Veridian inSight, LLC and
American Institutes for Research

Design Squad, Season 2 Final Evaluation Report

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About this Document

The formative evaluation of Season 2 of *Design Squad* was performed in two parts. Part 1 included a field test conducted by American Institutes for Research in spring 2008. Part 2, conducted by Veridian inSight, included follow-up interviews with teachers whose classrooms participated in the field test. The teacher interviews were conducted in fall of 2008.

This document is the *Design Squad*, Season 2 final evaluation report. It contains the following sections:

Section 1: Highlights from the teacher interviews conducted in fall of 2008 by Veridian inSight.
Section 2: Findings from the field test portion of the study conducted in spring 2008 by American Institutes for Research.

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Section 1: Teacher Interview Highlights

Teacher Interviews

Background

We conducted follow-up teacher interviews in fall of 2008. Each of the nine teachers who participated in the field test were interview by telephone to gain a better, more in-depth understanding of their experiences using the Design Squad Activity Guide in their classrooms.

Findings

Due to the qualitative, subjective nature of interview data, we will not report statistical summaries in this section. Rather, we list eight distinct themes that emerged from the interview data. Following each of the themes are lists of supporting comments and examples provided by the teachers.

1. **There were as many different approaches to using the Design Squad Activity Guide and related materials as there were teachers in the field test.**

    - Approach 1
        i. Did not show whole video to class.
        ii. Showed some of the DVD before the activity started.
        iii. Did not use web links.
        iv. One activity took two 70 minute periods.
    - Approach 2
        i. Used the full DVD as an "activator." They showed it to the kids during a class meeting before the activity started to introduce them to the design process. Then, they spent time discussing what they would be doing.
        ii. Used a team teaching approach (3 teachers). Teachers tried the activity as a group first. There was an English component, a science component, and a math component. Aligned to the units already taught.
        iii. Kids were paired up into teams of two.
        iv. Took 45 minutes for intro, plus 2 hours for 1 activity, then during the rest of the week, different teachers covered different aspects of the process. Science teacher had them draw a design, English teacher had them do a writing project on their experiences.
        v. Did not use web links due to time constraints.
    - Approach 3
        i. Showed full DVD.

ii. Took as much time as she wanted because they did this after state testing (more than a week for 2 activities).
iii. Supplemented with additional material on how engineers think (she has a lot of additional materials on engineering and earth science).

- Approach 4
  i. Showed DVD, but stopped it and discussed it as they went along, in the first class. In the next class, did the activity.
  ii. Gave the kids the hand-outs without any additional guidance.
  iii. Took a little less than 2 class periods per activity.
  iv. Kids were far below grade level, so she adapted the materials for her kids.
- Approach 5
  i. Did not use the DVDs.
  ii. Took one period in most sections, but in some it took two periods.
  iii. Did not try to link it to the curriculum (life sciences). Used it as an extra activity.
- Approach 6
  i. Kids watched the DVDs at beginning.
  ii. Kids were in teams of 2-3 kids.
  iii. Kids read the lesson, had a time limit to make the boats, on second day floated the rest of them. Took two full periods. Second activity took two periods, as well. Asked them to do the task with minimal direction.
- Approach 7
  i. Watched video, then materials, then did the activity. Took two class periods per activity.
  ii. Chose the activities based on weaknesses in the existing curriculum—picked the ones that would fill the gaps the best. Needed something for mechanical engineering.
  iii. This year, he has integrated the DS activities with other materials, PowerPoint slides, etc. that he uses in his classroom for bioengineering and engineering design process. More discussion of the steps. Used the video at the end (not by design, but because of a student with disabilities) and it worked nicely as a review tool. Took about a month. All 200 kids in the middle school in town are doing it.
- Approach 8
  i. Before using it, talked about the design process.
  ii. Used the DVDs as an anticipatory set to get them interested in the process. Didn't show the whole episode. Just the intro and the building parts.

iii. Let the kids try the activities without any guidance.
iv. Took about 2-3 days per activity.
v. Using it now, too.

