



MULTIMEDIA RESEARCH

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Contribution of Multimedia to Girls' Experience of Citizen Science

Summative Evaluation of *SciGirls* Season Three



Report for
Twin Cities Public Television
by
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EXECUTIVE SUMMARY

Produced by Twin Cities Public Television, St. Paul, MN, and sponsored by the National Science Foundation, *SciGirls* (Season Three) is a multimedia project that presents videos and games designed to engage and educate millions of children about citizen science. Multimedia Research, an independent evaluation group, implemented a summative evaluation that assessed a model of citizen science engagement and education that examined the contribution of *SciGirls* multimedia to preteen girls' experience of citizen science.

In the evaluation's mixed-methods experimental design, fifth grade girls at five nationally distributed sites were randomly assigned to one of two groups: A treatment group (n = 49) that experienced 2 hours of *SciGirls* multimedia at home followed by a 2.5 hour live citizen science session; or a control group (n = 49) that experienced the live citizen science session without prior exposure to *SciGirls*. Prior to beginning the evaluation, the two groups were equivalent in their interest in nature and science ratings.

In the *SciGirls* experience, participants viewed three half-hour videos in which female mentors guide different groups of middle school ethnically diverse girls as they learn about citizen science protocols and collect and share data. Participants also played two games supporting the citizen science experience.

For the evaluation's live citizen science session, *FrogWatch USA*, a project of the Association of Zoos and Aquariums, was chosen to represent the field of contributory model citizen science and is one of the six citizen science projects covered by *SciGirls* multimedia. In a *FrogWatch USA* session, participants engage in citizen science by learning to identify calls of frogs and toads and collect data in community wetlands, adding to a publicly accessible database.

Drawing on research in interest development, sources of self-efficacy, and multiple platform learning, the summative evaluation examined how *SciGirls* multimedia enrichment contributes to fifth grade girls' (1) interest in the *FrogWatch USA* session and citizen science generally, (2) self-efficacy in the *FrogWatch USA* session and citizen science generally, and (3) learning about the practice of citizen science. Data collection methods included post surveys with quantitative rating scales and open-ended questions as well as individual post interviews. Contributing to scale development and validation were the DEVISE project of grant partner Cornell Lab of Ornithology as well as fifth grade girls in NASA S'COOL citizen science programs and in science classrooms in six states.

Key Findings

The treatment group demonstrated significantly higher levels of interest than the control group in their *FrogWatch USA* session. Both treatment and control groups rated their quantitative interest in *FrogWatch USA* very high, but prior exposure to *SciGirls* multimedia successfully triggered more interest for the treatment group. Treatment girls felt that their interest increased because the *SciGirls* videos and games prepared them for the *FrogWatch*

USA session, showed them that *FrogWatch USA* would be fun, and explained why citizen science data collection is important.

Both treatment and control groups were moderately interested in finding out more about other citizen science projects and somewhat likely to look for another citizen science project to do in the future. The two groups did not differ significantly in their quantitative interest ratings of pursuing more citizen science beyond *FrogWatch USA*. Girls who reported interest in other citizen science projects explained that they were influenced by *SciGirls* videos that showed how girls like themselves could participate in citizen science and that portrayed how fun citizen science is.

Treatment and control groups displayed equal and high self-efficacy ratings with respect to their *FrogWatch USA* session and other citizen science projects. Treatment girls who reported positive self-efficacy ratings felt that they did better in their *FrogWatch USA* session and would do a good job in a different citizen science project because they saw girls like themselves successfully participating in both *FrogWatch USA* and other projects. They felt that *SciGirls* multimedia prepared them in advance for the frog content and activities and also showed them the process of other citizen science projects.

The treatment group demonstrated significantly better understanding than the control group of the unique practice of citizen science. Exposure to *SciGirls* multimedia helped treatment girls understand the features of the practice of citizen science: that anyone can participate; that participants use the same protocol so data can be combined and be high quality; that citizen science data can help real scientists come to real conclusions; and that citizen science brings together a wide community of scientists and volunteers to work together and share data to which the public, as well as scientists, have access.

Within the treatment group, pre-exposure to *SciGirls* produced a significantly stronger impact on minority girls than non-minority girls. By stratified random assignment, treatment and control groups included equal percentages of minorities (38%), comprising African American, Latina, Asian and multiethnic girls. Within the treatment group, minority girls (n = 18) produced significantly stronger results compared to non-minority girls (n = 31). These findings must be qualified by the small sample size, but minorities displayed higher interest in their *FrogWatch USA* session, higher interest in finding out more about other citizen science projects, greater likelihood to look for a future citizen science project to do, greater perceived efficacy in doing other citizen science projects, more similarity to the video girls, and stronger interest in their *SciGirls* experience.

Recommendations

Each of the six citizen science projects highlighted in a *SciGirls* video should consider utilizing *SciGirls* multimedia prior to citizen science sessions with preteen girls. For logistical reasons, *FrogWatch USA* was chosen to represent the contributory model citizen science projects covered in the *SciGirls* videos. Besides *FrogWatch USA*, highlighted projects in *SciGirls* include Celebrate Urban Birds, Monarch Larva Monitoring Project, Student Cloud Observations Online, Nature's Notebook, and Seafloor Explorer. Although each of these projects has unique elements, we can generalize from the summative evaluation findings that prior exposure of preteen girls to the *SciGirls* materials associated with a respective project can increase project interest, help prepare girls for their citizen science sessions, and improve understanding of citizen science practice.

Informal and formal educators working with preteen girls could use *SciGirls*' resources – video in particular – independently of specific citizen science projects to introduce the practice of citizen science generally and generate interest and participation in citizen science more broadly. Exposing young girls to the process and fun of citizen science via video will increase not only knowledge about citizen science, as demonstrated by the evaluation's results, but also might stimulate participation in projects not highlighted in the videos.

The differential impact of *SciGirls* on minority girls' interest and efficacy should encourage researchers to explore these issues with larger samples. Further research might focus on ethnically diverse or homogeneous groups and collection of a much wider variety of background information to shed more light on how peer-oriented multimedia influences youth outcomes, how minorities might respond differently to contributory model citizen science, and how groups differ in their pathways of science interest and self-efficacy.

To contribute to potential comparisons across citizen science and science programs more generally, the Girls' Interest in Nature and Science Scale (GINSS), developed and validated as part of the summative evaluation, is available for use by other evaluators and researchers (see Appendix A).

In conclusion, the *SciGirls* multimedia experience contributed significantly to girls' experience of citizen science. Exposure to *SciGirls* triggered interest that was carried into a subsequent citizen science session and increased preteen girls' understanding of the unique practice of citizen science, with a special influence on minority girls' interest and self-efficacy. *SciGirls* multimedia shows youth the process and practice of citizen science, demonstrates the fun of citizen science, and presents peers with whom girls can identify. Incorporating multimedia is recommended as an effective method for influencing girls' citizen science interest, self-efficacy and learning.

INTRODUCTION

During the previous three decades, informal science educators and professional scientists have been supporting a movement to increase public participation in scientific research (PPSR), alternatively referred to as citizen science (Storksdieck, 2014). The field has grown exponentially, with more than 1,000 citizen science (CS) projects now featured on the aggregator websites of scistarter.com and citizen science.org. In this effort, different models of public participation have been described based on depth of involvement in the scientific research process, including co-created projects, collaborative projects, and contributory projects (Bonney et al., 2009). Most CS projects, and those of concern in this evaluation, fit into the contributory model in which public volunteers follow scientist-designed protocols to collect data or samples over wide geographic areas and over time. This information is intended to help scientists address authentic research questions, such as regional trends or patterns in biological populations.

Most CS projects have been designed principally with scientists' research outcomes in mind rather than considering specific outcomes for the public participants themselves (Bonney, Shirk, et al., 2014). Thus relatively few CS projects have evaluated their impact on adult volunteers and even fewer on youth participants. In fact, a recent review of youth CS projects located only two unpublished evaluations of the contributory model in which youth participants self-reported on outcomes (Bonney, Phillips, Enck, Shirk, & Trautmann, 2014). The review summarizes that youth who participated in the project *BirdSleuth* enjoyed the experience and demonstrated increased biology knowledge, and youth who participated in the project *Butterfly WINGS* reported increased interest in science and more positive science attitudes. An additional unpublished evaluation indicates that students in the *LiMPETS* program become more knowledgeable about the ocean, more conservation minded, and more interested in pursuing a science career (Dean, 2014).

In a comprehensive review of the field of PPSR informal education, Bonney et al. (2009) recommended designing projects to engage new audiences such as youth and to test outcomes of enhanced PPSR models. The evaluation reported here addresses an intersection of these two recommendations by focusing on a model of citizen science engagement and education for preteen girls that combines *SciGirls* multimedia online experiences at home with *FrogWatch USA*, a contributory-model citizen science experience presented in community wetlands.

SciGirls (Season Three) is the first national children's television series and website designed to engage and educate millions of children about CS. The multimedia project is produced by Twin Cities Public Television and largely supported by the National Science Foundation, with additional funding by INFOR, Northrop Grumman Foundation, and PPG Industries Foundation. *SciGirls* videos, games and activities on PBSKids.org are intended to activate children's interest in participating in CS, strengthen their feeling of efficacy to do CS, and educate about the features of CS practice. In six half-hour episodes of *SciGirls*, different groups of middle school ethnically diverse girls are guided by female mentors as they learn about CS protocols and collect and share data for a range of CS projects. The six CS episodes present Association of

Zoos and Aquariums' *FrogWatch USA*, Cornell Lab of Ornithology's *Celebrate Urban Birds*, NASA's *Student Cloud Observations Online (S'COOL)*, University of Minnesota's *Monarch Larva Monitoring Project*, USA National Phenology Network's *Nature's Notebook*, and Zooniverse's *Seafloor Explorer*)¹. The *SciGirls* website also presents two games that link the video episodes with CS field experience: *Rule the Roost* introduces a simplified CS data collection protocol, and *Creature Features* presents a hunt-type platformer game to support learning about birds and frogs and their sounds in different environments.²

Our evaluation focuses on the overarching question of what value a home experience of *SciGirls* multimedia contributes to a subsequent citizen science project-based experience in an outdoor nature setting. To represent the field of contributory CS projects, we chose for this evaluation the Association of Zoos and Aquariums' *FrogWatch USA* project, during which participants learn to identify calls of frogs and toads and collect data in community wetlands, adding to a publicly accessible database.³ In the mixed-methods experimental study, fifth grade girls randomly assigned to a *SciGirls* online experience and a subsequent *FrogWatch USA* CS session (treatment) are compared to girls randomly assigned to experience *FrogWatch USA* without prior exposure to *SciGirls* (control). Drawing on research in interest development, sources of self-efficacy, and multiple platform learning, the study examines how multimedia enrichment contributes to girls' (1) interest in the *FrogWatch USA* CS session and CS generally; (2) perceived self-efficacy in the *FrogWatch USA* CS session and CS generally; and (3) learning about the practice of citizen science.

BACKGROUND LITERATURE

Interest development. Hidi and Renninger (2006) proposed a four-phase model of interest development and suggested that educational interventions can support development of interest for particular content: *Triggered situational interest*, stimulated externally by specific situations or learning environments, may be a precursor to reengage similar content leading to *maintained situational interest*. Maintained interest may evolve into a more enduring self-regulated *individual interest* in an early *emerging* phase and a later *well-developed* phase. Various learning interventions, including videos and digital games, have been shown to trigger positive affective responses that support development of content interests. Science television has a long proven history of fostering children's interest in science content (M. Chen, 1994; Fisch, 2004; Mares, Cantor, & Steinbach, 1999; Rockman et al, 1996; Steinke et al., 2009).

It is increasingly common in the last two decades for children's public television series to include multiple platform experiences, making digital games and offline activities available in conjunction with online and broadcast video. Recent studies of the impact of such multimedia components reveal significant triggering of content-specific interest in youth. An experimental

¹ CS project websites: celebrateurbanbirds.org; aza.org/frogwatch; mlmp.org; scool.larc.nasa.gov; usanpn.org/natures_notebook; seafloorexplorer.org

² See www.pbskids.org/scigirls for CS videos and games

³ See www.aza.org/frogwatch for full description of the *FrogWatch USA* CS project

study of *Cyberchase* showed that fourth graders exposed to math multimedia components demonstrated more interest in school math activities compared to those not exposed to the materials (Fisch, Lesh, Motoki, Crespo, & Melfi, 2010). Elementary school children, who experienced *Spyhounds* multimedia components, significantly increased their interest in science and in doing science activities at home (Paulsen & Andrews, 2014). With respect to the *SciGirls* format in particular, evaluation that focused on exposure to season two episodes and website activities showed a positive influence on fifth grade girls' interest in carrying out science investigations (Flagg, 2012) and in doing hands-on robotics engineering (Flagg, 2013). Thus, applying Hidi and Renninger's (2006) construct of situational interest within an informal science learning context, we hypothesize in this study that experiencing CS via the multimedia platform of *SciGirls* will trigger interest that is carried into the subsequent *FrogWatch USA* field session, thereby generating in the treatment group higher interest than the control group in the frog CS session itself and in doing other CS projects.

