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Design Squad:
Final Evaluation Report
Executive Summary

PREPARED BY:
Peggy Vaughan, Ph.D.
Emilee Pressman
Irene F. Goodman, Ed.D.

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EXECUTIVE SUMMARY

Design Squad is a PBS television series developed by WGBH and designed for 9- to 12-year-olds. The overall goal of *Design Squad* is to provide these youth with hands-on experiences and positive images of engineering through a television series that is billed as "part reality competition, all engineering, and major fun." The accompanying *Design Squad* outreach initiative consists of the *Design Squad* Engineering Events and the Educator's Guide and Activities.

Goodman Research Group, Inc. (GRG), a research firm specializing in the evaluation of educational programs, services, and materials, conducted a comprehensive multi-method external evaluation of the first season of the *Design Squad* TV series and outreach initiative. The broad evaluation goals were to: assess the extent to which children's knowledge, interest, and awareness of engineering increased as a result of watching the *Design Squad* series, document the implementation of community events resulting form the November 2006 Engineering Summit, and assess the effectiveness of the Afterschool Educators Guide with leaders and students.

This document presents a summary of methods and key findings from each evaluation component. Recommendations for the project overall are presented at the end. These are presented collectively in order to integrate the findings in a meaningful way and interrelate each component of the *Design Squad* project overall

DESIGN SQUAD TELEVISION SERIES

Methods

GRG recruited eight classrooms with 139 fifth and sixth grade students in California and Massachusetts. Students' average age was nearly 11 years old. Just over half of the students were girls. Two-thirds were White (63%), 17% Hispanic, 15% African American, and 9% Asian.

Students watched four episodes of the *Design Squad* series (*The Need for Speed, Rock On, Skunk'd* and *Got Game*) and completed a pre survey one week before viewing and a post survey about one week after viewing all four episodes, as well as a post-viewing content survey after each episode.

Also at pre and post, students were divided into pairs, given hands-on materials, and asked to work together to complete a "thinking task." The thinking task involved students thinking aloud as they worked on one of two separate challenges. The challenges were adapted from the WGBH *Building Big* and *Design Squad* Event Guide activities. Challenge one, Paper Bridge, had the students build a paper bridge that was strong enough to hold 100 pennies. Challenge two, Pop Fly, had students make a device to launch a paper ball twenty feet. GRG researchers instructed the students, "*While you are thinking about what you will do, you can draw on this paper and work with the materials. We will ask you to talk about your ideas out loud, as we are interested in knowing what kids are thinking."* The GRG researcher observed

and recorded how students completed the steps of the task, as well as which design process steps students talked about as they worked with the materials.

Key Findings

Students showed increased understanding of the steps of the Engineering Design Process (EDP) after watching four *Design Squad* Episodes.

At pre and post, students were asked to think about the steps they would take in designing and building a birdhouse. The number of statements that reflected the Engineering Design Process that they correctly selected increased significantly from pre (average 7.75 EDP steps) to post (average of 8.27 EDP steps). Also at pre and post, students were asked to write *the best way to go about designing and building something*, in order to see if they included any design process steps in their open-ended response. The number of students who included *thinking of solutions/brainstorming* and *redesign* increased significantly. Finally, after watching *Design Squad*, a significantly higher number of students mentioned those same two steps during the hands-on thinking tasks; they discussed *brainstorming* and *redesign* while building a paper bridge or making a device to launch a ball.

Students' attitudes about engineering and about engineering stereotypes improved significantly after viewing four *Design Squad* episodes.

After watching four *Design Squad* episodes, students were significantly more likely to agree with three statements about the type of work engineers do and their approaches to the work. In addition, students' negative stereotypes about engineering and gender roles decreased significantly from pre to post.

After viewing four *Design Squad* episodes, students had a greater interest in participating in an engineering afterschool program.

Before and after watching *Design Squad*, students rated their interest in participating in various afterschool programs. At post, nearly two-thirds were interested in participating in an engineering program, compared to just below one third at pre.

Across all four episodes, the majority of students demonstrated good recall and understanding of the series content.

After watching each episode, students were asked to write two things they learned. The majority were able to describe accurately specific engineering-related content or concepts, such as the relationship between weight and speed, the relationship between sound waves and length of materials, how the ear drum and air molecules allow one to hear sound, the need to remove paint from the area before welding, how to design a bike, wireless transmission, servos, and how pulleys and track systems work.

A vast majority of students learned pro-social messages about teamwork and how teams solve problems from watching *Design Squad*.

