little bit more about building.*
> *If we find something online, how to make one, we would print that out.*
> *Everyone has different ideas so I'd want to hear their ideas.*

Another engineering step that the *SciGirls* teams showed was *planning by sketching, drawing a detailed design*, which was noted by interview respondents:

I would probably work on what it would look like on paper. Write it down on a piece of paper and draw it out.
First, me and my friends would think of a design, and then we could sketch it out in a notebook.
I'd sketch it out so I would know what I was doing.

The bridge responses were also coded for the mention of *building a prototype or model* or any kind of practice bridge; for example:

I would build a model of it to see how it turns out.
We'd build small little models.
We'll make different types of bridges to see which one is the sturdiest, and then which one is the sturdiest is the one we'll go across all the time.

The final step which was looked for in the bridge project responses was an indication that the child would *test, evaluate and redesign* their bridge. To be coded into this category, the child's response needed only to mention testing the bridge; for example:

I'd put something on it to test it to see if it was heavy enough for someone to walk over it.
I would test it out a few times and make sure it was safe.
I would put it all together and test it out. If it worked, I would put it over the creek….Then I would improve on it if I had time.

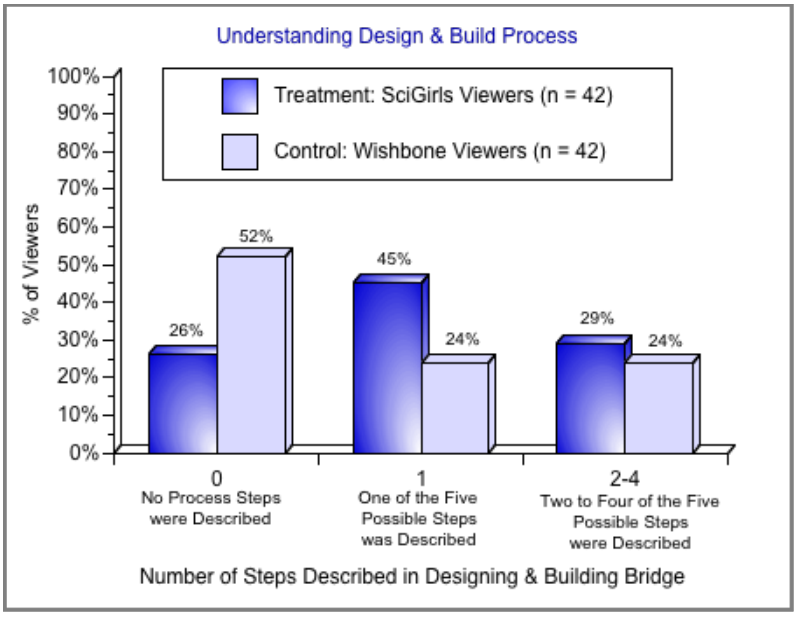
Both groups included girls who were unable to provide answers that employed any of the above design and build steps. These girls jumped right into describing materials and logistics of construction and did not mention any of the design process steps as presented above; for example:

Wishbone Control: *I would get wood, and I would bring that, nails, and a hammer and bring that to the creek. I would have my friends put on bathing suits and jump into the creek and hold up some of the boards of wood, and I would hammer them in with nails. Then they would go under what we did and hold more boards, and I would hammer them in on the top so that they go across.*

SciGirls Treatment: *I would go to the lumber store and buy hammers, nails, wood and those screw driver things or a drill. I would come back and ask my friends and family to help me build the bridge. I would take the wood and make it so it would be an arch, and use hammer and nails to look like that. I would take two boards and nail them together and put them on each side of the arch as railings so nobody would fall. I would go get the paint and then I would paint it.*

After open-ended responses were coded as explained above, the number of design and build steps that each child successfully described were counted to test the hypothesis that *SciGirls* viewers would describe more steps than *Wishbone* viewers. Describing more steps implies a better understanding of the engineering process.

