implementing out-of-school time STEM resources

Best Practices from Public Television

by Christine Andrews Paulsen

Business leaders, educators, and government leaders agree that, in order for the United States to retain its standing as a world leader, public and private institutions need to work together to develop a well-qualified workforce in science, technology, engineering, and mathematics (STEM). However, the number of graduates with STEM degrees has not been equal to the need, partly because many students arrive at college unprepared to handle math and science (U.S. Department of Commerce, 2012).

In response to this crisis, billions of dollars have been invested in the public and private sectors to bolster children's academic achievement in STEM, to fuel their interest in STEM activities, and to foster their desire to pursue STEM in college and as a career (U.S. Government Accountability Office, 2012). Though many of these investments are going into formal classroom programs, others target children in out-of-school time (OST) settings including afterschool programs, scout troops, museums, science centers, parks, zoos, aquaria, and homes.

In 2009, the National Research Council (NRC) argued, "Programs, especially during out-of-school time, afford a special opportunity to expand science learning experiences for millions of children" (NRC, 2009, p. 5). The report also says:

> Science media, in the form of radio, television, the Internet, and hand-held devices, are pervasive and make science information increasingly available to people across venues for science learning. Science

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media are qualitatively shaping people's relationship with science and are new means of supporting science learning. (NRC, 2009, p. 3)

The National Science Foundation (NSF) has funded many programs to enable public media producers, including public television (TV) stations, to provide children's STEM programming in OST settings. These projects typically include a children's TV series (animated or not) aired on the Public Broadcasting Service (PBS), plus resources, such as hands-on activity guides and educator toolkits, to support STEM learning in OST settings. Evaluation studies have demonstrated the positive impact of educational TV on children's STEM learning outcomes (Fisch, Lesh, & Crespo, 2010). This conclusion is echoed in a recent NRC report, which states that "the evidence is strong for the impact of educational television on science learning" (NRC, 2009, p. 3). Studies have also demonstrated the positive effect of the TV programs' STEM-related OST resources on children and OST practitioners. Educational

Table 1. PBS Programs Reviewed

PROGRAM	DATES PRODUCED	TARGET AUDIENCES	STEM CONCEPTS COVERED	PAPERS REVIEWED
DragonflyTV	2002–2009	9–12-year-olds	Science	Apley, 2006; Apley, 2008; Flagg, 2009; Robles, Helms, & Phillips, 2009
SciGirls (DragonflyTV spinoff)	2010–present	8–12-year-old girls	Science	Flagg, 2012; Knight-Williams & Williams, 2008
Cyberchase	2002–2012	8–12-year-olds	Math	Apley, Graham, & Goldman, 2010; Fisch, 2006; Flagg, 2003a, 2003b
ZOOM	1999–2005	5–11-year-olds	Science, math, engineering	Goodman, 2005
FETCH!	2006–2010	6–10-year-olds	Science, math, engineering	Londhe, Kochman, & Goodman, 2007; Londhe, Pylvainen, & Goodman, 2009; Paulsen & Bransfield, 2009; Paulsen & Carroll, 2011; Paulsen & Goff, 2006
Design Squad	2007–2011	9–12-year-olds	Engineering	Vaughan, Pressman, & Goodman, 2007
Design Squad Nation (Design Squad spinoff)	Since 2011	9–12-year-olds	Engineering	Paulsen, Green, & Carroll, 2011

TV programs offer children the opportunity to experience the same content across multiple contexts—home, camp, school—increasing the likelihood that they will experience a transfer of learning from one situation to the next (Fisch et al., 2010; Knight-Williams & Williams, 2008; Londhe, Pylvainen, & Goodman, 2009).

This paper explores the lessons learned from seven such programs and their NSF-funded outreach initiatives: *DragonflyTV* and *SciGirls,* produced by Twin Cities Public Television (TPT) in Minnesota; *Cyberchase,* produced by Thirteen in association with WNET in New York; and *FETCH! with Ruff Ruffman*, *ZOOM, Design Squad,* and *Design Squad Nation,* all produced by WGBH in Boston.[1] Evaluations of these programs and their supporting materials yield recommendations both on the content and format of OST STEM resources for elementary and middle school children and on outreach to engage target audiences. The promising practices outlined here can guide resource developers and practitioners as they create STEM resources or implement them in OST programming.