Sources of Self-Efficacy. In extending the theory of interest development to informal learning settings, Renninger (2007) submitted that "fun" activities may support successful interactions with science that increase feelings of science self-efficacy. Self-efficacy is a theoretical construct of the social cognitive psychologist Albert Bandura (1977) and pertains to a belief in one's ability to perform in a given domain of activity. Bandura proposed that we form our self-efficacy beliefs as we interpret information from four sources: physiological state, social persuasion, mastery experience and vicarious experience. The latter two sources are of interest in this study.

Based on results of engaging in activities themselves (i.e., mastery experience), youth develop beliefs about how well they will perform in similar subsequent activities (Britner & Pajares, 2006). Applied to technology-enhanced learning environments such as websites and games, users who have successful interactions may acquire more positive feelings about their competence to do similar tasks. Vicarious experience refers to learning from observations of others performing or modeling tasks in one's immediate environment or in mass media (Bandura, 2001). Models perceived to be similar to the viewer and performing tasks that are novel to the observer appear to have greatest influence on self-efficacy beliefs (Bandura, 1997; Zeldin, Britner, & Pajares, 2008). Applied to the video medium, the viewer who sees characters similar to themselves succeeding in unfamiliar tasks may conclude: If they can do it, so can I (Steinke et al., 2009).

As children experience success or failure with tasks and as they observe others modeling tasks, they may adjust their perceptions of their own efficacy for related activities. With few exceptions, studies of science, math, engineering or technology (STEM) self-efficacy have focused on high school and older students and applied correlational or predictive analyses (as reviewed by Usher & Pajares, 2008). Few studies have employed interventions to examine if and how science efficacy beliefs may be modified in children. Studies of change in children's science self-efficacy in the digital gaming literature presented mastery experiences with immersive virtual worlds. Fifth graders demonstrated significant increases in science self-efficacy after playing in a virtual world about landforms and ecosystems (Meluso, Zheng, Spires,

& Lester, 2012). Sixth graders increased significantly in science self-efficacy after exposure to a problem-based multimedia program about the solar system (Liu, Hsieh, Cho, & Schallert, 2006). Experience of virtual worlds also significantly influenced middle school students' beliefs in their ability to do scientific inquiry (Bergey, Ketelhut, Liang, Natarajan, & Karakus, 2015; J. Chen, Metcalf, & Tutwiler, 2014).

In addition, few studies have investigated how children's STEM self-efficacy beliefs are influenced through vicarious experiences of observing media-based models. Schunk and Hanson (1985) found that children who watched videos of same-age, same-gender peers successfully modeling subtraction operations improved significantly in subtraction self-efficacy compared with those who observed a teacher model or no model. Fourth graders exposed to *Cyberchase* episodes, in which characters model math problem-solving, sustained their pre to post levels of self-efficacy regarding school math problems, whereas a control group exposed to a history video series declined in their school math confidence ratings (Fisch et al., 2010). Viewing of season one episodes of *SciGirls* significantly influenced fifth grade girls' feelings of competence for doing some but not all engineering design tasks, compared to a control group who viewed a literacy video series (Flagg, 2010).

The treatment intervention of the study reported here provides vicarious experiences with CS via *SciGirls* videos of same-age, same-gender, ethnically diverse peers successfully doing CS. The intervention also provides mastery experiences with CS via games of frog and bird identification and data collection. Based on the preceding literature review, we hypothesize that girls exposed to both vicarious and mastery experiences on the *SciGirls*' website will demonstrate greater feelings of efficacy with respect to a subsequent CS session (*FrogWatch USA*) and future CS activities, compared to girls not exposed to *SciGirls* prior to *FrogWatch USA*.

Learning. According to Renninger and Hidi (2006), for situational interest to move into later phases of interest, content knowledge needs to develop concurrently. Individual participant content knowledge generated through CS projects ranges from acquisition of specific facts and concepts to more sophisticated understanding of the process and methods of scientific research (Dickinson & Bonney, 2012; Shirk et al., 2012). The participant content in this study is knowledge of the practice of CS, with the belief that youth who acquire awareness and understanding of what the CS community does will be more interested in future CS participation.

Descriptions of contributory-type CS projects typically emphasize four common characteristics – that members of the public are active participants; that following a specific CS protocol is critical to contributing to valid science research; that professional scientists use CS data to generate knowledge about real-world problems; and that a virtual collaboration occurs where participants and scientists share data online (Bonney et al., 2009; Bonney, Shirk, et al., 2014; Dickinson & Bonney, 2012; Wiggins & Crowston, 2012). Given these observations of unique features of CS, the four intended learning outcomes for the fifth grade girls in this study include the understanding that (1) in CS anyone can participate; (2) CS participants use the same protocol so data can be combined and be high quality; (3) CS data can help real scientists come

to real conclusions; and (4) CS brings together a wide community of scientists and volunteers to work together and share data to which the public, as well as scientists, have access.

The four CS features above are communicated in different ways in the *FrogWatch USA* sessions and in the *SciGirls* experience. In the *FrogWatch USA* sessions, girls learn about CS practice via a leader-presented PowerPoint and participant activities followed by field-based frog call data collection. In the *SciGirls* videos, the four features of CS practice are embedded in a narrative form via stories and in interactive experiences via games of animal identification and observation.

One might assume that providing with multiple examples of concepts via different learning platforms can yield a better understanding of content; however, little research has examined this issue with children. Fisch's 2013 review of three informal education multimedia projects for children pointed out that different combinations of media (video, web, hands-on) produced greater effects than a no media control group but that more media did not necessarily produce the best impact. For example, using the multiple media of *Cyberchase*, Fisch et al. (2010) found that exposure to narrative-based video plus online games showed more consistent effects on students' mathematical problem-solving compared with video alone, games alone, video plus games plus hands-on activities, and no exposure. Fisch and his colleagues speculated that cross-platform impact depends on providing multiple examples of a concept in different contexts to increase the possibility of transfer to new situations. The *Cyberchase* study found evidence that transfer of learning occurs across media such that children can apply their learning from one medium to their learning in a second medium when they are closely aligned in content (Fisch et al., 2010). In our study, the treatment group experiences multiple exposures to CS practice via *SciGirls* videos and games and could transfer that learning to enrich their subsequent experience of the leader-guided frog CS sessions, and so we hypothesize that the treatment group will demonstrate a better understanding of the features of the practice of CS compared to the control group girls.

METHOD

Experimental Design

To assess hypotheses about the contribution of *SciGirls* to CS interest, self-efficacy and learning, the evaluation employed a mixed-methods experimental design, illustrated below. Recruited girls agreed to participate both in PBSKids.org activities and in *FrogWatch USA* sessions. Girls were randomly assigned to a treatment group, who experienced the *SciGirls* web activities at home prior to a live *FrogWatch USA* CS session, or to a control group, who attended the live CS session first followed by the *SciGirls* at home experience. The addition of *SciGirls* after *FrogWatch USA* for the control group was included so they also would have the opportunity to experience the multimedia materials. Random assignment to a treatment or control group before the intervention permits causal inferences and meets the “gold standard” for impact studies (Song & Herman, 2010). Implementations of the *FrogWatch USA* sessions were observed by an evaluator. After their *FrogWatch USA* session, all girls completed an online survey and subsequent phone interview. Control girls also completed another brief online survey after their *SciGirls* experience.

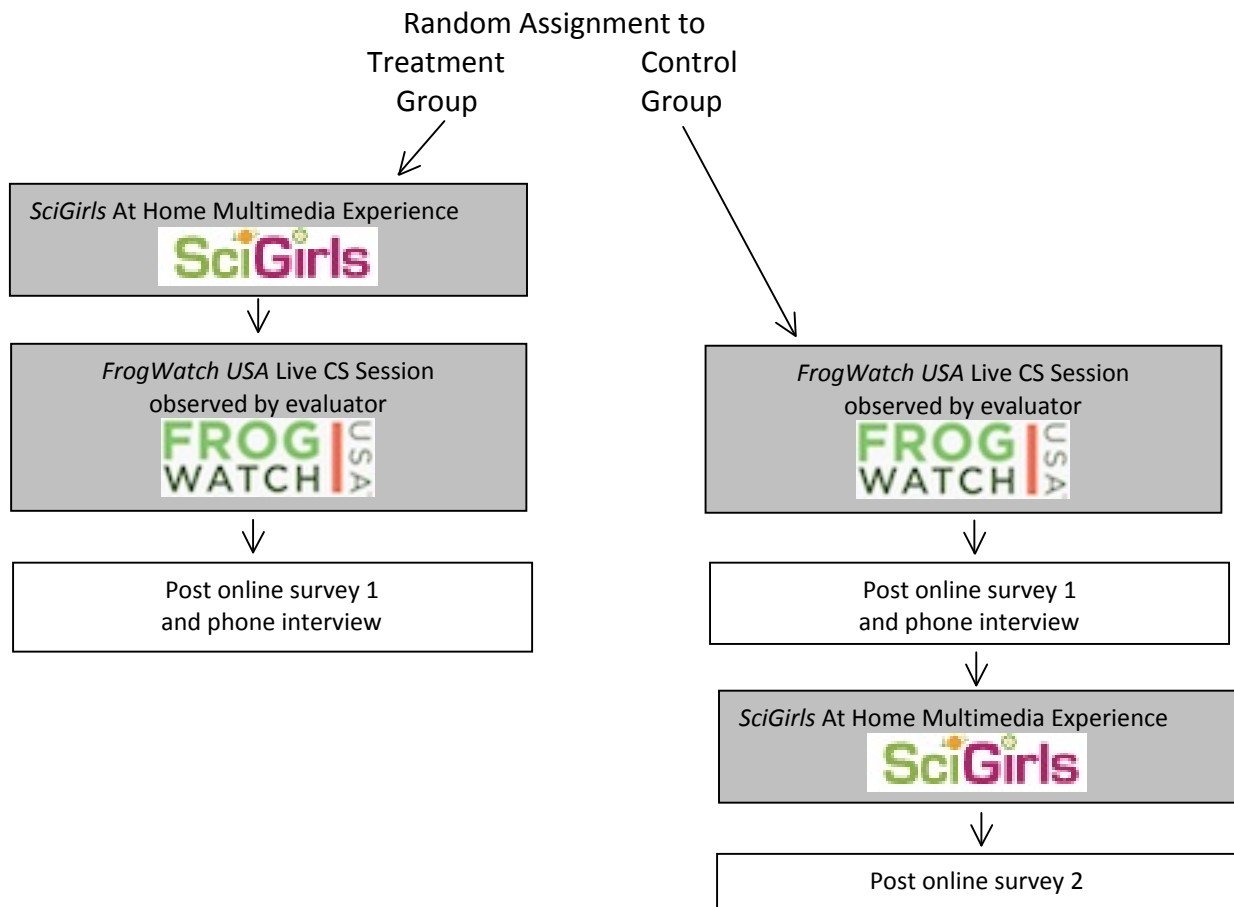


Table 1 presents the evaluation questions for interest, self-efficacy and learning and the data sources to address each question. Online survey 1 and the phone interview were completed by both treatment and control girls after their *FrogWatch USA* CS session, and online survey 2 was completed by the control group only, after their exposure to *SciGirls*. Details about the data collection measures are presented later in this Method section.

Table 1. Evaluation questions and data sources

Evaluation Questions	Treatment Group Data Sources		Control Group Data Sources		
	Survey 1	Interview	Survey 1	Interview	Survey 2
Questions about Interest					
Will treatment group demonstrate greater interest than control group in <i>FrogWatch USA</i> CS session?	X		X		
Will treatment group demonstrate greater interest than control group in finding out more about other CS projects?	X		X		
Will treatment group demonstrate greater likelihood than control group to look for another CS project to do in the future?	X		X		
What is liked or not liked about their <i>FrogWatch USA</i> CS experience?	X		X		
Which <i>SciGirls</i> activities are completed?	X				X
How much do participants like their <i>SciGirls</i> experience, and what is liked or not liked?	X				X
Does <i>SciGirls</i> increase interest in participating in <i>FrogWatch USA</i> , and if so, how?		X			
Does <i>SciGirls</i> increase interest in doing other CS projects, and if so, how?		X			X
Questions about Self-Efficacy					
Will treatment group demonstrate greater feelings of efficacy than control group with respect to <i>FrogWatch USA</i> CS session?	X		X		
Will treatment group demonstrate greater belief than control group that they can be good at doing other CS projects?	X		X		
What is most difficult or challenging to learn or do in the <i>FrogWatch USA</i> session?	X		X		
How much do participants think the video girls are like them, and how are the video girls perceived as like or not like the participants?	X				X
Does <i>SciGirls</i> increase feelings of efficacy with respect to <i>FrogWatch USA</i> session?		X			
Does <i>SciGirls</i> increase feelings of efficacy with respect to other CS projects?		X			
Questions about Learning about CS Practice					
Will treatment group demonstrate better understanding than the control group of the practice of CS?	X	X	X	X	
Does control group add to their understanding of the practice of CS after exposure to <i>SciGirls</i> ?					X

Sites

To represent the six CS projects covered by *SciGirls* multimedia, one project was chosen for the evaluation's live CS experience. We selected *FrogWatch USA* because its content and female leader availability best fit the launch schedule of materials on the *SciGirls* website. Female leaders were preferred for this study because the *SciGirls* videos feature female adult mentors. To participate in the evaluation, *FrogWatch USA* chapter sites had to meet three criteria: (1) availability of female session leaders certified by *FrogWatch USA* and experienced with children's groups; (2) good density of frog and toad calling in May to June; and (3) be near minority populations. Seventeen sites met these criteria distributed into five regions. To provide national coverage and stay within budget, one site in each of the five regions participated in the evaluation: Fort Wayne Children's Zoo in Fort Wayne, IN; Greenville Zoo in Greenville, SC; Hiram College in Hiram, OH; Nashville Zoo/Owl's Hill Nature Sanctuary in Nashville, TN; and Roger Williams Park Zoo in Providence, RI. Site institutions and leaders received stipends to cover expenses and staff time.