- Approach 9
  i. Modified them to meet the needs of the lower-achieving students.
  ii. DVDs shown after they were done. Used it as review.

2. Teachers choose the activities that had the easiest materials to collect and were seen as most engaging to the students or filled gaps in their own curricula.

- "Design Squad was the full package. This *filled our need* for some activities related to mechanical engineering. This program brought cohesiveness to my unit on mechanical engineering."

3. Teachers reported that the students responded very positively to the activities, that they were engaged and enthusiastic.

- Teachers reported:
  - Went smoothly with all kids, 6th through 8th grades.
  - Materials were not hard to find or collect.
  - Handouts were nice and simple.
  - Materials were clear and DVDs were engaging.
  - The students were excited. They really liked it and were engaged. They were focused and took the activities seriously. Saw only positive changes.
  - One teacher reported that only a few kids were frustrated because you never get 100%.
  - Most relevant portions of the videos were the kids building the object and the animations.
  - Kids liked the "building" part of the DVDs, but were not interested in the animations.
  - A new teacher found Leader Notes to be useful, especially guidance on how to help if kids encounter specific problems.
  - One teacher didn't see any profound changes in the kids because they are already very bright and interested.

- Interesting teacher quotes:
  - "One team was…so excited that they had been able to stack five books on top of the table they built--and they were still going!"
  - "(The animations) were really effective because they really got to the point of how you would use (the materials) to make a strong structure. They were more useful than anything else (on the DVDs)."

- "The kids in my class who are at the foundation level (kids who normally struggle) excelled. They are tinkerers. Their skill is in their hands. You give them those types of things and give them some guidance and they quickly fall into line and love this stuff."

- "This is a great program because the kids (in my classrooms) are far more receptive to learning things if they can actually do it, try it, and play with it. Today's children respond to these types of activities much better than the old way of teaching things."

- "I'm going to take the DVD on the kayak to the high school engineering club and have them try to make the shrink-wrapped boat. That was so cool. The plan is that in a couple of years, the high school kids will mentor the middle school kids."

- "Kids are now telling me that they are watching Design Squad on TV."

4. Teachers encountered very few problems with the activities in their classrooms.

- In 3/9 classrooms, classroom management was an issue and/or the kids were already in "summer mode" and were not engaged in the survey (which probably explains the results we observed last spring in the student survey).
- Two classrooms ran out of time at the end of the year before they could do more than one activity.
- Some teachers reported that the DVDs were too long and contained material that was irrelevant (all the interaction and discussion between the kids when they weren't engaging in the design process), and they felt compelled to sift through the DVDs to find the most relevant parts.
- The "Take it to the Next Level" activities were too hard for one of the two classrooms that tried them. In one school, none of the groups were successful at these activities.
- A couple teachers who were new to teaching or teach classes with low-performing students struggled to help the kids at the "lower end of the spectrum."
- Feeding the episodes from the Web to the Smartboard has been a challenge this fall for one teacher. She reported that the videos don't always work and that frustrated the kids.

5. **Teachers from diverse subjects were able to use the materials to make linkages to their subjects and integrate the materials with their own curricula. This included science, earth science, technology, math, life science, and even English.**

    - In one school, three teachers used the materials to teach in a team approach (math, science, and English).
    - Two life science teachers were least able to make strong connections between Design Squad and their curricula, but one life science teacher used the Helping Hand as an illustration of engineering of medical devices (which the class had covered earlier).

6. **Teachers had only a few suggestions for improving the Activity Guide, including cutting out some material from the DVDs, adding closed captioning to the DVDs, stressing the real-world implications of the activities, and helping teachers to see the linkages between engineering and subjects like life sciences.**

    - "It would be more useful to cut back the DVD so it only includes the design process and the animations so it could be used for an introduction at the start of class (like PBS does with the Evolution video which only includes highlights from the longer program)."
    - "There was a lot of talking going on in the DVD, seemed distracting, the DVDs were all over the place. There was so much conversation. They were trying to get you into the competitive spirit of it, it was distracting."
    - "…would be useful to stress the real-world applications of the activities."
    - "Would be great if the guide could help teachers make better linkages with life sciences: for example, a delivery system for reducing the size of brain tumors—combining engineering and life sciences."
    - "Add subtitles or closed captioning for students with auditory impairments."