Methodology and Resources Reviewed

As shown in Table 1, all seven programs reviewed in this article aired on PBS stations in the early 2000s; all were targeted to children at the elementary or early middle school level. To compile promising practices from these programs and their associated resources, I reviewed published and unpublished evaluations and then followed up with the programs' producers to verify program details and confirm my interpretation of the lessons learned.

The programs offered a wide variety of elementary- and middle school-level STEM resources to OST organizations and at-home audiences. All of the resources were available at no charge; however, some activities did require the purchase of materials or supplies, an issue discussed below. Generally, the programs offered the following types of resources for informal STEM learning:

- **Television episodes** offered online or on physical media
- **Educator guides** to leading hands-on STEM activities with children
- **Activity sheets** instructing children to do hands-on STEM activities
- **Activity kits** containing activity sheets, educator guides, and, in some cases, materials such as seed packets
- **Club guides** for 6–12 weeks' worth of structured or semi-structured STEM programming, including detailed instructions on how to lead STEM activities; activity sheets with instructions for children; and additional materials such as certificates, membership cards, and posters
- **Activity cards** providing families with quick ideas for doing STEM activities at home
- **Websites** featuring additional materials and, in some cases, opportunities to share work with others
- **Promotional materials**, such as advertising content, posters, flyers, costumes for characters in the TV programs, stickers, and tattoos
- **Online or in-person training** for OST practitioners

In addition to these tangible resources, public TV stations also offered grants or in-kind support to community partners for STEM events and activities. The stations' outreach teams supported partners with workshops or technical assistance on STEM concepts and national standards, setting up a STEM program or integrating STEM resources into existing programs, and managing groups of children. Exhibits in museums or science centers and overnight events in museum or camp settings rounded out the offerings.

Promising Practices for Implementing STEM Resources in OST

The promising practices suggested by the seven public TV programs and their associated materials are generalizable across many kinds of programs and resources. The recommendations fall into two main categories:

- Content and format of OST STEM resources
- Outreach to and collaboration with OST communities

Content and Format of OST STEM Resources

Whether they are media producers, curriculum developers, or practitioners introducing STEM activities in their own programs, people who develop and use OST STEM resources should consider these recommendations:

- Understand the audiences' needs.
- Evaluate STEM resources before and after implementation.
- Require only inexpensive, easy-to-find supplies for STEM activities, and provide options or alternatives.
- Require minimal preparation time.
- Ensure that paper-based resources, such as children's activity sheets, are available and are easy to reproduce.
- Provide opportunities for adapting or modifying activities based on the young people's skill level or other factors.
- Include support for OST practitioners.
- Promote effective use of video.
- Make STEM activities fun, creative, and as game-like as possible.
- Consider safety when designing and delivering STEM activities.

Audience Needs

Review of the PBS programs suggests that, during the planning phase, developers of OST STEM resources must gather data—even anecdotal data—about the needs of the target audiences, including both the OST practitioners who will facilitate the activities and the children who will participate in them. Different communities have different priorities, demographic compositions, and available resources. During the needs assessment, developers must learn what audience members know and want to know about STEM. Also important are whether practitioners and children are comfortable engaging in STEM activities and whether programs have access to necessary resources including funding, in-kind donations, staff, volunteers—even storage space. Undertaking a needs assessment early in the development process can ensure that the materials are on target and appropriate for various audiences, including children of different ages and practitioners with varying amounts of experience with leading STEM activities. The needs assessment keeps developers from wasting time and financial resources by having to go back to the drawing board if the resources are not well received (Apley et al., 2010; Fisch, 2006; Goodman, 2005; Paulsen et al., 2011).

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Understanding audience needs can also help OST practitioners as they deliver STEM programs to elementary and middle school children. Practitioners who have identified their children's literacy levels, prior experiences with STEM, and motivation to learn about STEM may save valuable time because they can tailor the program to children's needs *before* delivering the program and discovering too late that the program was not appropriate for their group.

Evaluation Before and After Implementation

STEM resources should be evaluated both before and after implementation. Pilot testing before implementation offers an opportunity to try out STEM resources to ensure that they are usable and accessible (Goodman, 2005; Paulsen et al., 2011). It also enables OST STEM resource developers to ensure that the messages and content are on target and have a good chance of meeting audience needs. Data from an evaluation conducted after the resources are used can drive informed decisions about program impacts and improvements (Apley et al., 2010; Knight-Williams & Williams, 2008). As the needs of elementary and middle school children change over time, the OST resources need to evolve to meet those changing needs.