Participants

Recruitment. Sites recruited participants through an evaluator-provided parent information letter distributed to neighborhood schools and home-school networks. The letter invited graduating fifth grade girls to participate during a weekend at the end of the school year in a free multimedia enrichment experience in nature and science involving the local *FrogWatch USA* institution and PBSKids.org. The letter described project requirements and referred interested parties to an online application and permission form to be completed by both the child and a parent. Recruitment conformed to IRB requirements (E&I Review Services, #13086-01).

Through the online application, parents and children confirmed their interest and availability and gave permission or assent to participate in (a) enrichment activities of a *FrogWatch USA* session on either one of two weekend days and (b) online PBSKids.org activities during the week before or after the frog sessions. The application also obtained parent permission and child assent for children to participate in post online surveys and a phone interview. To prevent unintended early access to the *SciGirls* website, only PBSKids.org was referred to in both the letter and application. Participants learned about *SciGirls* just prior to when their group, either treatment or control, was to participate in the *SciGirls* portion of the evaluation. Participants received a small monetary incentive upon completion of all activities and data collection.

Stratified random assignment. To support individual random assignment to either the treatment group or control group, girls had to be available on both Saturday and Sunday session days. Stratifying on self-reported minority status, girls were randomly assigned to groups for each site by coin toss, thereby determining when the child would complete PBSKids.org activities and on which day the child would participate in the *FrogWatch USA* session. A total of 108 girls were confirmed to participate: 54 for each group. A total of 98 attended *FrogWatch USA* sessions: 49 for each group. The 10 girls who did not attend their

frog CS session reported no-show reasons related to session scheduling rather than to the session content or evaluation requirements; for example, illness and unforeseen obligations such as soccer playoffs and out-of-town parental visitation.

Age. The sample of 98 fifth grade girls included 10 year-olds (27%), 11 year-olds (69%), and 12 year-olds (4%), with an average age of 10.8 years. Age distribution and mean age did not differ significantly between treatment and control groups.

Minority representation. Based on 2013 U.S. census tables, racial or ethnic minorities comprise 45% of the population of fifth grade female students.⁴ To represent this population, the evaluation sample included 38% who self-identified as a minority, including 12% Black/African American; 9% Hispanic/Latina; 3% Asian; and 13% multiethnic. The term *minority* in this study refers to the ethnically diverse subsample, whereas *non-minority* refers to girls who self-identified only as white. Due to stratified random assignment, minority girls were equally distributed in the groups for treatment (n = 18) and control (n = 19).

Interest in nature and science. Despite individual random assignment, groups might still differ in their preexisting interest in nature and science, which could influence group post-comparisons. Consequently, we developed and validated an interest scale, which was included in the online recruitment application. Nine statements were presented in random orders with 5-point Likert ratings from “strongly disagree” to “strongly agree:”

Girls' Interest in Nature and Science Scale

It's fun to do science activities.

It's fun to collect things from outdoors.

I want to understand how things in nature work.

I like to observe birds, butterflies, bugs or other things in nature.

I like to identify things in nature.

I enjoy watching nature shows

I like to hear about new discoveries in science.

I enjoy reading about science.

I like talking about science topics with others.

Analysis of the scale's psychometric properties with a sample of 212 nationally distributed fifth grade girls assessed in school classrooms showed a unidimensional scale with loadings greater than 0.60 on one factor and high scale reliability (ordinal alpha = .88). More details on the development and properties of Girls' Interest in Nature and Science Scale (GINSS) are presented in Appendix A. For the evaluation sample of 98 girls, high scale reliability was also obtained (ordinal alpha = .87). The mean and median summated GINSS scores for both the treatment and control groups were 4.4 out of 5 and thus did not differ significantly. The girls participating in the evaluation's enrichment experiences rated their interest in nature and science quite high

⁴ <http://www.census.gov/hhes/school/data/cps/2013/tables.html>. Table 2.

and significantly higher than girls in the classroom validation sample.⁵ However, the treatment and control groups were equivalent in their interest upon starting the study. GINSS scores also did not differ significantly by age group or minority/non-minority status.

Materials and Procedure

SciGirls multimedia experience. The *SciGirls* multimedia experience on pbskids.org/scigirls consisted of watching three half-hour videos and playing two games. Evaluation participants were asked to view the videos called *Feathered Friends*, *Frog Whisperers* and one of two other programs: either *Sky Girls* or *Flower Power* (videos available at <http://goo.gl/VTN73b>). These videos are associated respectively with the CS projects of Cornell Lab of Ornithology's Celebrate Urban Birds, Association of Zoos and Aquariums' FrogWatch USA, NASA's S'COOL, and USA National Phenology Network's Nature's Notebook. Each half-hour *SciGirls* episode presents a detailed story of a group of girls who participate in the respective CS experience. Of the 13 girls appearing in the four *SciGirls* episodes, nine are minorities including African American, Latina, and Asian. Episode summaries are available in Appendix B.

As an example of the video narratives, the episode associated with *FrogWatch USA* begins by introducing the group: two African American girls, one Latina girl, and one Caucasian girl. The girls meet their mentor, a *FrogWatch USA* program leader, who teaches them how to recognize different frog calls. She takes them to a nearby stream to explore frog habitats, where they are amazed at the experience of holding a live frog. As night falls, they hike to a rural stream and record the frogs they hear, following the *FrogWatch USA* protocol (see video frame below). The next night they visit an urban park to monitor frogs, so they can compare the two locations. They're surprised how many fewer frogs they hear in the urban park. The next morning they enter their data into the FrogWatch.FieldScope.org website and enjoy a Skype call with a scientist who will use their data. Finally, the girls prepare a presentation to share their *FrogWatch USA* experience with the public at a local Earth Day celebration.



⁵ Validation sample: $N = 212$, $M = 3.7$, $SD = 0.7$; Evaluation sample: $N = 98$, $M = 4.4$, $SD = 0.4$; two-tailed $t(290) = 10.39$, $p \leq 0.0001$.

In addition to viewing three videos, the *SciGirls* multimedia experience included two games:



Creature Features (pbskids.org/scigirls/games/creature-features) is a classic platformer game in which players listen for and locate frogs and birds with particular animal features as they move through four environments (city day, city night, park day, park night). Players use a camera tool to take pictures of the animals they see, which brings up text and image information about the creatures' features. As players find animals, they unlock binoculars and microphone tools to help locate other frogs and birds.



The second game, *Rule the Roost*, is a simplified CS experience that changes monthly (pbskids.org/scigirls/games/rule-the-roost). Evaluation participants logged in with a user name and joined an online team to complete the real-world task of the month. The Big Question of the month during our evaluation period was “When looking for robins, does time of day matter?” which relates to the *Feathered Friends* episode and the Celebrate Urban Birds CS project. Participants were directed to view a short video of girls who present the Big Question, show what a robin looks like, and explain steps to observe robins outside. Participants were asked to add their outdoor robin observation to the *SciGirls* website database, thereby earning points for their team.

Treatment girls spent about 2 hours completing the *SciGirls* experience during a 10 day period prior to their *FrogWatch USA* session, and control girls completed the *SciGirls* experience during the 10 days after their frog CS session. Treatment girls were asked during their *FrogWatch USA* session to confirm verbally their completion of *SciGirls* activities. Furthermore, because web analytics were not available, both treatment and control girls self-reported in a check-off list which specific *SciGirls* activities they had completed. There was high fidelity to the evaluation’s required activities as indicated in Table 2, which presents the percent of girls who self-reported completing *SciGirls* activities. All girls watched three videos and a majority completed the two games. Girls who did not complete *Creature Features* and/or *Rule the Roost* reported website usability difficulties.

Table 2. Percent of groups who reported completing *SciGirls* activities

	<i>Feathered Friends</i>	<i>Frog Whisperers</i>	<i>Sky Girls</i>	<i>Flower Power</i>	<i>Creature Features</i>	<i>Added robin data to Rule the Roost</i>
Treatment (N = 49)	100%	100%	67%	53%	90%	76%
Control (N = 49)	100%	100%	76%	39%	98%	84%

In addition, small portions of each group reported playing an unassigned *SciGirls* game called Aquabots (6% of treatment, 4% of control) or watching unassigned videos from previous seasons of *SciGirls* (8% of treatment, 10% of control).

FrogWatch USA session. At each of the five sites, the same *FrogWatch USA*-certified leaders ran both the treatment and control sessions to limit a “teacher effect” for the CS session. Three sites were randomly assigned to run treatment groups on Saturday and control groups on Sunday; two sites reversed this order. Leaders did not know which day involved which group of girls nor had leaders viewed any of the *SciGirls* materials prior to their sessions. Eight to 12 girls attended each session (mean = 9.8). Leaders attempted to make the two *FrogWatch USA* sessions equivalent in content and experience, so if something occurred or did not occur during Saturday’s session then an effort was made to replicate on Sunday’s session. For example, one site discovered, caught, and discussed a snake in the rafters on Saturday; and then on Sunday, the site also presented a snake to the girls. Or when technology did not operate on Saturday, then that same technology was also not used on Sunday. Fortunately such unique occurrences happened only on Saturday and accordingly could be added to or subtracted from the Sunday session.

The *FrogWatch USA* staff of the Association of Zoos and Aquariums provided leaders with a suggested agenda for the five sites to follow for a 2.5 hour session, as outlined below:

1. Introduction: Intro of leaders, participants, evaluator. Overview of session.
2. Frog call activity: To hear calls of four local species they are to learn.
3. Citizen science: PowerPoint and Q&A on what citizen science is, why frog monitoring is needed, what *FrogWatch USA* volunteers do, how *FrogWatch USA* data are used. Preview of *FrogWatch FieldScope* website to demonstrate data sharing and working together.

4. Data collection protocol: PowerPoint on importance of protocol and review of protocol features, including recording weather, monitoring at least 30 minutes after sunset, being quiet for 2 minutes, listening for 3 minutes to identify frog species and call intensities.
5. Snack break
6. Call intensity activity: To learn levels of call intensity.
7. Call identification activity: To learn and practice identification of at least four local frog calls.
8. Data collection: Walk to data collection site. Follow data collection protocol. Leaders would submit data at later time.
9. Return to classroom for concluding review.
10. Handout from evaluator providing instructions for the post-survey and phone interview.

To establish implementation fidelity, sessions were observed with an agenda checklist. Although teaching styles varied across sites, evaluators' observations confirmed that the treatment and control groups at each site received the same content presentations for approximately the same periods of time. A few differences occurred among sites related to technology and weather:

- One site unexpectedly lost Internet access, so for both sessions the PowerPoint information was read or summarized by the leader from her own iPad, and frog audio was played from the iPad.
- One site did not have audio access for the initial frog call game, so the leader mimicked the frog calls herself, for both sessions.
- Because of late sunset times, two sites had to start data collection before 30 minutes after sunset in order to return children to their parents by 9:45PM.
- One site had bad weather for both sessions and substituted a pre-recorded audiotape of local frogs to simulate data collection, with lights off.
- One site heard no frogs during both of their sessions' data collection periods but in both sessions walked to a second site where frogs were heard.

Measures

Activity interest scales. To assess the hypothesis about interest in the *FrogWatch USA* session and in doing other CS programs, we drew on the interest/enjoyment sub-scale from the Intrinsic Motivation Inventory (Deci & Ryan, n.d.). The interest/enjoyment subscale includes agree-disagree statements that are often reworded to refer to specific activities. The subscale has shown high reliability for a variety of youth participants in different settings and target activities (e.g., Hong & Masood, 2014; Wilde & Urhahne, 2008).

To assess scale reliability for this evaluation, a pilot study was implemented with 82 fifth grade girls in CA, FL and NC who had participated in NASA's S'COOL CS project. Four interest statements from the interest/enjoyment subscale were modified to refer to the S'COOL cloud observation activity (e.g., *I had a lot of fun while doing S'COOL*). In an online survey, the four statements were integrated with other post-activity statements and presented in random order for each respondent, who rated on a 5-point disagree-agree scale. Reliability for the pilot

Interest Scale was high (Cronbach's $\alpha = .85$). All statements contributed positively to scale reliability and were retained for the *SciGirls* evaluation.

For this evaluation, the four scale statements were modified to refer to the frog activity, as shown below. The statements for the Frog Activity Interest Scale were presented in the online post-survey in random order for each respondent. Data for the evaluation sample of 98 girls demonstrated high scale reliability (Cronbach's $\alpha = .85$).

Frog Activity Interest Scale
I enjoyed doing FrogWatch very much.
I had a lot of fun while doing FrogWatch.
I thought FrogWatch was very interesting.
I would like to do more citizen science activities.