7. **Teachers suggested that the best way to encourage teachers to use Design Squad would be a personal approach: enlisting teachers who have used the activities to speak with other teachers and to demonstrate the activities. This outreach could take many forms:**

    - Where:
        - At a conference, WGBH could have teachers and students doing the activities and demonstrate how well it works.
        - At staff meeting presentations in large school districts. Get on their agenda.
        - Send a short video of teacher and student testimonials that teachers can watch and share with each other.
        - Send a short video of actual teachers using the activities in a classroom. "A lot of teachers who are new to teaching do not have a

lot of experience with organized chaos. So a video lesson that shows a five minute snippet would be great so they can see how to do hands-on learning."

- Create a loose organization in various regions or tap into the existing ones. "It has to be personal—one person to another. I have more resources presented to me than I ever would have realized." There needs to be some semi-formal or informal network of teachers who want to use technology in their classroom.

- Who:
  - Have kids talk about how much fun it is at a conference or include testimonials from students in the DVDs or written materials.
  - Have teachers do presentations at conferences or meetings and offer testimonials. "I'm going to be much more receptive listening to teachers talk about their experience with this than someone from Design Squad."
  - Match the background of the teachers with the schools (i.e., urban school teachers with other urban schools). "Teachers roll their eyes when the academic levels of our students don't match with teachers from wealthy school districts who come in and talk to us about some great new activity. I think, well all your kids are at grade level and all your teachers have been teaching forever. You don't have the same challenges we do."
  - "Contact the department heads because we have department meetings regularly. We've had external people come in and meet with us to describe different program. It would be great if the person who comes to the meeting can demonstrate how to actually do the activities in the meeting so we can see how easy it is to do."
- Things to consider:
  - Teachers are more likely to attend local professional development meetings than national meetings.
  - A lot of teachers are concerned with "pacing" so it might be helpful to include some guidance from other teachers who have used the materials with a diverse classroom of learners so they can determine how to best meet the needs of learners who are moving at different paces. "Teachers need to see how it's going to actually make student achievement better."
  - "Teachers always need professional development points (PDPs). So, if they could offer seminars that offer PDPs and make them free or low cost, they (WGBH) are going to get the teachers to attend. This would be enticing to a lot of schools."

8. Teachers offered additional ideas for reaching out to teachers and encouraging them to use Design Squad or to try engineering activities in their own classrooms.

- Advertise in the NSTA journal (They have a list a freebies, new materials and curricula).
- Send a single flyer with the activity there (e.g., TOPS ads), including the visuals, and a web link for more information and links to the videos.
- It is not necessary to send a DVD, but make it easy to request a DVD. Teachers indicated they would be willing to pay a nominal cost for one.
- Tie the activities into the standards in each state and emphasize this in the marketing materials.
- Include information on how to integrate this into other content areas such as English language arts, social studies (e.g., What did the ancients do when they needed to carry stuff?), and mathematics.
- Revise the DVDs so they include an interesting story line (e.g., Jasper Woodbury series) that will engage the kids, rather than a competition between teams.
- Some states have key science leaders, those are strong people, and good individuals to reach out to.
- State conventions are a great place to promote materials. Especially free materials, like DVDs and a one-pager.
- Organize the materials in a binder by difficulty, content covered, standards, time requirements, materials required.
- Work with associations and groups such as the New England League of Middle Schools to get the word out.

Section 2: Field Test Findings

AMERICAN INSTITUTES FOR RESEARCH®

DESIGN SQUAD, SEASON 2

FIELD TEST FINDINGS

JANUARY 16, 2009

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Introduction

This document is an addendum to the *Design Squad,* Season 2 Final Evaluation Report. This document contains detailed summaries of the data analyzed for the field test portion of the study only. This document does not contain a summary of the teacher interview portion of the study.