Almost nine out of ten responses to *"Write two things that you learned from* Design Squad *about working together on teams"* addressed positive skills such as *communication*, *listening*

to others, *cooperation*, *patience*, and *the need to get along.* When students wrote "*two things that they learned about how teams solved problems,"* nearly 80% of responses focused on the engineering design process and associated decision-making strategies, such as consulting an expert or voting on an idea.

The *Design Squad* series was highly appealing to and positively rated by the vast majority of students in the target audience of 9- to 12 -year-olds.

Students rated *Design Squad very* positively; 81% reported that they *liked the whole show a lot* or *completely loved it.* Other highly rated areas were the challenges and the teams. Ninety percent indicated an interest in watching *Design Squad* again and 92% would tell a friend to watch. Open-ended comments were also quite positive; matching closely the producers' description of the series, students liked the show's design, competition, teamwork, the fun, and entertainment.

Students favored the Engineering Design Process components of the show.

When asked what they liked best about the show, a third of children noted liking an aspect of the engineering design process best. Sample engineering design-related responses included testing, watching them build the project, the designing, and how teams worked together.

DESIGN SQUAD AFTERSCHOOL EDUCATOR'S GUIDE

Methods

Nine afterschool sites (representing the Pacific Northwest, Midwest, Southeast, and Northeast) participated in the evaluation. To qualify for participation, leaders agreed to complete three units of activities with their students over eight weeks, fill out surveys prior to beginning the *Design Squad* activities and after completing three units, and administer pre and post surveys to their students. Eleven leaders completed both the pre and post surveys; 142 students completed the pre survey and 59 completed the post survey.

The average age of students at pre was 10.26 years (range = 7-15 years old); 54% were boys. Just over half (59%) were White, 30% African American, 10% Hispanic, and 5% American Indian/Alaskan Native.

Key Findings

Program leaders' comfort level talking with their students about engineering increased significantly after using the Educator's Guide and its activities.

Before and after using the Educator's Guide, afterschool leaders rated how comfortable they were talking with their students about engineering and about the content associated with the *Design Squad* activities. On the post survey, leaders reported statistically significant increases in their comfort level with general science and engineering and in the content areas of electrical circuits, and kinetic energy.

After completing the Design Squad Educator's Guide activities, afterschool leaders showed a much greater depth of understanding of the Engineering Design Process.

In the Afterschool leaders' open-ended definitions of the Engineering Design Process, collected at both pre and post, leaders showed greater understanding of the steps involved in their post survey responses. Many included testing and redesign and one leader's post definition referenced their use of the Educator's Guide and the idea of enjoyment of the Engineering Design Process steps - "*Reading the challenge/activity, thinking about how to create the invention, drawing, creating, testing, fixing and testing again until satisfied or happy with results."*

Afterschool students significantly increased their understanding of the Engineering Design Process.

Students demonstrated an increased understanding of the Engineering Design Process when answering questions that required open-ended descriptions and also accurately selecting from a list of 14 items steps that are part of the design process. From pre to post, there were statistically significant increases in the number of Engineering Design Process steps correctly explained by afterschool students in their descriptions of the steps they would take to design and create something. The three most common steps mentioned were *brainstorming, designing,* and *building*. After reviewing a list of steps that may or may not be part of the Engineering Design Process, there was a significant increase in the number of steps that were correctly identified.

After completing the Design Squad Educator's Guide activities, a large majority of students demonstrated a strong understanding of engineering and science concepts.

Students' strong understanding extended to science and engineering concepts that were part of the Educator's Guide content and activities. Students responded to questions about three of the guide's four Units: *It's Electric,* and *Cars, Cars, Cars*, and either *Blowin' in the Wind or Kick Start*. A majority of students answered correctly each multiple choice question about electrical circuits, switches, and conductors after conducting the Unit activities. In response to short-answer questions created for each unit, a large majority of students provided clear and accurate explanations.

Afterschool leaders relied on the Educator's Guide for the activities, found the guide useful, and will use the guide again in the future.

The Educator's Guide was a helpful resource for the leaders; the majority reported reading and referring to the guide and drawings as needed during the activities. All leaders rated the leader tips, discussion questions, challenge sheets, and the guide overall as quite useful. All afterschool leaders indicated that they are likely to use the guide again, and the vast majority of leaders are very or extremely likely to recommend the guide to others.

The guide's engineering activities were highly rated by the afterschool students.

The *Design Squad* Educator's Guide included a set of hands-on activities designed for "bringing engineering to life for kids aged 9-12." The afterschool students rated these hands-on activities very positively overall. The most popular activities were *Dance Off, Customized*

Car and Motorized Car, and *Kicking Machine*. Students liked these activities for reasons such as *It was a fun challenge, I got to make something cool, Creating it was fun* and *you were more hands on*. Leaders' reports confirmed these high student ratings; most said their students *liked a lot* or *completely loved* the Educator's Guide activities.