A second activity interest scale was implemented to assess appeal of the *SciGirls* multimedia. The scale instructions reminded respondents of their *SciGirls* experience as *videos and games*, and the four scale statements were modified to refer to *SciGirls*, as shown below. The statements for the *SciGirls* Activity Interest Scale were presented in the online post-survey in random order for each respondent (see Appendix C). Data for the evaluation sample of 98 girls demonstrated high scale reliability (Cronbach's $\alpha = .87$).

***SciGirls* Activity Interest Scale**
I enjoyed doing SciGirls very much.
I had a lot of fun while doing SciGirls.
I thought SciGirls was very interesting.
I would like to do more on the SciGirls website.

Frog activity self-efficacy scale. To assess the hypothesis about feelings of efficacy with respect to the CS activity of *FrogWatch USA*, we modified the youth science self-efficacy scale being developed by Cornell's Lab of Ornithology DEVISE project. The DEVISE youth scale includes four disagree-agree statements assessing feelings of competence about doing science activities and four about learning science topics (e.g., *I'm good at learning science topics*). From each of the two categories, we drew two statements. Together, the four statements produced a reliability alpha of .82, as reported in Cornell's validation process with 106 male and female fifth graders (N. Porticella, personal communication, March 10, 2015).

For our pilot study, the four statements were modified to specify the S'COOL CS activity in place of general "science topics" and "science activities," because self-efficacy is assessed typically at the level of the specific task (Schunk & Meece, 2005). The statements were integrated randomly into a list of other S'COOL statements in an online post-survey and administered to 82 fifth grade girls (Cronbach's $\alpha = .72$). All statements contributed positively to scale reliability and were retained for the *SciGirls* evaluation.

For this evaluation, the four scale statements were modified to refer to the frog activity, as shown below. Statements for the Frog Activity Self-Efficacy Scale were combined with the Frog Activity Interest statements and presented in the online post-survey in random order for each respondent (see actual FrogWatch scale formats in Appendix C). Data for the evaluation sample of 98 girls demonstrated scale reliability of .70 for the Frog Self-Efficacy Scale.

Frog Self-Efficacy Scale

I was good at following instructions for FrogWatch.
I could learn about frog and toad calls as quickly as others my age.
I could do FrogWatch just as well as others my age.
I was good at learning about frog and toad calls.

Online surveys. Following their *FrogWatch USA* session, both treatment and control girls completed at home an online survey via Survey Monkey. For both groups, surveys were completed within an average of 1.7 days after the frog CS session. Relevant to the interest outcomes, the survey presented the Frog Activity Interest Scale, rating questions about interest in other CS projects, and open-ended questions regarding what was liked and not liked about their *FrogWatch USA* experience. Relevant to the efficacy outcomes, the survey presented the Frog Activity Self-Efficacy Scale, a rating question about belief in one's ability to be good at doing other CS projects, and an open-ended question about what was most difficult or challenging to learn or do in the *FrogWatch USA* session. Relevant to learning about the practice of citizen science, the survey asked an open-ended question about what was learned about CS.

For the treatment group, the above post-survey also addressed reactions to *SciGirls*. Participants indicated on a check-off list which *SciGirls* activities they had completed, described what they liked and did not like about their *SciGirls* experience, completed the *SciGirls* Activity Interest Scale, and identified how much and how the onscreen video girls were like them and not like them. After the control girls' delayed experience of *SciGirls*, they completed an online survey with the same *SciGirls* questions as the treatment group and additional questions regarding further learning about CS from *SciGirls* and whether or not and how the *SciGirls* experience increased interest in doing other CS projects.

Structured phone interview. All girls responded to a structured phone interview within an average of two days after they completed their *FrogWatch USA* session post-survey. To illuminate the interest and efficacy hypotheses, the treatment girls answered four questions addressing how their *SciGirls* experience affected their interest in participating in and their ability to do *FrogWatch USA* and also other CS projects generally. Also both treatment and control groups answered questions to obtain information about girls' understanding of the four common features of citizen science practice: (1) In CS anyone can participate; (2) CS participants use the same protocol so data can be combined and be high quality; (3) CS data can help real scientists come to real conclusions; and (4) CS brings together a wide community of

scientists and volunteers to work together and share data to which the public, as well as scientists, have access. The questions to elicit participants' understanding of the features of CS practice are presented below:

Interview Questions about CS Practice

1. *Thinking about your experience with [both SciGirls and] FrogWatch, what does citizen science mean to you?*
2. *In what ways is citizen science different from the kind of science you have done in school or in after school programs?*
3. *Who can participate in a citizen science project?*
4. *There are many citizen science projects on different topics. Why is it important that people participate in citizen science projects?*
5. *Do you think that observations collected by girls like you are important to scientists? If Yes: Why do you think your observations are important to scientists?*
6. *All citizen science projects provide a procedure to follow. Why do you think everyone should use the same procedure in a citizen science project?*
7. *What happens to data that citizen scientists collect?*
8. *Why are citizen science data made available on a public website?*

Data Analysis

For all tests, statistically significant findings at $p \leq .05$ are reported, meaning that in 5 of 100 cases the result would appear by chance or that there is a 95% probability that the effect truly exists. For ease of reading, test results are reported in footnotes.

The study's rating scales are ordinal measures with non-normal score distributions; therefore, to assess the hypotheses we used non-parametric one-tailed Mann-Whitney U tests to compare mean rankings of responses of two independent samples (treatment, control) to determine if they reflect the presence of a beyond chance difference in the larger populations they represent (de Winter & Dodou, 2012; Siegel & Castellan, 1988). The Mann-Whitney U test asks if the majority of ratings of one group are ranked higher, beyond chance, than the majority of responses of another group. Comparisons between minority and non-minority subsamples with non-directional two-tailed tests constituted exploratory analyses because of small sample sizes.

Qualitative data comprised transcriptions of open-ended survey and interview questions. After training on responses from 10 randomly chosen participants, the author and a second evaluator, who did not participate in data collection, independently coded participant data that were presented in random order without group identification. Coding differences were clarified by discussion with a third researcher. Cohen's kappa coefficient measures the degree

to which two coders agree in their category sorting after accounting for chance. Coding of the groups' qualitative responses for questions of interest, self-efficacy, and similarity to video girls yielded kappa coefficients ranging from .81 to 1.0. For these topics, Fisher's Exact Probability Test was applied to assess whether groups differed significantly in the proportion with which they fell into category classifications.

Content analysis verified that all four learning outcomes were addressed in the *SciGirls* videos and games as well as during each of the *FrogWatch USA* sessions. Coding of participant responses into the four learning outcomes yielded Cohen's kappa of .89. Group differences of learning mean scores were analyzed with *t*-tests.

RESULTS

Interest

Fifth grade treatment girls, exposed to *SciGirls* multimedia prior to their *FrogWatch USA* session, rated interest in their frog CS session significantly higher than control girls not exposed to *SciGirls* prior to the frog CS session. Treatment girls observed that the *SciGirls* videos prepared them for their *FrogWatch USA* session and showed that *FrogWatch* would be fun.

The treatment and control groups did not differ in their interest ratings of pursuing more citizen science beyond *FrogWatch USA*. On average, both treatment and control groups were "moderately interested" in finding out more about other CS projects and "somewhat likely" to look for another CS project to do in the future.

Within each of the treatment and control groups, minority girls reported significantly more interest than non-minority girls in their *FrogWatch USA* session. Within the treatment group, but not the control group, minority girls compared to non-minority girls reported significantly higher interest in finding out more about other CS projects, greater likelihood to look for a future CS project to do, and stronger interest in their *SciGirls* experience.

Appeal of *FrogWatch USA* experience

After their *FrogWatch USA* session, all participants reported what they liked and did not like about their experience. Treatment and control groups did not differ significantly in categories of what was appealing or not about their *FrogWatch USA* experience. The girls liked *learning about different frogs and their calls* (45%), and some added their appreciation of their session's game-like activities of imitating and/or guessing frog calls (16%). Participants

I liked learning different frog calls because now when I go to the park to catch frogs I can recognize them.

noted that their experiences were *fun* (30%) but did not like the less active time spent sitting, talking or watching a slideshow (19%). Of the participants who had an outside experience at four of the five sites, 52% enjoyed listening for frogs and enjoying nature, although 23% were disappointed because their outside session was dark, buggy, cold, rainy, too short in duration, or lacking in frog sounds. Participant survey responses illustrating these categories are available in Appendix D.

Interest in *FrogWatch USA* experience

We hypothesized in this study that experiencing CS via the multimedia experiences of *SciGirls* would trigger interest that is carried into the subsequent *FrogWatch USA* session, thereby generating higher interest in the frog CS session for the treatment group compared to the control group. **Supporting the hypothesis, we found that experiencing *SciGirls* prior to the frog CS session resulted in significantly higher mean ranks on the four-statement Frog Activity Interest Scale compared to no *SciGirls* exposure.⁶**

Interest activated by prior exposure to *SciGirls* multimedia was strongly associated with interest in the subsequent *FrogWatch USA* session. The correlation between the treatment group's ratings on the *SciGirls* Activity Interest Scale and ratings on the Frog Activity Interest Scale was strong and statistically significant.⁷

Minority girls in each of the treatment and control groups reported greater interest in their *FrogWatch USA* session compared with non-minority girls. After their CS session, minority girls, comprising African American, Latina, Asian, and multiple ethnicities, showed significantly higher mean ranks on the Frog Activity Interest Scale compared to non-minority girls.⁸ There were no differences between minority and non-minority girls in the qualitative categories of what they said they liked or did not like about the frog CS experience.

In the treatment group's post interview, **a plurality of the 49 girls (47%) pointed out that their interest in the *FrogWatch USA* session increased because the *SciGirls* 'Frog Whisperers' video prepared them for their own frog citizen science session. Treatment girls also felt that *SciGirls* videos showed them that *FrogWatch USA* would be fun (31%), and they learned why CS data collection is important (10%).** Some treatment girls referenced increased interest in *FrogWatch USA* due to the *SciGirls* games: *Creature Features* exposed them to frog

The video about the frogs - it showed me what kind of stuff we might be doing, so it kinda made me excited.

⁶ Mann-Whitney U one tailed test on 5-point scale: Treatment *Mdn* = 4.8, *M* rank = 54.66, *n* =49; Control *Mdn* = 4.5, *M* rank = 44.34, *n* = 49; *z* = 1.87, *p* = .03. Statements of Frog Activity Interest Scale included: *I enjoyed doing FrogWatch very much. I had a lot of fun while doing FrogWatch. I thought FrogWatch was very interesting. I would like to do more citizen science activities.*

⁷ *r*(47) = .71, *p* < .0001.

⁸ Mann-Whitney U two-tailed tests on 5-point scale: Treatment Group: Minority *Mdn* = 5, *M* rank = 33.22, *n* =18; Non-Minority *Mdn* = 4.5. *M* rank = 20.23, *n* = 31; *z* = 3.25, *p* = .001. Control Group: Minority *Mdn* = 5, *M* rank = 31.63, *n* =19; Non-Minority *Mdn* = 4, *M* rank = 20.80, *n* = 30; *z* = 2.65, *p* = .008.

listening and frog facts prior to the CS session (18%) and the robin activity in *Rule the Roost* introduced them to CS data collection procedures (8%). A small number of treatment girls (10%) did not feel that their *SciGirls* experience influenced their interest in their subsequent *FrogWatch USA* session. Appendix E presents illustrative responses from treatment girls of how *SciGirls* influenced their interest in their *FrogWatch USA* session.

Interest in pursuing other citizen science projects

The study’s interest hypothesis also posited that groups would differ in their interest in pursuing other CS projects. **After their *FrogWatch USA* session, both treatment and control groups rated themselves on average “moderately interested” in finding out more about CS projects and “somewhat likely” to look for a future CS project to do, with no significant rating differences between groups.**

For both treatment and control groups, the greater the participants’ interest in the frog CS session, the greater their interest in pursuing other CS projects, as revealed by strong and significant correlations in Table 3, column 2. For the treatment group, interest in pursuing other CS projects was also strongly and significantly correlated with appeal of their prior *SciGirls* experience and with a perception that the girls in the videos are similar to themselves (see Table 3, columns 3 and 4).

Table 3. Spearman correlations between interest ratings for groups

	<i>FrogWatch USA</i> Activity Interest Scale	<i>SciGirls</i> Activity Interest Scale	How much girls in the <i>SciGirls</i> videos are like you
Interest in finding out more about other CS projects	Treatment: 0.56*** Control: 0.57***	Treatment: 0.56***	Treatment: 0.51***
Likelihood to look for another CS project to do in the future	Treatment: 0.73*** Control: 0.57***	Treatment: 0.60***	Treatment: 0.69***

Note: *** $p < .0001$

Within the treatment group, but not the control group, minority girls showed greater interest in CS generally than non-minority girls. After their exposure to *SciGirls* and *FrogWatch USA*, minority girls in the treatment group reported significantly greater interest than their non-minority counterparts in finding out more about CS projects⁹ and significantly greater likelihood that they would look for a CS project to do in the future.¹⁰

⁹ Mann-Whitney U two-tailed test on 4-point scale: Treatment Group: Minority *Mdn* = 4, *M* rank = 30.17, *n* =18; Non-Minority *Mdn* = 3, *M* rank = 22, *n* = 31; *z* = 2.08, *p* = .04.