Season 2 of *Design Squad* was evaluated in two parts. Part 1 included a field test in spring 2008. Part 2 included follow-up interviews with teachers whose classrooms participated in the field test. The teacher interviews were conducted in fall of 2008.

The specific goals of the field test were to measure changes over time in students':

- Knowledge of the engineering design process, and
- Attitudes towards and about engineering.

In addition, data on student and teacher knowledge of, and satisfaction with, the Activity Guide content were collected.

Schools were asked to use and evaluate up to two out of four possible activities in the Guide. The four distinct activities that schools were able to choose from included:

Table 1:
Activities

Challenges	Summary
"Watercraft"	Build a boat that holds 25 pennies for at least 10 seconds before sinking.
"Paper Table"	Use tubes of newspaper to make a table strong enough to hold a book.
"Zip Line"	Design and build something to carry a ping-pong ball from the top of a zip line to the bottom in 4 seconds.
"Helping Hand"	Build a device that lets you grab objects and drop them into a container 2 feet away.

Because the study took place at the end of the academic school year, schools were asked to complete at least one activity, and up to two activities, if time allowed. All but two of the classrooms did try-out two activities (see Table 2).

Before using the materials, educators were instructed to gather parental permission forms for all students who would participate in the study. Students without permission slips were allowed to stay in the classroom, but they did not respond to the student surveys.

The first research activity was the administration of the student and teacher pre-tests. After completing the pre-tests, teachers implemented the activities in their classrooms over a period of 1-2 weeks. Teachers were allowed to use the materials in any manner they deemed most useful. WGBH also provided teachers with DVDs that contained the television programs that accompanied each of the activities they were assigned. The television shows also included 2-3 brief animations (graphical,

animated depictions of science concepts) each. WGBH was interested in studying whether the animations enhance the episodes. Schools were provided with no specific guidance on how to use the DVDs and animations. Teachers were allowed to decide how to best incorporate them in their classrooms.

After completing the activities, the teachers administered the student and teacher post-tests.

Sample Characteristics

Twelve classrooms at 11 different schools were recruited for the study. However, after reviewing the materials, several teachers reported that they did not have sufficient time to fully complete the study. Thus, the final study sample included the following educational settings:

Table 2:
School Sample Characteristics

Location	Urbanicity	Number of Classrooms and Teachers	Number of Students	Activities
CA	Suburban	1	15	Zip Line & Helping Hand
MA	Rural	1*	19*	Kayak & Helping Hand
MA	Urban	1	39	Paper Table
MA	Urban	1	23	Watercraft & Paper Table
MA	Suburban	1	39	Watercraft & Helping Hand
NH	Urban	2	142**	Teacher 1 = Paper Table & Zip Line Teacher 2 = Zip Line & Helping Hand
NJ	Suburban	1	27	Paper Table & Zip Line
VA	Urban	1	20	Paper Table
TOTAL	**--**	**9**	**324**	**--**

*Student and teacher data were not submitted for this classroom at the end of the field test. This teacher did participate in the follow-up teacher interview study.
**Across multiple sections of the same course.

Schools received a $100 incentive for their participation.

Table 3:
Demographic Characteristics of the Student Sample*

Characteristic	Total (n=305) Frequency (%)
Gender	
Female	151 (50%)
Male	154 (50%)
Hispanic or Latino	
Yes, Hispanic or Latino	51 (17%)
No, not Hispanic or Latino	254 (83%)
Race / ethnicity	
White	225 (74%)
Black or African-American	27 (9%)
Asian	25 (8%)
American Indian or Alaskan Native	10 (3%)
Other (Identified as Hispanic, but no race or ethnicity identified)	35 (12%)

*Does not include data for one classroom from rural MA.

The student sample was balanced evenly between males and females. The sample was also fairly representative of nationwide race and ethnic distributions. Students in the sample ranged in age from 11 to 15, and the average age was 12 years old.