DESIGN SQUAD ENGINEERING SUMMIT

Methods

Ninety-three people attended the Washington, D.C. *Design Squad* Engineering Summit in November 2006. Of those, more than half completed a survey at the end of the summit. Fifty attendees reported their plans to share materials and target outreach to schools, engineers, community partners, and others. All attendees were sent a follow-up survey developed by GRG and WGBH in February 2007 about their plans and actions to date; 25 attendees filled out this detailed survey. Later in the spring of 2007, 13 of the 25 also filled out an online Activity Log, reporting on the outreach events they had planned and conducted. Six respondents participated in phone interviews to provide more in-depth information detailing their extensive outreach work.

Key Findings

Engineers who attended the *Design Squad* Engineering Summit and completed surveys about their activities reported highly successful and extensive *Design Squad* volunteer outreach activities, including educator trainings, visits with kids, and community events.

Engineers who described their post-summit outreach activities coordinated large and small-scale events, activities, and trainings at schools, colleges, museums, festivals, fairs, and special events, with attendance ranging from 50 to over 500. One team provided engineering activities to 1,800 students at six schools.

Engineers who used the Educator's Guide and Event Guide for outreach plan to continue using the guides in future outreach activities.

Engineers indicated that they planned to continue using *Design Squad* in their corporate and community outreach and trainings. A few of the planned activities described included summer educator trainings with middle school teachers and ongoing STEM trainings at a local university. Many viewed the *Design Squad* guides as the "best support they could get," and plan to continue to hand out the guides to community partners and volunteers throughout the year.

RECOMMENDATIONS

WGBH has appropriately targeted an important age range by gearing *Design Squad* to middle school students. Findings from this evaluation showed positive outcomes for both boys and girls. This is critical given that girls in this age range are at risk for moving away from science and dropping out of the STEM pipeline. Based on the evaluation findings, GRG makes the following recommendations to the *Design Squad* team.

SERIES

Continue the series in its current format and provide additional opportunities to include the target audience of 9 - to 12 -year-olds' ideas in upcoming seasons.
Students rated the show highly. Given student interest in all aspects of the show, seeking input on new challenges and program ideas from middle school students will be a positive means to continually engage the target audience.

Continue to emphasize the Engineering Design Process components of show and the connection to teamwork.
Students highly favored and responded well to the examples and practice of the Engineering Design Process viewed on the series, particularly the testing, building and designing the *Design Squad* teams carried out.

Continue to provide ongoing outreach to afterschool educators and students in order to enhance the visibility of the Design Squad series to the targeted age group.
Establishing and emphasizing the link between watching the show and doing the activities would potentially benefit both students and leaders in afterschools. Given the strong appeal, the *Design Squad* series can serve as an ongoing link for promoting interest in engineering activities in afterschools.

AFTERSCHOOL

Consider providing* Design Squad *Program DVD's for the afterschool leaders and students in any further dissemination of the Educator's Guide.
Given the varying levels of staff background and leader experience, access to the *Design Squad* DVD's may enhance the value of the Educator's Guide to some afterschool programs. Leaders commented that their afterschool students may learn even more from the activities if they had the opportunity to watch some episodes before or during the process.

Consider adding resources to the already highly rated Educator's Guide, such as reproducible handouts and a glossary of terms, in order to enhance leaders' implementation.
A few program leaders discussed the importance of preparation and wanted easy-to-replicate (i.e., black and white) handouts to use as they prepare and work with their staff members. One leader suggested that even more drawings and a user-friendly glossary of engineering terms would help clarify questions and further increase leader understanding. Another leader suggested a section with student handouts.

ENGINEERING SUMMIT

Plan ahead for ways to track and stay connected with Engineering Summit attendees who continue to do outreach and trainings, in order to be aware of their work and to continue to meet their needs for outreach activities.
Respondents appreciated the value of support received from WGBH and the usefulness of having such well-designed guides. By keeping in touch with summit attendees, WGBH can tailor new resources and training offerings accordingly. For example, a few engineers noted

they would like to be able to leave something with the educators and children they visit in schools. The goal would be to enhance the link between the *Design Squad* activity and engineering by giving something to the students with the *Design Squad* logo. Suggestions included a two-to three-page page comic book style handout, a bookmark, or ruler.

Continue providing access to Design Squad resources via the Web site for those outreach partners who have come to rely on the Web for engineering activities.
Useful materials and engineering ideas to have at events and trainings would be helpful. For example, downloadable *Design Squad* bookmarks or stickers that can be printed and put on challenge materials like ping-pong balls, flags, or banners were suggested as potentially useful to distribute at outreach events.