¹⁰ Mann-Whitney U two-tailed test on 5-point scale: Treatment Group: Minority *Mdn* = 5, *M* rank = 31.86, *n* =18; Non-Minority *Mdn* = 4, *M* rank = 21.02, *n* = 31; *z* = 2.76, *p* = .006.

In the treatment group’s post interview about the influence of *SciGirls* on interest in doing citizen science projects other than *FrogWatch USA*, **22% of girls reported that fun portrayals of citizen science by the video girls increased their interest (e.g., ‘It looked really fun when you saw it.’). Another 22% reported being influenced mainly by video models of how girls could participate in citizen science.** Treatment girls also described wanting to help scientists and their community as the video girls did (14%) and reported that CS activities in *SciGirls* can help them learn different types of science (14%). Some treatment participants (14%) agreed that *SciGirls* increased interest in other citizen science projects but could not explain how, and 14% did not feel that *SciGirls* influenced their interest.

It showed me that other children are engaged in citizen science projects.

Control girls who experienced *SciGirls* after the frog session reported the same categories of influence on their interest in doing other CS projects: Videos showed how girls could participate in CS (22%) and how fun CS is (18%), that CS helps the community (16%) and helps them learn about science (14%). There were no significant differences in proportions of categories between treatment and control girls or between minority and non-minority girls. Participant responses illustrating these categories are available in Appendix F.

Appeal of *SciGirls* video and games

After completing their respective *FrogWatch USA* and *SciGirls* experiences, treatment and control groups rated their *SciGirls* experience on the four statement 5-point *SciGirls* Activity Interest Scale¹¹. No significant difference was found in interest ratings of *SciGirls* based on whether exposure was before the frog CS session (treatment) or after (control). Both groups rated their *SciGirls* experience as highly appealing (medians = 4.5 for treatment, 4 for control).

All participants reported in an online survey what they liked and did not like about their experience of *SciGirls* videos and games. Girls liked *learning* from their experience generally (17%) and specifically from the videos (20%) and games (17%). Girls used the descriptor *fun* to describe their experience generally (11%) and to describe specifically the videos (16%) and games (26%). Viewers also liked that the videos presented *real girls* (19%) or were *interesting* (8%). Of the treatment group, 10% noted that the videos helped them in their subsequent *FrogWatch USA* session; whereas of the control group who experienced *SciGirls* after their frog CS session, 16% liked that the videos introduced other CS projects. Beyond describing the games as being educational and fun, a few girls (5%) noted that in *Rule the Roost* they got to participate in citizen science.

I liked SciGirls because the videos helped me learn about interesting things that I wanted to know about. The games were fun and interesting as well. The Frog Whisperers video gave me an idea of what we were going to do in FrogWatch.

¹¹ Statements for *SciGirls* Activity Interest Scale include *I enjoyed doing SciGirls very much. I had a lot of fun while doing SciGirls. I thought SciGirls was very interesting. I would like to do more on the SciGirls’ website.*

In answer to what was not liked about their *SciGirls* experience, participants described the 30-minute videos as too long (21%) or boring (6%) and described the games as difficult or confusing (12%), having accessibility issues (9%) or boring (4%). Participant responses illustrating the appeal categories for the *SciGirls* experience are available in Appendix G.

Within the treatment group, minority girls expressed significantly stronger interest on the *SciGirls* Activity Interest Scale compared with non-minority girls.¹² When asked what they liked about their *SciGirls* experience, minority girls were significantly more likely than non-minority girls to describe that they liked *learning* from *SciGirls* (72% vs. 32%).¹³ For example, an African American treatment girl explained about the videos: *I liked watching all the cool things that we can do to learn about nature.* A Latina treatment girl wrote about games: *On the Creature Feature game I learned some of the animals calls and where some animals can be found.*

Self-Efficacy

Experiencing *SciGirls* did not raise the treatment girls' quantitative ratings of self-efficacy in their *FrogWatch USA* session significantly higher than the control group's. Treatment girls who felt they did better in *FrogWatch USA* because of *SciGirls* thought that the multimedia experience prepared them in advance for their session. The treatment and control groups also did not differ in their quantitative ratings of how much their respective experiences made them believe that they can be good at doing other citizen science projects. However, within the treatment group, minority girls rated significantly higher than non-minority girls both their perceived efficacy in doing other CS projects and their similarity to the girls in *SciGirls* CS videos.

Perceived Efficacy in *FrogWatch USA* session.

We hypothesized that those exposed to *SciGirls* would demonstrate greater feelings of efficacy with respect to the *FrogWatch USA* session compared to girls not exposed to *SciGirls* prior to the CS session. Both groups completed the four statement 5-point Frog Activity Self-Efficacy Scale after their frog CS session.¹⁴ **The treatment and control groups did not differ significantly in their feelings of efficacy related to their *FrogWatch USA* session.** Both groups displayed high confidence about their abilities in the frog CS session (medians = 4.75 for treatment, 4.5 for control). Also minority and non-minority girls did not differ in their Frog Activity Self-Efficacy Scale ratings within either group.

¹² Mann-Whitney U two-tailed test on 5-point scale: Treatment Group: Minority *Mdn* = 4.8, *M* rank = 31.86, *n* = 18; Non-Minority *Mdn* = 4, *M* rank = 21.02, *n* = 31; *z* = 2.61, *p* = .009.

¹³ *p* = .009, two-tailed Fisher's Exact Probability Test.

¹⁴ Statements for the Frog Activity Self-Efficacy Scale include *I was good at following instructions for FrogWatch. I could learn about frog and toad calls as quickly as others my age. I could do FrogWatch just as well as others my age. I was good at learning about frog and toad calls.*

In addition, the treatment group reported the same main difficulties or challenges in their *FrogWatch USA* session as the control group: 53% of both groups felt it was most challenging to learn and identify the different frog calls whereas 10% of both groups reported difficulty staying quiet during data collection.

In their post interview, **treatment girls explained that *SciGirls* multimedia helped them do better in their frog session because the ‘Frog Whisperers’ video and ‘Creature Features’ game increased their knowledge of frogs and their calls (39%), made them aware of what would happen in the frog session (20%), or taught them about the data collection protocol (16%).**

Another 18% of treatment girls agreed that *SciGirls* helped them do better in the *FrogWatch USA* session but could not describe that influence, and 6% did not feel that *SciGirls* influenced them.

Appendix H presents illustrative responses from treatment girls of these categories of how *SciGirls* influenced their feelings of efficacy in the *FrogWatch USA* session.

When we were doing Name That Tune [in FrogWatch USA session], I knew some of the sounds because of the feature creature game. The FrogWatch video, it helped me more because it was showing the girls – they were listening to frogs. It showed the part where you have to wait 30 minutes after sunset and then wait 2 minutes for the frogs to settle in and then 3 minutes more of silence to listen to the frogs.

Perceived efficacy in other CS projects

The treatment and control groups did not differ significantly in their quantitative ratings of how much their respective experiences made them believe that they *can be good at doing other CS projects* (Group Medians = 3 out of 4). Half (49%) of both groups chose the highest response “a lot” when rating how much their experience made them believe they could be good at other CS projects. **Within the treatment group, exposure to *SciGirls* had a significantly stronger impact on minority girls’ ratings that they would be good at doing other CS projects compared to non-minority girls.¹⁵**

In their post interview, **22% of treatment girls felt that they learned from *SciGirls* videos about the process of other projects and that made them believe they could do a good job in a different citizen science project.**

Treatment girls (16%) also explained that they could do other citizen science projects because the video girls were like them (e.g., ‘I saw a lot of girls my age doing it, so I thought I could do it too.’). Treatment girls described being motivated to help

Because when I was watching the videos and how they recorded their data, I thought that was the same as when you do other animals. I think the videos helped because when they did that to collect the data, I saw how they did it.

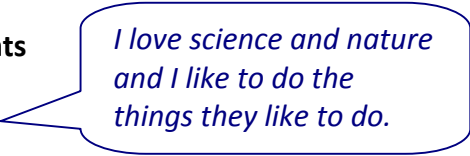
¹⁵ Mann-Whitney U two-tailed test on 4-point scale: Treatment Group: Minority *Mdn* = 4, *M rank* = 30.47, *n* = 18; Non-Minority *Mdn* = 3, *M rank* = 21.82, *n* = 31; *z* = 2.23, *p* = .026.

scientists by participating in citizen science (8%) or felt that they learned science information from *SciGirls* that would help them do a good job in a different citizen science project (8%). Another 16% of treatment girls were positive about the impact of *SciGirls* but could not describe what in their experience influenced their belief that they could do a good job in another citizen science project, and 29% did not feel that *SciGirls* influenced their feelings of future efficacy (e.g., 'I already thought I could do a really good job on a citizen science project.'). Appendix I presents illustrative responses from treatment girls of these categories of how *SciGirls* influenced their feelings of efficacy in a different CS project.

Perceived similarity to video girls

In the self-efficacy literature, it is suggested that success in influencing efficacy beliefs may relate to how similar viewers perceive themselves to be like the models in vicarious experiences (Bandura, 1997). After experiencing both *FrogWatch USA* and the *SciGirls* videos, all participants rated how much the girls in the videos were like them. **The treatment and control groups produced similar rating distributions with respect to how much the video girls were like them.** One-fifth of both groups felt that the onscreen girls were *a lot* like them (treatment = 18%; control = 16%), and a plurality of both groups said the girls are *mostly like me* (treatment = 49%; control = 45%).

Treatment and control girls did not differ in their response categories of how the video girls were like them. **Participants described a variety of ways that the video girls were like them: they both liked nature and/or science (41%); had the same personal interests or activities (20%); liked going outdoors (10%); liked helping animals or the environment (8%); were the same age (7%); liked to learn (7%), or liked to have fun (6%).** Many fewer participants reported in their open-ended response how the video girls were not like them. These participants said they did not share the video girls' personal interests or activities (9%); did not like going outside like the video girls (5%), or were shy, unlike the outgoing video girls (5%). Participant survey responses illustrating these categories are available in Appendix J.



I love science and nature and I like to do the things they like to do.

Of the 13 girls appearing in the four *SciGirls* episodes that the treatment participants viewed, nine (69%) are minorities, including African American, Latina, and Asian. **Within the treatment group, minority girls rated how much they were like the video girls significantly higher than non-minority girls.**¹⁶ One-third (33%) of minority treatment girls felt that the video girls were *a lot* like them compared to 10% of non-minority treatment girls.

¹⁶ Mann-Whitney U two-tailed test on 4-point scale: Treatment Group: Minority *Mdn* = 3, *M* rank = 30.39, *n* = 18; Non-Minority *Mdn* = 3, *M* rank = 21.87, *n* = 31; *z* = 2.18, *p* = .029.

Learning

Experiencing *SciGirls* videos and games prior to the citizen science session of *FrogWatch USA* produced significantly better understanding of the features of the practice of CS compared to no multimedia exposure. Additionally, for the control group, exposure to *SciGirls* multimedia after *FrogWatch USA* yielded increased understanding of the features of CS practice.

We hypothesized that those who experienced *SciGirls* videos and games prior to the *FrogWatch USA* session would demonstrate a better understanding of the features of CS practice compared to those who only experienced the frog CS session. Girls' survey and interview responses about CS were coded as showing or not showing understanding of four CS features, yielding a learning score of 0 to 4. Participant responses illustrating the learning categories are available in Appendix K.

On average, the treatment group displayed significantly better understanding of CS features compared with the control group, with a mean learning score of 2.84 compared to 2.47, out of a possible score of 4.¹⁷ Minority and non-minority subsamples did not differ in their learning results.

Exposure to *SciGirls* before *FrogWatch USA* increased girls' learning about citizen science that anyone can participate; that participants use the same protocol so data can be combined and be higher quality; that the data can help real scientists come to real conclusions; and that the practice brings a wide community of scientists and volunteers to work together and share data to which the public, as well as scientists, have access.

Anybody can participate in a program like this.

Your data wouldn't be as correct if you didn't use the same procedure.

Citizen scientists can collect data and report it and that helps the professional scientists so they would know what's going on in the areas where the citizens are.

[CS] means that I get to participate in activities that can share my data with other people and see how my data is related to others in my area.

After the *FrogWatch USA* session, the control group experienced the *SciGirls* videos and games and were again asked in a post-survey what citizen science means to them. **With exposure to *SciGirls*, the control group added significantly to their pre-*SciGirls* understanding of CS features.¹⁸** Most of this change was an increase in understanding that citizen science data can help real scientists come to real conclusions.

¹⁷ Treatment $M = 2.84$, $SD = 0.83$; Control $M = 2.47$, $SD = 1.24$; one-tailed $t(83) = 1.72$, $p = .04$

¹⁸ Control pre *SciGirls* $M = 2.47$, $SD = 1.24$; Control post *SciGirls* $M = 2.63$, $SD = 1.11$; paired t-test $t(48) = 2.69$, $p < .01$

DISCUSSION

The evaluation of *SciGirls* Season Three assessed a model of citizen science (CS) engagement and education that presents *SciGirls* multimedia online experiences at home prior to *FrogWatch USA*, a live CS experience presented in community wetlands. This study examined how multimedia enrichment contributes to preteen girls' (1) interest in the *FrogWatch USA* session and CS generally; (2) self-efficacy in the *FrogWatch USA* session and CS generally; and (3) learning about the practice of CS. In the mixed-methods experimental design, fifth grade girls were randomly assigned to one of two groups: a treatment group that completed 2 hours of *SciGirls* online videos and games at home followed by a 2.5 hour *FrogWatch USA* session; and a control group that experienced a *FrogWatch USA* session without prior exposure to *SciGirls*.