Teachers indicated the following special needs in their classrooms that participated in the *Design Squad* activities:

- Autism (2)
- ADD / ADHD (2)
- General learning disabled (2)
- Vision Hearing impaired (1)

Teachers reported a wide range in the numbers of years they have been teaching: from four years to 48 years: 3 teachers had taught from 4-6 years, one teacher had taught for 12 years, another for 31 years and another for 48 years.

Two teachers indicated that they held a Bachelor's Degree in the following:

- BS Chemistry and Environmental Science
- BA in liberal arts

Six teachers indicated that they held a Master's Degree in the following:

- Education (3)

- Education Specialist
- Computer science
- Communication
- Chemical engineering

All of the teachers in our sample reported having Internet connections in their classrooms, use media-based resources, and watch TV programs streamed from the Web to their classrooms. Teachers used a variety of media-based resources, including:

- Streaming videos (e.g, Youtube.com videos, Videos downloaded from PBS, other) (4)
- DVDs (2)
- Computer (e.g., general web use) (2)
- Local newspaper (1)
- Smart board (1)

All of the teachers in our sample reported that they had at least heard of the engineering design process, but 2 out of 8 were not sure they knew what it was before participating in the study. One teacher reported:

> *"I've done smaller design challenges and relate it to the scientific method of 'making a plan and testing it out'. I also try to integrate it into specific content (i.e., we built boats out of foil to hold marbles when studying buoyancy)."*

Another commented:

> *"It is a logical step by step process to identify needs, define problems develop and implement solutions."*

We asked teachers to indicate how often they typically lead activities that involve the engineering design process. One teacher was unsure, three said "3 to 5 times per year," one said "6 to 10 times per year," three said "More than 10 times per year."

Detailed Findings: Field Test

Student Knowledge

We asked students a series of questions in the pre-test and post-test surveys to assess their knowledge of the field of engineering as well as their knowledge of the engineering process. We computed a pre-test and a post-test score for each student based on their responses to a set of 11 questions designed to assess their knowledge and understanding of science concepts and the design process. Students were able to earn a total of 32 possible points.

We compared student scores on the pre-test to their scores on the post-test. The average pre-test score was 22. The average post-test score was 24. While this appears to be a slight increase, the difference was statistically significant ($t_{(203)} = -4.487$, $p = 0.000$).[1] Thus, the study found that students learned about science, engineering and the engineering process after using the *Design Squad* activities.

Student Attitudes

Please note that the findings summarized in this section on Student Attitudes should be interpreted with caution, based on the input received from teachers after the Field Test. In follow-up interviews with teachers, most reported that

- Their students already held positive attitudes towards engineering and had little room to improve or
- That by the time they asked students to answer the attitude questions, students had already "checked out for the summer" or
- The students found the survey too long and had difficulty staying focused.

Some teachers also reported experienced classroom management problems that prevented the students "from taking the survey seriously."

We asked students to respond to a series of questions that measured their attitudes towards engineering, before and after participating in the *Design Squad* activities. The results from each question are included below.

[1] We controlled for the effects of time and clustered children at the program level to account for intraclass correlations (correlations within each program).

Table 4:
Percent of Students Who Agreed with Each Statement at Pre-Test and Post-Test (n=305)

	Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree
Engineering is boring.					
Pre-Test	16%	44%	32%	5%	4%
Post-Test	12%	23%	53%	6%	6%
Engineers help make people's lives better.					
Pre-Test	3%	2%	16%	45%	34%
Post-Test	2%	3%	14%	57%	23%
Men are better than women at engineering.					
Pre-Test	50%	34%	10%	2%	3%
Post-Test	41%	46%	9%	3%	2%
Only geniuses can succeed in engineering.					
Pre-Test	35%	47%	14%	2%	3%
Post-Test	27%	52%	16%	4%	1%
Most people my age think engineering is cool.					
Pre-Test	13%	42%	36%	7%	2%
Post-Test	12%	22%	56%	6%	4%
It would be fun to be an engineer.					
Pre-Test	8%	17%	50%	16%	10%
Post-Test	9%	16%	55%	13%	8%
Engineering is too hard for most people.					
Pre-Test	7%	32%	50%	8%	3%
Post-Test	6%	26%	57%	8%	4%
Most people my age know what engineering is.					
Pre-Test	2%	12%	43%	29%	15%
Post-Test	4%	8%	23%	53%	12%
Engineers solve interesting problems.					
Pre-Test	1%	4%	24%	46%	24%
Post-Test	3%	3%	19%	57%	19%