OST practitioners should also review STEM resources before implementing them to ensure that they understand how to use them and to get clarification if necessary. Practitioners should consider sharing feedback on the OST STEM resources with the developers in order to inform improvements to future materials.

Accessible Supplies

Many OST settings, including low-income households, have limited budgets for purchasing supplies for STEM activities. In addition, OST practitioners typically have little time to hunt for special supplies that are not readily available (Goodman, 2005; Knight-Williams & Williams, 2008). The *FETCH!* camp guide evaluation found that camp counselors preferred that the suggested list of materials have a list of optional items or alternative materials for supplies that were harder to come by, such as pH strips (Paulsen & Carroll, 2011). In another example, *ZOOM* activities require materials that cost only $25 for a group of 20 children (Goodman, 2005). OST practitioners should allow sufficient time to search the Web for the least expensive sources of materials, especially if local sources are scarce.

Minimal Preparation Time

OST practitioners in the programs I reviewed reported they had little preparation time for STEM activities. Many worked only part-time and were not paid for preparation time, so they had little motivation to spend significant time preparing for a single activity. For example, activity leaders did not want to cut toothpicks in half for *Cyberchase* Workshops-in-a-Box (Flagg, 2003a; Goodman, 2005). To ease the burden on OST practitioners, elementary and middle school OST STEM resource developers should ensure that materials for each activity are easy to find and prepare. Pilot testing should provide some idea of the preparation time required for each activity. In one example, the *FETCH!* camp guide evaluation found that a single shopping list, rather than lists of materials with each activity, would have made the process of collecting supplies more efficient for camp counselors (Paulsen & Carroll, 2011).

Ease of Reproduction

Few OST settings have access to large color printers capable of reproducing oversized or colorful materials. STEM resources, such as children's activity sheets, should be provided as simple, two-color documents. For example, the *ZOOM* activities were designed in black and white specifically so that they were easy to photocopy (Goodman, 2005). The *SciGirls* activity guide evaluation found that, though 70 percent of practitioners who used the guides used both digital and hard copies, the remaining 30 percent relied solely on hard copies (Flagg, 2012).

Adaptable Activities

OST STEM resource developers should ensure that activities can be modified or adapted to match the children's skill levels or other factors (Apley et al., 2010; Flagg, 2003a, 2009; Goodman, 2005; Knight-Williams & Williams, 2008; Londhe et al., 2007; Paulsen et al., 2011). OST programs often mix age groups, whether by design or out of necessity because of space and time limitations. STEM resources developed for fifth-graders may be used in a setting that also includes third-graders. Other factors include group sizes and the skill level of activity leaders. For example, one OST program may have a trained engineer leading STEM activities, while another relies on parents or volunteers.

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To ensure that all elementary and middle school programs can benefit, STEM resources should include recommendations for use in different settings and with different sizes of groups. For example, *ZOOM* developed two formats for its hands-on activities: "'Workshop' activities are for small groups [fewer than 20 participants] and last 30–45 minutes each. 'Event' activities are for larger groups and last 15–20 minutes each" (Goodman, 2005, p. 8). Also, because attrition in OST settings is so common, it's important to design activities that don't rely on participation over an extended time.

Resources should also include recommendations for use with children of different ages or skill levels. For instance, OST practitioners may want to separate children into age groups for the purposes of completing STEM activities. Alternatively, they may pair children who are close in age or assign older children to act as mentors to younger children.

Practitioner Support

Whenever possible, OST practitioners leading STEM activities should be trained, whether online or in person, to prepare for activities ahead of time and to help children work in a self-directed manner (Flagg, 2003a, 2009; Knight-Williams & Williams, 2008). At a minimum, they should receive written or electronic information to help them learn about STEM content, national STEM standards, and other information. Evaluations of the *FETCH!* online training and the *Design Squad* educator's guide both found that practitioners were more comfortable leading STEM activities after receiving training (Paulsen & Bransfield, 2009; Vaughan, et al., 2007). In the *SciGirls* outreach evaluation (using investigations from *DragonflyTV*), one participant requested that activity guides be "a little more content-oriented so that if an OST practitioner wanted to use the materials and didn't have the background...you could reference other [content] areas" (Knight-Williams & Williams, 2008, p. 50).

Each of the *ZOOM* facilitator guides gives adult facilitators information about how to model and facilitate inquiry-based science activities, background about science content along with child-friendly explanations, suggested questions to ask children to help guide investigation and draw out science concepts and process, group management tips, connections to related *ZOOM* science activities, and ideas for extending an activity (Goodman, 2005).