Interest. As predicted by the interest model of Hidi and Renninger (2006) and the evaluation's hypothesis, the intervention of *SciGirls* successfully triggered *situational interest* that carried into the subsequent *FrogWatch USA* CS session. Although both groups rated their quantitative interest in the *FrogWatch USA* session very high, those exposed to the *SciGirls* multimedia experience displayed a significantly higher content-specific interest than those not exposed. Treatment girls reflected that their interest increased because the *SciGirls* videos and games prepared them for their session, showed them that the CS experience would be fun, and explained why CS data collection is important. These interest triggers parallel sources of interest summarized by Renninger and Hidi (2011), including features such as novel information, intensity, and meaningfulness.

The evaluation also looked at whether interest in CS projects became more general as a result of the informal enrichment experiences. In quantitative ratings, both treatment and control groups were moderately interested in finding out more about other CS projects and somewhat likely to look for another CS project to do in the future. Interest in pursuing other CS projects was strongly and significantly correlated with interest in the *FrogWatch USA* session, implying the importance of the appeal of the live activity in raising CS interest generally. Interest triggered by prior experience of *SciGirls*, as indicated by quantitative ratings, did not appear strong enough to move the treatment girls significantly further than control girls toward Hidi & Renninger's second level of *maintained situational interest* in which children reengage in similar content. Nonetheless, the treatment group's quantitative interest in pursuing other CS projects was strongly and significantly associated with high interest in their prior *SciGirls* experience and their perception that the girls in the videos are very similar to themselves.

Moreover, once control girls experienced the *SciGirls* multimedia, 78% agreed that *SciGirls* increased their interest in doing CS projects beyond *FrogWatch USA*. Their explanations for increased interest replicated the treatment girls' responses that the videos showed how girls like themselves could participate in CS and also portrayed how CS projects are fun. Thus both groups of girls noted qualitatively the positive impact of the *SciGirls* experience on more general interest in future CS projects.

Self-Efficacy. The *SciGirls* multimedia components provided vicarious CS experiences via peer models in the videos and mastery CS experiences through the *Creature Features* and *Rule the Roost* games. Both of these sources were hypothesized to influence girls' perceptions of their own efficacy in the *FrogWatch USA* session and in other different CS projects. Treatment girls identified with the video girls in a variety of ways, and they felt they did better in the *FrogWatch USA* session because *SciGirls* video and games prepared them in advance for the frog content and activities. Additionally, treatment girls agreed that they could do a good job in a different CS project because they learned from *SciGirls* about the process of other CS projects and saw girls like themselves in the videos successfully participating in other projects.

Although our qualitative data showed a self-perceived influence on CS efficacy of prior exposure to the *SciGirls*' vicarious and mastery experiences, results from the quantitative rating questions of efficacy in CS did not reveal significant differences between the treatment and control girls, contrary to our hypothesis. Both groups rated their self-efficacy very high for the *FrogWatch USA* session and for how good they believed they could perform in other CS projects. Given that both groups of girls entered the study with very high interest in nature and science, it is possible that they also began with high feelings of general science self-efficacy that were manifested in our high CS efficacy ratings. Our quantitative measures may lack sensitivity to discriminate differences at the upper levels of efficacy beliefs, which may lead to a potentially mistaken conclusion that a treatment has no effect. Alternatively, it is possible that the *FrogWatch USA* leaders were so effective in making girls feel successful in the CS session that exposure to *SciGirls* could not add significantly to the impact of the live mastery experience. Supporting this interpretation is Britner and Pajares' (2006) finding that for (largely white) middle school girls mastery experience was a stronger predictor of science self-efficacy than vicarious experience. However, the authors point out that vicarious experience still contributes to positive self-efficacy, particularly when models are perceived as similar to the observers, as was the case for our treatment girls.

Learning. Confirming our learning hypothesis, the experiences of the treatment girls led to a significantly better understanding of the features of the practice of CS compared to control girls. The treatment group learned about CS practice via *SciGirls*' videos and games and transferred that learning to enrich their understanding of CS as presented in the leader-guided *FrogWatch USA* session. Successful interactions in *Creature Features* and *Rule the Roost* as well as exposure to multiple instances of CS projects in *SciGirls* videos helped treatment girls understand that anyone can participate in CS; that CS participants use the same protocol so data can be combined and be high quality; that CS data can help real scientists come to real conclusions; and that CS brings together a wide community of scientists and volunteers to work together and share data to which the public, as well as scientists, have access. Moreover, once the control girls experienced *SciGirls* after their *FrogWatch USA* session, they increased significantly in their understanding of CS practice. These findings contribute to the learning literature that multiple examples and different experiences of concepts via a variety of platforms and settings can yield a better understanding of content (Fisch, 2013).

Impact on minority girls. The inclusion in the evaluation of a heterogeneous collection of minority girls (i.e., African American, Latina, Asian, multiethnic) was intended to represent the proportion of minorities in the larger U.S. population of fifth grade females rather than included for a purposeful comparison of minority and non-minority subsamples. Nonetheless, treatment group results that showed a stronger impact of *SciGirls* on minority girls are tantalizing, merit discussion, and invite further research and replication. Within the treatment group that was exposed to *SciGirls*, minority girls demonstrated significantly higher interest than non-minorities in finding out more about other CS projects, greater likelihood to look for a future CS project to do, and stronger belief in their efficacy to be good at doing other CS projects. Minority treatment girls also liked their *SciGirls* experience more and felt they were more like the video girls compared with their non-minority counterparts. These same variables did not show significant minority/non-minority differences in the control group that was not exposed to *SciGirls*. The method of random assignment to groups, stratified by minority status, permits us to conclude that the experience of *SciGirls* multimedia contributes to the minority girls' more positive responses; yet this conclusion must be qualified by the small sample size.

The very few studies that have explored the development of STEM interest or self-efficacy specifically with ethnically diverse youth give some support for our findings. An intervention study with African American and Latina middle school girls utilized story narratives about groups of female peers to motivate engagement with e-textile projects (Erete, Pinkard, Martin, & Sandherr, 2015). The authors' observations suggest that narratives triggered interest in science activities because the girls identified with the characters and the real-world context. Similarly, our minority fifth grade girls, who were exposed to the narratives of *SciGirls*, explained their increased interest in future CS activities because they learned about girls similar to themselves doing fun activities helpful to their community. Usher and Pajares' extensive 2008 review of sources of self-efficacy notes only two studies that examined the relationship of STEM self-efficacy and ethnic background in youth. These studies suggest that ethnically diverse youth might interpret the sources of self-efficacy differently than their white counterparts, with more emphasis on vicarious experiences. Within our treatment group, the minority girls appeared to be more responsive than the non-minorities to the vicarious experiences of seeing same-age, same-gender video girls of various ethnicities doing novel CS activities.

The evaluation also showed that minority girls in both treatment and control groups reported significantly greater interest in their *FrogWatch USA* citizen science session compared with non-minority girls, even though prior interest in nature and science was equivalent for the subsamples in each group. We can only speculate on a variety of mediating variables to explain these results; for example, a recent survey regarding out-of-school STEM programs revealed that minority parents have a more positive opinion of such programs than non-minority parents (Afterschool Alliance 2015), hinting at a possible influence of parental attitude on youth interest in the *FrogWatch USA* experience.

Recommendations. Four recommendations to the field of citizen science and science education emerge from the results:

- 1) **Each of the six CS projects highlighted in a *SciGirls* video should consider utilizing *SciGirls* multimedia prior to live CS sessions with preteen girls.** For logistical reasons, *FrogWatch USA* was chosen to represent the contributory model citizen science projects covered in the *SciGirls* videos. Besides *FrogWatch USA*, highlighted projects in *SciGirls* include Celebrate Urban Birds, Monarch Larva Monitoring Project, S'COOL, Nature's Notebook, and Seafloor Explorer. Although each of these projects has unique elements, we can generalize from the summative evaluation findings that prior exposure of preteen girls to the *SciGirls* materials associated with a respective project can increase project interest, help prepare girls for their CS sessions, and improve understanding of CS practice.
- 2) **Formal educators and informal educators working with preteen girls could use *SciGirls*' resources – video in particular – independently of specific CS projects to introduce the practice of citizen science generally and generate interest and participation in citizen science more broadly.** Exposing young girls to the process and fun of CS via video will increase not only knowledge about CS, as demonstrated by the evaluation's results, but also might stimulate participation in CS projects not highlighted in the videos.
- 3) **The differential impact of *SciGirls* on ethnically diverse girls' interest and efficacy within the treatment group should encourage researchers to explore these issues with larger samples.** Further research might focus on ethnically diverse or homogeneous groups and collection of a much wider variety of background information to shed more light on how peer-oriented multimedia influence youth outcomes, how minorities might respond differently to contributory model citizen science, and how groups differ in their pathways of science interest and self-efficacy.
- 4) **To contribute to potential comparisons across CS and science programs more generally, the Girls' Interest in Nature and Science Scale (GINSS), developed and validated as part of the summative evaluation, is available for use by other evaluators and researchers.**

In conclusion, the *SciGirls* multimedia experience contributed significantly to girls' experience of citizen science. Exposure to *SciGirls* triggered interest that is carried into a subsequent live CS session and increased preteen girls' understanding of the unique practice of CS, with a special influence on minority girls' interest and self-efficacy. *SciGirls* multimedia shows youth the process and practice of CS, demonstrates the fun of CS, and presents peers with whom girls can identify.

APPENDIX A

Psychometrics for Girls' Interest in Nature and Science Scale (GINSS)

The *SciGirls* season three episodes focus on nature topics experienced through the science inquiry protocols of citizen science projects; thus, for the evaluation online application process, we developed and piloted a *Girls' Interest in Nature and Science Scale*. Inspired by an early draft of the Cornell Lab of Ornithology's DEVISE project's Adult Interest in Science and Nature Scale (now just Science Scale¹⁹), a 9 statement scale was piloted with fifth grade girls.

With randomized presentation of statements, the scale was administered online as part of a larger survey to a total sample of 212 fifth grade girls from nationally distributed classes in Sacramento, CA; Austin, TX; Bethlehem, GA; Miami, FL; Jacksonville, FL; Kenly, NC, and Bryn Mawr, PA. Half of the sample were 10 years old and half were 11 years old. Our sample was homogeneous in age and gender to match the intended *SciGirls* evaluation sample. The participant sample was ethnically diverse but such background information was not individually recorded for the pilot study.

Descriptive statistics. The statements were presented in random order for each respondent with five response categories: strongly disagree (1), disagree, not sure, agree, strongly agree (5). The table below presents descriptive statistics for the scale statements, ordered by mean rating.

Items in <i>GINSS</i>	Mean	Median	Std Dev
1. It's fun to do science activities	4.17	4	0.88
2. It's fun to collect things from outdoors	4.11	4	0.95
3. I like to hear about new discoveries in science	3.96	4	0.99
4. I want to understand how things in nature work	3.93	4	0.95
5. I like to identify things in nature	3.76	4	1.06
6. I like to observe birds, butterflies, bugs or other things in nature	3.61	4	1.17
7. I enjoy watching nature shows	3.50	4	1.16
8. I enjoy reading about science	3.32	3	1.11
9. I like talking about science topics with others	3.20	3	1.16
Total Scale	3.72	3.78	0.71

Reliability. If the scale statements have a strong relationship to the intended scale construct, then the statements will have a strong relationship to each other. To assess the homogeneity of items within the scale, the most commonly used statistic for internal consistency reliability is Cronbach's alpha; whereas ordinal (polychoric) alpha is more appropriate for our data because

¹⁹ <http://www.birds.cornell.edu/citscitolkit/evaluation/instruments>

it has been shown to estimate reliability more accurately for our Likert-type ordinal (not continuous) response formats (Gaderman, Guhn & Zumbo, 2012).

Polychoric alpha coefficients are presented in the table below. The total scale reliability coefficient is .88. The large (> .8) individual item and total scale coefficients are appropriate for research purposes (Nunnally, 1979) and “very good” as rated by DeVillis (2012). DeVillis also suggests that “a scale with an alpha of .85 is probably perfectly adequate for use in a study comparing groups with respect to the construct being measured” (p. 110). All nine statements contribute positively to scale reliability and were retained in the scale used in the summative evaluation.

Items in <i>GINSS</i>	Polychoric reliability if item dropped
1. It’s fun to do science activities	0.88
2. It’s fun to collect things from outdoors	0.87
3. I like to hear about new discoveries in science	0.87
4. I want to understand how things in nature work	0.87
5. I like to identify things in nature	0.87
6. I like to observe birds, butterflies, bugs or other things in nature	0.87
7. I enjoy watching nature shows	0.87
8. I enjoy reading about science	0.88
9. I like talking about science topics with others	0.88
Total Scale	0.88

Exploratory Factor Analysis. Through exploratory factor analysis, our goal is to assess how well our girls’ scale scores reflect a single common dimension of interest in nature and science or multiple dimensions. We determined if our data are suitable for factor analysis by looking at several measures of sampling adequacy (Dziuban & Shirkey, 1974): KMO (Kaiser-Meyer-Olkin) index equals a “meritorious” .86, above the acceptable value of .5; Bartlett’s test is highly significant ($\chi^2 (212) = 867.95, p < .00001$); and the majority of inter-item correlations are greater than .3. Consequently, factor analysis is appropriate for our data set.