To further analyze these data, we compared the average attitude scores at pre-test and post-test (after reversing the direction of some items that were negatively worded). The average attitude score at pre-test was 3.56. The average attitude score at post-test was 3.54. We found no statistically significant differences between student attitudes on the items in Table 4 before they did the *Design Squad* activities and after they did the activities ($t_{(181)} = 0.614$, $p = 0.540$).

We asked students to indicate how they would feel if they were asked to work with a team to design or build something like a small rocket or a sculpture that moves in the wind.

Table 5:
Percentage of Students Who Indicated Various Feelings about Participating in Engineering Activity

Feelings	Pre-Test[2]	Post-Test
a. Interested	69%	55%
b. Shy	14%	15%
c. Excited	49%	44%
d. Embarrassed	3%	6%
e. Challenged	58%	51%
f. Bored	11%	16%
g. Motivated	38%	34%
h. Discouraged	3%	5%
i. Scared	9%	4%

We asked students to indicate their level of interest in participating in different type of activities during the rest of the school year or over the summer. Table 6 summarizes the findings.

Table 6:
Percentage of Students Interested in Activities (n = 305)

Participating in …..	Not at all interested	A little interested	Somewhat interested	Very interested	Extremely interested
A science program					
Pre-Test	28%	37%	22%	8%	5%
Post-Test	27%	47%	17%	6%	4%
An engineering program					
Pre-Test	20%	23%	36%	14%	7%
Post-Test	22%	44%	18%	11%	5%
A program where I could design and build projects, like making a go-cart or making an instrument I could play in a band					
Pre-Test	10%	15%	32%	19%	24%
Post-Test	11%	12%	46%	17%	14%

We also asked students to tell us how much they liked engineering—before and after *Design Squad*. Students reported the following:

- I love engineering (6% at pre-test; 8% at post-test)
- I like engineering a lot, but I don't love it (30% pre-test; 33% post-test)
- I only like engineering a little bit (54% pre-test; 44% post-test)
- I do not like engineering at all (7% pre-test; 15% post-test)
- I don't know what engineering is (2% pre-test; 1% post-test)

We asked students to indicate whether any of the following items may be part of working in an engineering job. Student responses are summarized below:

[2] Percentages do not add up to 100% because students could pick more than one response.

- Having a problem you are trying to solve (71% at pre-test; 83% at post-test)
- Trying out different ideas (66% pre-test; 82% post-test)
- Getting only one right answer (7% pre-test; 7% post-test)
- Making predictions (guesses) about what will happen (52% pre-test; 72% post-test)
- Testing to see what happens (64% pre-test; 79% post-test)
- Knowing for sure what is going to happen before you test an idea (9% pre-test; 14% post-test)
- Learning from mistakes (64% pre-test; 80% post-test)
- Working only by yourself (1% pre-test; 10% post-test)
- Changing your ideas (56% pre-test; 74% post-test)
- Talking to people about your ideas (68% pre-test; 80% post-test)
- Being bored (7% pre-test; 9% post-test)

At pre-test and at post-test, we asked students to tell us what profession they wanted to pursue as an adult (see Table 7). The most popular responses at pre-test and at post-test were:

- Sports-related jobs (13% of pre-test responses and 10% of post-test responses)
- Scientist (11% pre-test; 6% post-test)
- Health professional (10% pre-test; 9% post-test)
- Engineer (8% pre-test; 4% post-test)

Table 7:
Question: What's one job you would like to do when you are older?