The left-hand columns in the chart below show that more than half (52%) of the *Wishbone* viewers compared with 26% of the *SciGirls* viewers did not describe any of the five coded process steps (0 steps) when explaining how they would design and build their bridge. The explanations of these girls focused on obtaining materials and logistics of constructing the bridge rather than any of the engineering design process steps. The center set of columns reveal that 45% of the *SciGirls* viewers and 24% of the *Wishbone* viewers described at least one of the five possible steps (1 step). The right-hand columns indicate that 29% of *SciGirls* viewers and 24% of *Wishbone* viewers explained two, three or four of the five possible steps (2-4 steps). The frequencies of respondents describing three or four steps were too small for valid statistical analysis, so these frequencies were combined with those describing two steps, thus producing the 2-4 step group in the chart. None of the viewers gave a response that was coded for all five steps.



Statistically, the number of steps described by the girls in their bridge solution was significantly related to which television series they viewed.[7] The *SciGirls* viewers demonstrated better understanding of the engineering design process when compared with the *Wishbone* viewers.

[7] A 2x3 chi-square test indicates that the relationship between group and number of steps was significant, χ^2 (2, N = 84) = 6.642, p = 0.0361. Without combining data into the 2-4 step group, one could use a Median Test on the step data: the *SciGirls* median of 1.1 is significantly greater than the *Wishbone* median of 0.88, $p \leq .0001$.

CONFIDENCE RELATED TO ENGINEERING DESIGN PROCESS

We were interested to what extent viewing of same-sex models in the four *SciGirls* engineering design shows influenced the girls' self-efficacy beliefs – or confidence - that they are able to participate in the steps of the design and build process. The measurement instrument presented two hypothetical design and build projects and asked the children to indicate on a five-point scale how confident they were in doing each of the steps and to tell why or why not. We intentionally invented projects that were not included in the programs nor significantly related to the projects featured in the four episodes. This measure required the transfer of confidence acquired in one context (the engineering projects in the episodes) to similar but new projects (the projects in the self-efficacy instrument). Typical summative evaluations do not measure transfer but instead measure viewers' perception of content that explicitly appears in the TV programs. Our measure looked at transfer to new content and thus put the *SciGirls* series to a test more stringent and challenging than is typical.

Responding to two hypothetical design and build projects, the Treatment group included significantly more girls than the Control group who rated themselves "definitely" able to *brainstorm* and *test*. The *SciGirls* viewers also were more confident of their ability to *model* and *present,* but the differences did not reach significance.

Two scenarios [Device; House] were presented to the participants in order to enlarge the data set and dilute content-specific issues. The scenarios were presented in one order to a random half of the samples and in reverse order to the other random half.

Device Problem
Now imagine that you have a new neighbor who uses a wheel chair. You and your girlfriends team up to design, build and test a device that she can use to grasp cups and glasses in kitchen cupboards above her head.

House Problem
Now imagine that your school principal puts you on a team of girls to design, build and test some kind of house for bats to put up around the school. This will attract more bats, and since bats eat mosquitoes, there will be fewer mosquitoes on the playground.