Use of Video

The evaluations I reviewed show that combining media with outreach is a powerful way to deliver engaging STEM content in OST settings. Video is best used to introduce science concepts or to model the science inquiry process (Knight-Williams & Williams, 2008; Paulsen et al., 2011). In evaluating the use of *DragonflyTV* video in classrooms, Rockman and colleagues (2003) found that playing complete half-hour episodes was rarely effective. Rather, video was more effective when used to stimulate discussion and inspire engagement in related hands-on activities. When practitioners used video clips to pose a question, allowed students to explore their own answers, and then played the rest of the video, they observed increased engagement and improved understanding of the process of inquiry (Rockman, 2003).

Despite the potential of video to engage children in STEM learning, its use may not be possible in some OST settings (Knight-Williams & Williams, 2008; Paulsen et al., 2011). In addition to technological problems, videos' depiction of resources or environments radically different from those of the OST program may prevent the use of videos (Knight-Williams & Williams, 2008). In the *Cyberchase* Workshops-in-a-Box evaluation, some leaders had trouble playing videotapes, so they couldn't access instructions that were included there (Flagg, 2003a).

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Fun, Creative Activities

In the Workshops-in-a-Box evaluation, children reported that they enjoyed the "academic" activities less than the game-like ones—even though all the activities taught math concepts (Flagg, 2003a). The *Cyberchase* at-home evaluation found that the math activities resonated with children because they were presented as magic tricks rather than as math problems (Flagg, 2003b). An evaluation of the *FETCH!* activity guide in camps found that the appeal of the activities lay in children's perception that they were fun (Paulsen & Goff, 2006). Children in the *Design Squad Nation* evaluation reported that they enjoyed the at-home activities because they required creativity and did not feel like schoolwork (Paulsen et al., 2011). Therefore, rather than positioning STEM activities as math, science, or engineering tasks, OST practitioners should try presenting them as games.

Safety Considerations

The *ZOOM* evaluation recommended that activities *never* "include a heat source or any dangerous tools or substances, encourage items to be thrown in the air, or require large bodies of water" (Goodman, 2005, p. 8). The *FETCH!* camp guide evaluation further suggested that activities should not include dangerous substances like ammonia (Paulsen & Carroll, 2011).

Outreach to and Collaboration with OST Partners

In addition to the content and format of the resources themselves, evaluations of the seven programs suggest that the other key to success is to work closely with OST partners. My review uncovered the following promising practices:

- Focus on the shared mission to encourage OST partners to implement STEM activities.
- Consider local or national partner relationships as a leverage point to reach a wider audience.
- Look for ways to maintain long-term relationships with local OST organizations.
- Clarify expectations at the outset about participants' roles and responsibilities.
- Recognize that OST organizations may see publicity value in using STEM resources designed for a nationally broadcast program.
- Consider providing OST organizations with financial or in-kind support to implement STEM activities.

Shared Mission

In order to encourage OST partners to implement STEM programs, resource developers can clearly align their activities with the OST organizations' missions (Apley, 2006; Robles et al., 2009). In the case of *DragonflyTV*, "recognizing that the two sets of partners [the show producer and an OST museum collaborator] shared a common mission was crucial in building trust and understanding, and in allowing these quickly established and intense partnerships to move ahead" (Apley, 2006, p. 10).

Partnerships and Wider Audiences

One goal of all the programs reviewed was to reach out to the largest possible audiences. STEM resource developers can use established local partnerships as leverage to reach out to a wider community (Apley et al., 2010). For example, by partnering with a local Boys & Girls Club to develop resources, a STEM resource developer may be able to use the relationship to gain credibility and establish contact with other Boys & Girls Clubs and distribute the resources to clubs outside its local sphere. Partnerships with local or national STEM professionals may also be helpful. Some programs found that corporate partners offered volunteers who helped staff the STEM programs or provided mentoring. *ZOOM* reached out to engineers by establishing partnerships with national engineering societies. "National professional organizations are an effective way to begin creating relationships with non-traditional practitioners who might be interested in providing informal educational experiences to children" (Goodman, 2005, p. 10).