The exploratory factor analysis utilized the software FACTOR (Lorenzo-Seva & Ferrando, 2006) and followed tested recommendations for the most appropriate procedure in applied research to examine dimensionality underlying Likert-scored items. For ordinal scales, parallel analysis using minimum rank factor analysis and polychoric correlations have been shown to outperform other analyses (Timmerman & Lorenzo-Seva, 2011; Baglin, 2014).

High factor loadings (see table below) on each item in a one-factor model were produced. Costello and Osborne (2005) recommend that “5 or more strongly loading items (.50 or better) are desirable and indicate a solid factor” (p. 5). The proportion of common variance explained by the unidimensional model is 70%. Parallel analysis also advised a one-factor solution. Therefore, our scale scores reflect a single common dimension of interest in nature and science for fifth grade girls.

Items in <i>GINSS</i>	Factor 1 Loading
1. It’s fun to do science activities	0.60
2. It’s fun to collect things from outdoors	0.73
3. I like to hear about new discoveries in science	0.64
4. I want to understand how things in nature work	0.70
5. I like to identify things in nature	0.72
6. I like to observe birds, butterflies, bugs or other things in nature	0.74
7. I enjoy watching nature shows	0.72
8. I enjoy reading about science	0.64
9. I like talking about science topics with others	0.60

Given the reliability and single factor results, a composite score of the *GINSS* was appropriate to use in our evaluation as a measure to examine equality of randomly assigned groups. For the evaluation sample of 98 fifth grade girls, high scale reliability (polychoric alpha = .87) was obtained. Scale scores did not differ by group, by age, or by self-reported status as minority (n = 37) or non-minority (n = 61).

This scale is available for researcher use. Please let us know how you use it.

Contact: Dr. Barbara N. Flagg, Director, Multimedia Research, Flagg@multimediarsearch.org

Cite as: Flagg, B. N. (2015). *Girls’ Interest in Nature and Science Scale*. Bellport, NY: Multimedia Research.

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APPENDIX B

SciGirls Season 3 Evaluation Episode Summaries,

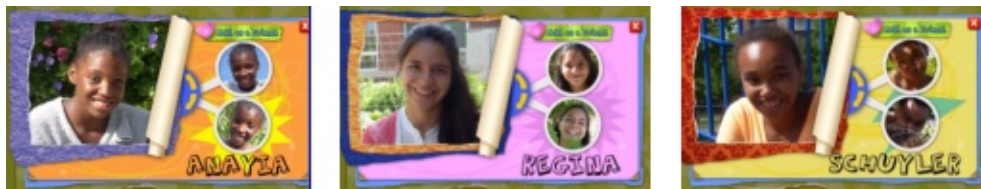
As described by SciGirls Executive Producer Richard Hudson

Frog Whisperers (<http://bit.ly/SciGirlsFrogWatch>)



Amanda, Clara, Alanna, and Madison are concerned about St. Louis' declining amphibian population. So they volunteer for *FrogWatch USA*, a citizen science project that invites nature lovers to report frog and toad calls within a specific area. With the guidance of their mentor, Laura Seger, the girls learn to recognize the sounds of six local frog species. Then they pull on their boots and head out to the wetlands, ready to listen to frogs in their natural environment. They also listen to frogs in an urban habitat, and compare the two sites. Finally, the girls enter their data into the *FrogWatch USA* website, proud to submit their discoveries to researchers. And since they want to share their findings with an even bigger audience, they do a presentation at an Earth Day celebration at the St. Louis Zoo, showing off a poster, a puppet show and even a rap.

Feathered Friends (<http://bit.ly/SciGirlsBirds>)



Anayia, Regina and Schuyler live in Denver's inner city, where they enjoy watching nature in the city's many parks. A hands-on opportunity to help ornithologist Dr. Viviana Ruiz-Gutierrez band birds whets their interest in observing birds. Viviana tells them that everyone can take part in the citizen science program, Celebrate Urban Birds, by tracking 16 bird species in their city. They record their findings, proud that their data will be used by scientists like Viviana to understand how birds adapt to urban environments. The team then investigates what makes an ideal bird habitat and uses this knowledge to create a storybook for local elementary school students. They also bring a selection of bird-friendly plants for the school garden and encourage the kids to pledge to help make healthy green spaces for birds *and* people.

Flower Power (<http://bit.ly/SciGirlsNaturesNotebook>)



Claire, Elle and Jordan are weary of the long, cold Minnesota winter. So they head to the Minnesota Landscape Arboretum, where naturalist Lauren Borer points out the first signs of spring! The girls learn they can help scientists better understand the seasonal changes by participating in Nature's Notebook, a national citizen science project that tracks the natural life cycle of plants and animals. They each pick a plant species to monitor and record their findings every few days. They also snap photos, sketch pictures and compose poems, all inspired by the plants they observe. The girls, growing ever more curious, wonder if the annual time frame for sugar maple trees to bud has changed significantly in recent years and compare their data with records from previous years. They ultimately share their discoveries with Arboretum visitors, presenting a work of art that incorporates their data, photos and sketches, and conveys the importance of keeping nature records over time.

SkyGirls (<http://bit.ly/NASA-Scool>)



Want an accurate weather forecast? You need accurate satellites! Virginia Beach buddies Emma, Lauren and Madison enjoy the beach and love to watch clouds. They take part in S'COOL, a NASA project, that relies on citizen scientists to provide cloud observations from the ground at the same time a CERES satellite passes overhead. Mentor Dr. Yolanda Roberts teaches the girls the twelve types of clouds and their location in the atmosphere. The trio then spends two days scanning the sky and submitting their data to S'COOL's website, and they meet a leading NASA research scientist, Dr. Lin Chambers. A week later, the girls receive data the satellite collected and compare it to their observations. With their results, they create a display for the Virginia Air and Space Museum, including a 12 foot-banner depicting the Earth's troposphere.

APPENDIX C

Questions in post survey for Interest and Self-Efficacy Scales

Statements from the Frog Activity Interest Scale and Frog Activity Self-Efficacy Scale were combined and presented in two questions, with statement order randomized for each respondent. The questions were presented after the *FrogWatch USA* session as part of an online post-survey. Scale reliability (N = 98) for Frog Activity Interest Scale equals .87 and for Frog Activity Self-Efficacy Scale equals .70.

Q#. Click a circle to show how much you disagree or agree with each statement below.
Disagree is on the left and Agree is on the right.

	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
I could do FrogWatch just as well as others my age.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I thought FrogWatch was very interesting.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I had a lot of fun while doing FrogWatch.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I was good at learning about frog and toad calls.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q#. Click a circle to show how much you disagree or agree with each statement below.
Disagree is on the left and Agree is on the right.

	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
I was good at following instructions for FrogWatch.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I enjoyed doing FrogWatch very much.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to do more citizen science activities.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I could learn about frog and toad calls as quickly as others my age.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

The *SciGirls* Activity Interest Scale statements were presented in random order for each respondent in an online post survey. The treatment group responded after exposure to *SciGirls* and their subsequent *FrogWatch USA* session. The control group responded after exposure to *FrogWatch USA* and their subsequent *SciGirls* experience. Scale reliability for *SciGirls* Activity Interest Scale equals .87.

Q#. Think about your *SciGirls* experience with videos and games. Then click a circle to show how much you disagree or agree with each statement below.

	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
I enjoyed doing <i>SciGirls</i> very much.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I thought <i>SciGirls</i> was very interesting.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I had a lot of fun while doing <i>SciGirls</i> .	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to do more on the <i>SciGirls</i> ' website	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

APPENDIX D

Participant responses illustrative of *FrogWatch USA* appeal categories

Participants were asked: *What did you like about your FrogWatch experience and why? What did you not like about your FrogWatch experience and why?*

All quotes are presented as they were written in participant surveys.

During their *FrogWatch USA* session, the girls liked learning about different frogs and their calls (45%); for example:

I liked learning different frog calls because now when I go to the park to catch frogs I can recognize them.

I liked doing the FrogWatch because I got to learn about frogs, what sounds they make. Learning the sound of the frogs because now I can tell if the frogs in my backyard are bullfrogs or tree frogs.

I liked that we learned the different sounds of frogs and that I learned more about frogs. And why I like it was because it was new and I thought that the different sounds were cool.

Half (52%) of the participants in the four sites that could go outside during the session enjoyed their experience listening for frogs and enjoying nature; for example:

I liked walking in the forest we got to see the frogs, not just hear them. I also like going in the forest at night because I never get to do that.

I liked that we were able to go on a hike to the swamp to listen to the frogs in the area. Because I don't have a swamp near my house.

*I liked actually listening for the frogs because it was fun to be in the middle of the woods/wetlands and hearing all the funny noises. The frogs were really loud.
I liked that I was outside enjoying nature.
Getting to hear the frog calls live and in person because I felt so connected to nature.*

But 23% of the girls were disappointed with their outside experience because it was dark, buggy, cold, rainy, too short in duration, or lacking in frog sounds:

*I didn't really enjoy going outside walking in the dark, and walking a long time.
It was dark and bugs were everywhere.
What I disliked about the frog watch was that it was a cold rainy night.
I didn't like that we couldn't go outside more and explore the frogs in the wild.
I did not like that we only heard one frog. I thought that we would hear a lot and that was a disappointment.*

Some girls specifically noted the game-like activities (16%):

*I like when the whole class was taught how to make frog imitations.
I like that we got to make the frog sounds of household items.
I liked the guessing game you had to guess where the sounds were coming from because there were some sounds that I got right.*

Participants described their experiences as *fun* (30%):

*I liked that everybody got a fair time to talk and have fun.
I liked everything. It was fun.
It was fun. I love animals and I like learning about them.
I like that it was fun.*

But 19% of the girls did not appreciate the inside time of sitting, talking or watching a slideshow:

*Some of it was boring. When we sat there and talked.
I didn't like how we sat there most of the time.
I didn't really like the slideshow. It wasn't really about frogs.
Honestly I absolutely hated it. The activities were really babyish and no kid would want to sit through 90 slides.*

APPENDIX E

Treatment responses illustrative of SciGirls impact on interest in FrogWatch USA

Those treatment group participants who felt that their *SciGirls* experience of videos and games increased their interest in *FrogWatch USA* were asked: *What parts of your SciGirls experience increased your interest in participating in the frog session?* All quotes are presented as they were given by participants.

A plurality of treatment girls reported that the *SciGirls* videos prepared them for their own *FrogWatch USA* session (45%); for example:

The videos when they were taking the data kind of prepared me for what we would be doing.

The video about the frogs, it showed me what kind of stuff we might be doing, so it kinda made me excited.

SciGirls increased my interest because the videos were instructions and helped me during the FrogWatch.

In the FrogWatch video, it told me a little bit more about what I was going to be doing.

Watching it [frog video] helped me learn about it, and it made me more interested because I wasn't going to be completely confused.

Watching one of the videos helped me learn more about the frogs for the FrogWatch.

I knew more about what types of frogs there were and the different types of calls that they made.

Treatment girls felt that seeing the video girls having fun increased their interest in the frog CS session (31%); for example:

When they were talking about the frogs, like when they were laying on the dock and just listening, I thought it was going to be fun and stuff.

In one of the videos, it showed a bunch of these girls watching and looking for frogs, and it was very entertaining. I wanted to do it in person. It was actually pretty fun.

In the videos, they were having so much fun, and it looked fun doing it...so when the FrogWatch happened, I did have a lot of fun and enjoyed it a lot.

The frog video affected my interest because it seems fun, and it seemed really fun to do.

The video of the FrogWatch really encouraged me because I have never actually seen or heard frogs before in real life. So when I saw the video, I was like it was so cool – maybe we could hold some frogs!

Treatment girls specifically noted that the *Creature Features* game increased their interest because the game exposed them to frog listening and frog facts prior to the *FrogWatch USA* session (19%); for example:

One of the games where you had to listen to the calls of animals and then find where they were, and then you had to collect your data and write it in your little book that was on the screen. It increased my interest by what it was about and that I wanted to learn about it.

In the Creature Features game, it had, instead of giving you a game and just playing, it actually gave you information and the sounds of the frog, which I thought was cool because in most of the games in which you participate in science, they don't do that. On Creature Features, we had to listen to sounds in night time and in FrogWatch USA, we had to narrow down what type of frog call we were listening to. The game, Creature Features – that inspired.

Treatment girls also suggested that the videos affected their interest because they learned why data collection is important (12%); for example:

When I was watching the videos, it helped me understand why we were doing the FrogWatch and why it helps scientists.

It made me more interested in frogs and making me want to do more with frogs and help them not be as endangered.

The videos gave me a lot more info on how my data could help the world to know how many frogs were in the area.

Finally, 8% of treatment girls specifically noted that the *Rule the Roost* increased their interest because the robin activity introduced them to data collection; for example:

Playing Rule the Roost gave me an example about how to do the data.

That one game where you had to record your data, because it showed me more of how you had to do it.