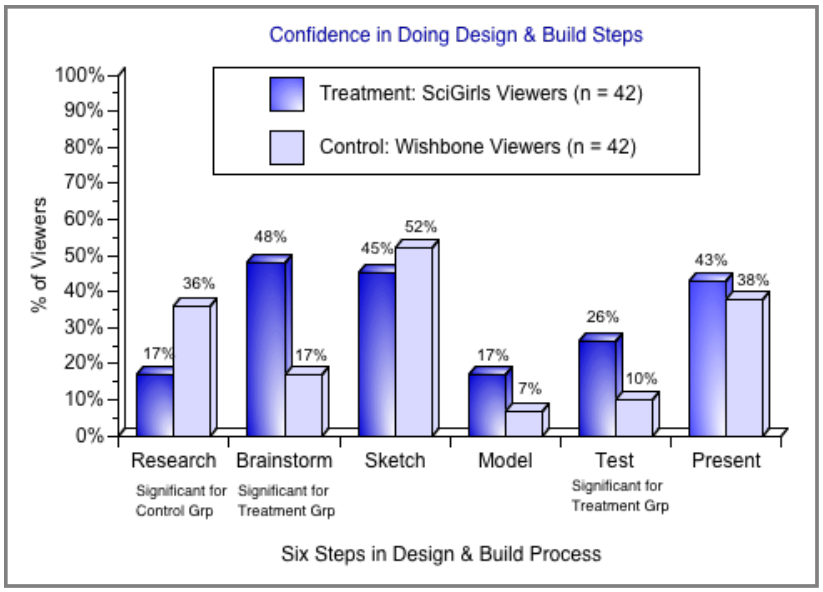
After identifying each problem as presented above, the interviewer asked respondents to rate how confident they were to do each of the following engineering process steps related to the problem:

*…do background **research***
*…contribute to the **brainstorming** of ideas about designing, building and testing the* [*device/house*]
*…work on a design **sketch** or drawing of the* [*device/house*]
*…help build a prototype or **model** of the* [*device/house*]
*…**test** and evaluate the model of the* [*device/house*]
*…**present** the team's decisions about the* [*device to your neighbor/bat house to your principal*]

For each of the steps above, the girls were shown a written five-point scale to rate self-efficacy for the specific tasks:

I definitely could do it
I maybe could do it
I'm not sure that I could do it
Maybe I could not do it
I definitely could not do it

The self-efficacy rating instrument permitted a choice of five levels of confidence for each of six different engineering tasks for the two hypothetical design & build problems. However, a "ceiling effect" appeared in our results. This means that ratings bunched up at the most positive end of the instrument: 87% of all rating choices made by the girls were "*definitely could*" and "*maybe could*," constricting the variability in the data. To use comparisons of mean ratings when a ceiling effect is present can yield the mistaken conclusion that the treatment has no effect. To address the difficulty of this ceiling effect for analysis, we looked at proportional differences only at the highest level of confidence: We compared the proportion of treatment and control girls who chose "*definitely could*" for <u>both</u> the Device problem and the House problem for each engineering task (*research, brainstorm,* etc). The chart below summarizes these results; each column represents girls who felt they *definitely could* do the specified engineering task for both problems.



Which television series the girls viewed had a statistically significant influence on girls' strength of self-efficacy ratings for the engineering tasks of *research*[8], *brainstorm*[9], and *test*[10]. When rating their confidence regarding the design process for both the Device and House problems, significantly more *SciGirls* viewers than *Wishbone* viewers felt they *definitely could brainstorm* (48% vs. 17%) and *definitely could test* (26% vs. 10%). The difference between groups also favored the *SciGirls* viewers for the tasks of *model* and *present*, although statistical significance

[8] χ^2 (1, N = 84) = 3.941, p = 0.0471.
[9] χ^2 (1, N = 84) = 9.224, p = 0.0046.
[10] χ^2 (1, N = 84) = 3.977, p = 0.0461.

was not obtained. Significantly more of the control group felt that they *definitely could research* compared with the treatment group (36% vs. 17%), and the control group was also favored for the task of *sketching*, although the difference was not statistically significant

After providing their confidence rating, the girls were asked to explain why they could or could not participate in each engineering step. We had hoped that *SciGirls* viewers would spontaneously mention the programs, but only one response met our expectations: *In SciGirls, they map out what they'd do, so like that, I'd do that*. Adding interview probes about how the programs influenced their confidence or not in doing each of the engineering tasks might have revealed links to the *SciGirls* programs.

DISCUSSION

Engagement

Viewers of *SciGirls* rated the episodes as highly appealing, at a level comparable to that obtained by evaluations of other NSF-funded PBS STEM programming like *Fetch!* and *Design Squad*. The fifth graders expressed a desire to watch more shows because the series was interesting and fun and inspired them to do things. All viewers wanted to watch more *SciGirls* shows, indicating that the series can attract and hold the attention of tween girls.