Long-Term Relationships

The *ZOOM* evaluation highlights the importance of maintaining long-term relationships with OST partners:

> Sustained partnerships are a key component to ensuring the use of outreach materials. Throughout its history, the *ZOOM* outreach team has maintained relationships with existing outreach partners even while adding new partners of interest....These partnerships were maintained because the *ZOOM* team actively communicated with individual sites to learn about their needs and to refresh their materials each season. (Goodman, 2005, p. 10)

Regular updates of materials also figured in the *FETCH!* Lab evaluation, which recommended refreshing content annually in order to sustain both visitor interest in the *FETCH!* Labs and the relationship between the TV station and its OST partners (Londhe et al., 2007). Other ways to sustain relationships included enlisting STEM professional partners to offer supplementary in-kind or financial support, tutors, or much-needed supplies.

Clear Expectations

Partnerships with OST organizations go more smoothly when resource developers clarify expectations about participants' roles and responsibilities at the outset (Apley et al., 2010). Being proactive about roles at the start of collaboration prevents communication problems later in the partnership. For example, the evaluation of the *DragonflyTV* museum collaboration notes that "partners on both sides of the collaboration often began with little understanding of the other institution's organizational structure or the roles and relationships of different positions within the organizations" (Apley, 2006, p. 16). However, these relationships improved over time with better communication around roles and expectations (Apley et al, 2010).

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Publicity Value

Some OST practitioners may see collaboration with a nationally broadcast program as an "opportunity to boost their reputations within their own professional and local communities" (Apley, 2008, p. 13). One museum representative commented, "When you are a small museum, unless you are the only game in town, there is a lot of competition. I want people to think of us as often as they think of the Museum of Science in Boston. When you engage in projects like this, other museums take notice" (Apley, 2008, p. 14). Some museums looked to *DragonflyTV* as a means of driving viewers to their doors. An OST practitioner noted, "[M]y hope is we get kids who might not otherwise visit a living museum [zoo or aquarium]" (Apley, 2006, p. 11).

Financial or In-Kind Support

Offsetting costs for materials, resources, and staff time can be helpful to OST partners (Apley et al., 2010). In the *DragonflyTV SciGirls* outreach evaluation, one OST practitioner noted, "There were some financial constraints.... We definitely could have used more money for science equipment, supplies, etc." (Knight-Williams & Williams, 2008, p. 19). The *FETCH!* Labs evaluation found that the most significant challenges faced by museum partners related to monetary issues. *FETCH!* Labs faced constant lack of adequate funding. Although this issue did not prevent implementation of the *FETCH!* program, it manifested in other ways, such as shortage of staff and inadequate promotional efforts (Londhe et al., 2007).

Next Steps

This paper describes best practices gleaned from the experience of seven PBS TV programs and their distribution of STEM resources for use in OST settings. The STEM resources I reviewed varied from facilitator guides to online trainings, but one common element was the use of media, specifically TV programs. The evaluations of these programs reveal the power of media and its potential usefulness for teaching children about STEM in OST settings.

However, my review also uncovered gaps in our knowledge about the use of media, particularly videos. Thus, there is an opportunity for future research and evaluation to explore further the use of video in OST settings. Some potential research questions include:

- What are the differences between animated and live-action video with respect to STEM learning outcomes? Does the impact vary by children's age group, gender, or other factors?
- How feasible is the use of video in OST settings? What types of settings—for example, libraries vs. scout troops—are more likely to be able to use video in a meaningful way? What formats are most feasible? For example, are DVDs more or less likely to be used than downloadable videos?
- What is the optimal viewing time before the videos lose their ability to engage children? Does this time vary by children's age or other factors?
- What is the effect of empowering children to create their own STEM-related videos in OST settings? The popularity of websites like YouTube speaks to the ability of video to engage children. Future studies should explore the difference between limiting children to the role of passive observers vs. empowering them to create videos for STEM learning.

Researchers also have the opportunity to explore other whether other media can be used effectively in OST settings to deliver STEM content. They might look at whether technology-based media like websites and smartphone apps add value over more conventional technologies such as activity guides.

My review found that one of the major obstacles to providing STEM programming in OST settings, and the reason that public TV programs have included in-kind or financial support in their outreach efforts, has been lack of resources. Perhaps, with more research evidence to back them up, policymakers and funders will find ways to provide more significant funding for STEM programming in OST settings, supporting practitioners in engaging children in STEM learning, and, ultimately, increasing our chances of nurturing a generation of future STEM professionals.

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References

Apley, A. (2006). DragonflyTV *GPS: Going places in science. Study of collaborations between museums and media.* Portsmouth, NH: RMC Research Corporation.