APPENDIX F

Participant responses illustrative of SciGirls impact on interest in doing other CS projects

Both treatment and control group participants who felt that their *SciGirls* experience of videos and games increased their interest in doing CS projects other than FrogWatch were asked: *How did your SciGirls experience increase your interest in other citizen science projects?* All quotes are presented as they were given by participants.

Both treatment and control girls noted that their interest in other CS projects increased after exposure to *SciGirls* because the videos modeled how girls could participate in citizen science (22%); for example:

It kind of showed me what they did and what I could do too.

The way they were showing how and what they did sparked my interest for doing and learning more about those things.

I saw that there are other girls that do other citizen science projects, and the topics that they studied were very interesting.

How there were girls that were my age, I guess, and they knew what they were doing.

It showed me how easy it was to do a citizen science project, and how many different sorts there are.

It gave me examples of what citizen science is all about and how it works.

It showed me examples of how I could do it.

Girls reported more interest in other CS projects because the *SciGirls* videos portrayed citizen science projects as fun (20%); for example:

The girls on the videos looked like they were having a lot of fun doing the citizen science projects, and I was thinking that it might have been fun if I had been one of those girls doing it in the citizen science projects.

It increased my interest because it made citizen science sound all fun, and I love doing projects.

It looked really fun when you saw it.

The stuff they did in the video, it seemed very interesting, and I would like to try them. It seemed like they were having a lot of fun.

I saw how much fun the girls had too! They were hanging out together, and it gave me inspiration for me and my friends.

SciGirls also increased interest in other CS projects because participants want to help scientists and their community as the *SciGirls* did (15%); for example:

It increased my interest in citizen science because I think it is really cool that you can help scientists, so I will definitely start recording different birds in the area and look for different websites so I can put that information up.

On all that they [SciGirls] did, they were helping the scientists' research, and I was interested because I wanted to do that too.

It helped me realize that you don't have to have all of this science equipment to do something, and anything you do can be helping in citizen science.

I learned that doing citizen science projects helps scientists out.

It made me realize that there is a lot more programs I can do to help the community while participating in citizen science.

Participants suggested that their *SciGirls* experience increased interest in doing other CS projects because the CS activity can help girls learn different types of science (14%); for example:

It showed me different types of science; that it's not just FrogWatch, so if I didn't want to do frogs, I could do clouds or birds.

The space, NASA, it made me more interested in the probes. I would love to do more with those projects. I didn't know there was three layers of clouds, and I got more interested in that.

It made me want to learn about different things, different animals, different species.

APPENDIX G

Participant responses illustrative of SciGirls appeal categories

Participants were asked: *What did you like about your SciGirls experience of videos and games and why? What did you not like about your SciGirls experience of videos and games and why?* All quotes are presented as they were written in participant surveys.

Girls used the descriptor *fun*

- to describe generally their *SciGirls* experience of videos and games generally (11%); for example
They were fun.
They were really fun.
I liked how I didn't feel like it was a thing that was boring. I like how fun and friendly it was.
- to describe videos specifically (16%); for example:
I liked the SciGirls videos because it was fun.
I liked the videos. They were fun to watch.
- to describe games specifically (26%); for example:
The games were fun.
The games were fun to play.
I really enjoyed playing Creature Features because I thought it was fun to find the birds and animals.
I liked Creature Features it was really fun.
I really liked playing Rule the Roost it was a really fun game.

Girls described *learning* from their experience

- generally (17%); for example
I liked that you strongly tried to teach me.
Learning things because it's interesting and enjoyable!
- specifically from videos (20%); for example:
I liked seeing the different types of clouds and what they looked like. I liked learning about different kinds of birds in feathered friends.
I liked the videos because they taught me a BUNCH of different facts that I had never known before!
The videos helped me understand things better.
- specifically from games (17%); for example:
I liked the Creature Features game the best because the frog game gave you the calls of the frogs and birds which I thought was cool because it didn't only give you information about the animals.
In Creature Features, you got to see pictures and learn facts about creatures.
I liked that when you clicked on an animal, facts about the animal are shown, as well as distinguishing characteristics about the animal.
Rule the Roost let me see robins for the first time.

Viewers liked that the videos presented *real girls* (15%):

I liked that it was real people in the videos.

I like how they showed real life girls instead of just cartoons. I was able to relate to the real life girl.

I liked how the videos showed real girls doing citizen science and really encouraged me to do more for fun.

Viewers also liked that the videos were *interesting* (8%):

The videos were very interesting.

It was really interesting about catching the frogs, finding birds, etc.

I liked this because it was interesting to watch as girls did cool activities to learn about nature.

Of the treatment group, 10% liked that the videos helped them in the FrogWatchUSA session:

The one where they did the frog watch gave me an idea of what we were going to do.

My favorite video was the one about the Frogs! Because they learned and basically did the same thing that we did, so I was able to CONNECT even better with what we did.

The Frog Whisperers Video gave me an idea of what we were going to do in Frog Watch.

Of the control group who experienced *SciGirls* after their frog session, 16% liked that the videos introduced other citizen science projects:

I liked learning about some of the other citizen science projects that other girls participate in.

You learned about different citizen projects.

I learned there are different watches besides frogs.

A few girls (5%) noted that in *Rule the Roost* they got to participate in citizen science:

I like that our data we collected was going to be used by scientists, because I would be helping the world know how many robins there are.

I liked how in the Rule the Roost game, you get to actually go out and experience a Citizen Science project because it might make me and other people do more Citizen Science projects and it was interesting.

The videos were also described as too long (21%) or boring (6%); for example:

I did not like that the videos were 30 minutes long.

I wish that the videos were a little bit shorter, because it starts to get boring after about 20 minutes.

The videos were a little long, the sky girls cloud video was kind of boring.

Videos were boring.

Some participants complained that games were difficult or confusing to play (12%):

You could not jump easy on Creature Features.

*The Creature Features game was very irritating to play.
Rule the Roost was a bit confusing.
I did not like the games because they were kind of hard to understand what to do in them.*

Some girls reported difficulties getting the games to play smoothly (9%):
*The game did not work well on my iPad. I could not get to the next level.
Rule the Roost had problems on Windows 8 and Firefox.*

A few girls did not think the games were fun (4%):
*I didn't like the rule the roost because all you did was record data if you saw a robin or not.
Creature Features was a little boring because all you had to do was (very easily) find the
animal, take a picture of it and then read about it. I did not think it was very interesting
or very fun.*

APPENDIX H

Treatment responses illustrative of SciGirls impact on efficacy beliefs with respect to FrogWatch USA session

Treatment participants who felt they did better at the FrogWatch activities because they watched SciGirls videos and played the games before the frog session were asked: *What parts of your SciGirls experience helped you feel more successful in the frog session?* All quotes are presented as they were given by participants.

Treatment girls felt that *Frog Whisperers* and *Creature Features* increased their knowledge of frogs and their calls (39%): for example:

[from SciGirls] I already knew almost all the sounds of the frogs, because in the videos they were giving me clues about what I would learn in the frog watching session.

In the video about frogs, it helped me know the different kinds of frogs.

The creature features helped me with the frog calls.

When I played Creature Features, I know about the different types of frogs.

I kind of got a little bit of information before I went to go do the FrogWatch, and so I knew little bit more about the frogs and what they were talking about.

The *Frog Whisperers* video made treatment girls aware of what they could expect to happen in the *FrogWatch USA* session; for example:

Watching the Frog Whisperers video gave me an idea of what we would be talking and learning about during FrogWatch.

I knew what I was going to be doing.

Watching the video. It showed what they were doing, so I knew what I would be doing and kind of how things were going to go.

Watching the video helped the treatment girls learn the data collection protocol (16%); for example:

They sat outside with flashlights and waited for 2 minutes, then 3 minutes to see if they heard anything.

In the video, it said that we had to wait 2 or 3 minutes – 2 minutes for the timer and 3 minutes to hear.

APPENDIX I

Treatment responses illustrative of SciGirls impact on efficacy beliefs with respect to other CS projects

Treatment participants who felt that their *SciGirls* experience of videos and games made them believe they could do a good job in a different citizen science project were asked: *What parts of your SciGirls experience makes you think you could do a good job in a different citizen science project?* All quotes are presented as they were given by participants.

Treatment girls felt that *SciGirls* helped them learn about the process of other CS projects (22%); for example:

Because when I was watching the videos and how they recorded their data, I thought that was the same as when you do other animals. I think the videos helped because when they did that to collect the data, I saw how they did it.

I know the process I need to go through. For the birds, I do the same thing like for the frog, just at a different time.

Seeing video girls who were like them made the treatment girls feel that they too could do the CS projects in *SciGirls* (16%); for example:

I saw a lot of girls my age doing it, so I thought I could do it too, since all these girls all my age were doing it.

Because I knew that they were kind of my age and that I could do what they could do.

Treatment girls were motivated to help scientists by participating in CS (8%); for example:

When they showed that real scientists were looking over their data. The three videos showed the girls giving their data to online sites. That is pretty cool, thinking that the data is being a part of what other adults do.

Treatment girls felt they learned science information from *SciGirls* that would help them in a different CS project (8%); for example:

I watched the videos, and I learned more about different things in science, like knowing about different species of birds, frogs and clouds.

APPENDIX J

Participant responses illustrative of how participants see themselves as like or not like the SciGirls video girls

Participants who rated that the girls in the SciGirls videos were like them, either a lot, mostly, or a little, were then asked: *Tell us how the girls in the SciGirls videos are like you or not like you.* All quotes are presented as they were written in participant surveys.

Participants explained that the video girls were like them because they both liked nature and/or science (41%); for example:

The girls on the video lover nature and science and so do I.

They are alike me because we enjoy the same things like science.

The girls in the videos were mostly like me because I love science and animals.

The video girls also had the same personal interests or activities as the participant girls; for example:

I also want to volunteer at a dog shelter like one of the girls. Some of them do gymnastics like me.

The girls had dogs like me.

Some of the girls are into sports & so am I.

Both participants and the video girls like going outdoors (10%); for example:

The girls in the videos and I are alike in the way we both enjoy being outside.

Lots of them love to get out in nature and I love doing that.

They are like me because I like to go outside and explore around outside and look at different things.

Participants pointed out that like the video girls, they like helping animals or the environment (8%); for example:

We both also like helping animals and the environment.

The girls in the videos love working in nature and helping their planet. I like to do that to!

Some participants noted that the video girls are of a similar age (7%); for example:

We all look like we are the same age.

They're around my age.

Participants saw similarity in the video girls' interest in learning (7%); for example:

They are girls that like to learn like me.

The girls in the scigirls videos are mostly like me because they like to learn.

Some described the video girls as liking to have fun (6%); for example:

They like to have fun just like me.

They are like me because they like to do fun projects.

Many fewer participants reported in their open-ended response how the video girls were not like them. These participants said they did not share the video girls' personal interests or activities (9%); for example: *They are not like me in what they do outside of science.* Some suggested that they did not like going outside like the video girls (5%); for example: *They like exploring nature and I'm not that type of person.* And some participants noted that they were shy, unlike the outgoing video girls (5%); for example: *They were not like me because they were not shy.*

APPENDIX K

Participant responses illustrative of learning of four CS practice categories

All quotes are presented as they were given by participants.

(1) In CS anyone can participate

I think anybody can participate in a program like this.

[CS] means to me like anybody can do it.

[CS] is where regular people like you and me go out and figure out some things. It means anyone can be a scientist and discover something.

Anybody could participate if you really want to do it and you set your mind to it.

It [CS] means that a regular person is a scientist.

(2) CS participants use the same protocol so data can be combined and be high quality

People should use the same procedure, because if you alter it, your data won't get accurate. Everything needs to be the same so that everything can be accurate.

Your data wouldn't be as correct if you didn't use the same procedure.

If people weren't following the same steps, it might not be as accurate because they might not be doing the same things

If you are using different procedures, you can get different answers and then scientists can question that.

So the scientists know the information is true, so everyone collects similar information.

(3) CS data can help real scientists come to real conclusions

It [CS] does help scientists understand what weather conditions amphibians like to come out in and the different environments they are in. I think the observations we took are helpful to scientists.

It [CS] means helping a lot of scientists to collect data and helping them to monitor the environment better.

It [CS] means helping scientists and making observations about species.

It [our observations] helps them learn more about what kinds of frogs are in our areas and how they're doing and how many there are.

Citizen scientists can collect data and report it and that helps the professional scientists so they would know what's going on in the areas where the citizens are. The professional scientists can know what's going on in areas that they are not in themselves.

- (4) CS brings together a wide community of scientists and volunteers to work together and share data to which the public, as well as scientists, have access.

That it [CS] is a partnership between scientists and people to collect data.

Citizen science is citizens and scientists gather data together about the world and find out problems together as a team..

It [CS] means that I get to participate in activities that can share my data with other people and see how my data is related to others in my area.

It is important [that people participate in CS] because the citizen science projects that they do help people in a different state and when they share their data they help others to get more informed about the topic and get interested in the topic and learn about what they have done.

[CS is]When ordinary people from the community come together to collect data and then get access to the information.

[Data is made available on a public website] so everybody in the public can use this information to know about frogs in their area and frogs in other places.

[Data is made available on a public website] Because other people would like to know. It's not just scientists who would like to know or see what's going on, other people might like to know too.

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