One of the main reasons that viewers are so engaged by the series is the successful application by the producers of four of seven evidence-based strategies identified as effective in engaging girls with STEM in educational settings. Nine in ten (90%) *SciGirls* viewers noted at least one of the four strategies in their open-ended responses as to what they liked about the videos.

- One strategy suggested that girls are motivated by projects they find personally relevant and meaningful. More than half (55%) of the *SciGirls* viewers felt the engineering design projects were important or relevant to their personal interests.
- Another strategy proposed that girls are motivated when they can approach projects in their own way, applying their creativity, unique talents and preferred learning styles. Half (50%) of viewers liked how the real girls used their own creativity and talent to solve problems and complete the engineering projects.
- A third strategy noted that girls benefit from collaboration, especially when they can participate and communicate fairly. Almost half (45%) of the *SciGirls* viewers were energized by the teamwork and constructive interactions of the real girls.
- A final strategy indicated that girls benefit from relationships with role models and mentors. One-third (31%) of viewers identified the onscreen girls as role models for themselves and/or noted the help of the onscreen mentors in the real girls' projects.

The four production strategies were recognized by *SciGirls* viewers as appealing and engaging, as intended by the producers and as suggested by the research in other educational settings.

The animated stories of Izzie and Jake also engaged the *SciGirls* viewers. Viewers liked that the animated stories paralleled the stories of the real girls and that Izzie visited their stories to obtain help with her own problem. Viewers thought the stories were funny, valued that Izzie tried to do something meaningful with her projects and particularly enjoyed her creative problem solutions. On the other hand, our viewers' did not always appreciate when comedic bullying occurred between the two characters.

Understanding

Analysis of fifth graders' descriptions of how to design and build a bridge across a creek revealed that viewers of *SciGirls* compared with *Wishbone* viewers acquired a statistically significant better understanding of the steps of the engineering design process. In this case, the *SciGirls* viewers successfully transferred their learning of process steps to the new problem of

bridge building. This result is more meaningful when one recognizes that the design steps are not highlighted didactically in the shows but well integrated in the storytelling. The finding contributes support to the capacity model proposed by Fisch[11] in his extensive review of children's television research that educational content is better understood when closely tied or central to the narrative plotline.

Confidence

The evaluation looked at confidence as it pertains to a belief in one's ability to succeed in specific situations –that is a belief in "self-efficacy." Self-efficacy is a concern of the *SciGirls* team because research has shown that science self-efficacy is predictive of science achievement among middle school students.[12] Our measurement instrument put the *SciGirls* television series to a stringent and challenging test by looking at confidence in doing engineering design steps, not for projects that were actually presented in the four shows, but for two novel hypothetical projects. The *SciGirls* viewing group included significantly more girls than the *Wishbone* group who rated themselves "definitely" able to carry out the design steps of *brainstorming* and *testing*. The *SciGirls* viewers also were more confident of their ability to *model* and *present* their project, but the differences did not reach significance. For the tasks of *researching* and *sketching*, the *SciGirls* viewers did not demonstrate more confidence. The results give qualified support to Bandura's observation that self-efficacy beliefs can be influenced by vicarious experiences, in this case, seeing girls similar to oneself implement engineering tasks successfully.

In summary, the summative evaluation of *SciGirls* reveals that the television series attracts and engages girls through application of evidence-based strategies; uses winning fictional and factual narrative stories and characters to model effectively the engineering design process; and provides vicarious experiences by which viewers may increase their belief in their ability to execute the steps of the design process.

[11] Fisch, S. M. (2004). Children's Learning From Educational Television: *Sesame Street* and Beyond. Mahwah, NJ: Lawrence Erlbaum Associates.

[12] Britner, S. L. & Pajares, F. (2006). Sources of science self-efficacy beliefs of middle school students. Journal of Research in Science Teaching. 43(5), 485-499.