Apley, A. (2008). DragonflyTV *GPS: Going places in science. Study of collaborations between museums and media (season 6).* Portsmouth, NH: RMC Research Corporation.

Apley, A., Graham, W., & Goldman, E. (2010). *Developing sustainable summer outreach initiatives: Lessons from the* Cyberchase *summer challenge.* Portsmouth, NH: RMC Research Corporation.

Fisch, S. (2006). Cyberchase*, season 5 pilot summative research: How are outreach materials used?* New York, NY: MediaKidz Research and Consulting.

Fisch, S., Lesh, R., & Crespo, S. (2010). *Children's learning from multiple media in informal mathematics education.* In support of National Science Foundation Grant No. DRL 0723829. New York, NY: MediaKidz Research and Consulting.

Flagg, B. N. (2003a). Cyberchase *at home: Formative evaluation of outreach activities for parents and children.* Bellport, NY: Multimedia Research.

Flagg, B. N. (2003b). Cyberchase Workshops-in-a-Box: *Formative evaluation of outreach after-school activities for leaders and youth.* Bellport, NY: Multimedia Research.

Flagg, B. N. (2009, July 24). *Impact of television presentation formats on understanding* DragonflyTV *nano content* (Research report 09-010). Bellport, NY: Multimedia Research.

Flagg, B. N. (2012, September 4). *Formative evaluation of* SciGirls *season one activity guides* (Research report 12-012). Bellport, NY: Multimedia Research.

Goodman, I. (2005, August). *Six years of* ZOOM *science outreach: A summary.* Cambridge, MA: Goodman Research Group.

Knight-Williams, V., & Williams, D. (2008). *Summative evaluation report:* DragonflyTV SciGirls *grantee outreach program.* Sacramento, CA: Knight-Williams Research Communications.

Londhe, R., Kochman, M., & Goodman, I. F. (2007, November). *Summative evaluation of* FETCH! *outreach: Season 2 executive summary.* Cambridge, MA: Goodman Research Group.

Londhe, R., Pylvainen, H., & Goodman, I. F. (2009, August). *Summative evaluation of* FETCH! *year 3 outreach:*

Ruff Guide to Science *executive summary.* Cambridge, MA: Goodman Research Group.

National Research Council (NRC). (2009, January). *Learning science in informal environments: People, places, and pursuits.* Washington, DC: National Academies Press.

Paulsen, C. A., & Bransfield, C. P. (2009). "FETCH!" *online training evaluation report: Executive summary.* In support of NSF Grant Number 0813513. Concord, MA: Veridian inSight.

Paulsen, C. A., & Carroll, S. C. (2011). *Camp* FETCH! *guide: Evaluation report.* In support of National Science Foundation Grant No. 0840307. Concord, MA: Concord Evaluation Group.

Paulsen, C. A., & Goff, D. (2006, August 15). *Evaluation of the* FETCH! *activity guide: Executive summary.* Concord, MA: American Institutes for Research.

Paulsen, C. A., Green, S., & Carroll, S. C. (2011). Design Squad Nation: *Evaluation report.* In support of National Science Foundation Grant No. 0917495. Concord, MA: Concord Evaluation Group.

Robles, D., Helms, J., & Phillips, M. (2009). Dragonfly-TV: *Investigating the nanoworld.* Inverness, CA: Inverness Research.

Rockman, S. (2003, Spring). DragonflyTV *evaluation report, spring 2003.* San Francisco, CA: Rockman et al.

U.S. Department of Commerce. (2012). *The competitiveness and innovative capacity of the United States.* Washington, DC: Author.

U.S. Government Accountability Office (GAO). (2012). *Science, technology, engineering, and mathematics education: Strategic planning needed to better manage overlapping programs across multiple agencies* (GAO-12-108). Washington, DC: Author.

Vaughan, P., Pressman, E., & Goodman, I. F. (2007, October). Design Squad *final evaluation report, executive summary.* Cambridge, MA: Goodman Research Group.

Note

[1] *ZOOM* (NSF 9614743, 9814956, 0003651, 0125641, 0229796, 0337323, 0452485), *FETCH!* with Ruff Ruffman (NSF 0610406, 0714741, 0813513, 0840307), *Design Squad* (NSF 0515526, 0810996, 0917495), *Cyberchase* (NSF 9909404, 0206195, 0307763, 0407065, 0540279, 0638962, 0741683, 0840274, 1010981) and *DragonflyTV/SciGirls* (NSF 9909828, 0125738, 0741749).