Profession	Pre-Test (n = 354)[3]	Post-Test (n = 305)
Sports Related	47 (13%)	31 (10%)
Scientist (e.g., vet / Zookeeper / Marine Biologist)	38 (11%)	19 (6%)
Health Professional (e.g., doctor, surgeon, nurse, psychiatrist)	37 (10%)	28 (9%)
Engineer (specifically mentioned)	27 (8%)	13 (4%)
Performance (Actor, Actress, Director)	20 (6%)	12 (4%)
Lawyer	20 (6%)	12 (4%)
Artistic Design (Artist, Graphic, Fashion, & Interior Design)	19 (5%)	13 (4%)
Teacher or Professor	18 (5%)	7 (2%)
Business / Entrepreneur	11 (3%)	8 (3%)
Architect	10 (3%)	9 (3%)
Chef / Cook / Baker	9 (3%)	5 (2%)
Law Enforcement	8 (2%)	5 (2%)
Hair Dresser	6 (2%)	3 (1%)

[3] The number of responses is greater than the sample size of 305 because some students provided more than one answer in the pre-test.

Profession	Pre-Test (n = 354)[3]	Post-Test (n = 305)
Author	5 (1%)	2 (1%)
Computer / Game Programmer	5 (1%)	5 (2%)
Model	4 (1%)	1 (<1%)
Mechanic / Plumber	4 (1%)	1 (<1%)
Writer / Editor	3 (1%)	4 (1%)
Military	3 (1%)	3 (1%)
Cosmetologist	2 (<1%)	2 (1%)
Electrician	2 (<1%)	0 (0%)
Bartender	1 (<1%)	1 (<1%)
Dog Walker	1 (<1%)	0 (0%)
Famous	1 (<1%)	0 (0%)
Firefighter	1 (<1%)	3 (1%)
Florist	1 (<1%)	0 (0%)
Garbage Man	1 (<1%)	0 (0%)
Hotel Management	1 (<1%)	0 (0%)
Insurance Worker	1 (<1%)	0 (0%)
Journalist	1 (<1%)	5 (2%)
Painter	1 (<1%)	0 (0%)
Philanthropist	1 (<1%)	0 (0%)
Philosopher	1 (<1%)	0 (0%)
Pilot	1 (<1%)	0 (0%)
Priest	1 (<1%)	0 (0%)
Programming Microcontroller	1 (<1%)	0 (0%)
Real Estate	1 (<1%)	2 (1%)
Senator	1 (<1%)	0 (0%)
Stay at Home Mom	1 (<1%)	0 (0%)
Stewardess	1 (<1%)	0 (0%)
Wedding Planner	1 (<1%)	1 (<1%)
Air Traffic Controller	0 (0%)	1 (<1%)
No Response or Don't Know	15 (4%)	88 (29%)

Student Feedback on the Activities (Post-test)

We asked students to rate each **activity** on a scale of 1 to 5, where 1 = "didn't like it at all" and 5 = "completely loved it." The activity ratings are summarized below:

- **Watercraft**, average rating = 3.33 (standard deviation = 1.20, n=80)
- **Paper Table**, average rating = 3.11 (standard deviation = 1.01, n=132)
- **Zip Line**, average rating = 3.47 (standard deviation = 1.05, n=137)
- **Helping Hand**, average rating = 3.27 (standard deviation = 1.19, n=94)

We also asked students to rate the **stories** that accompanied each activity on the same scale of 1 to 5. The story ratings are summarized below:

- **Watercraft**, average rating = 2.90 (standard deviation = 1.24, n=62)
- **Paper Table**, average rating = 3.09 (standard deviation = 1.01, n=118)
- **Zip Line**, average rating = 3.30 (standard deviation = 1.10, n=115)
- **Helping Hand**, average rating = 3.17 (standard deviation = 1.20, n=82)

We also asked students to rate the **episodes** that accompanied each activity on the same scale of 1 to 5. The story ratings are summarized below:

- **Watercraft** (episode is called PVC Kayak), average rating = 3.31 (standard deviation = 1.21, n=72)
- **Paper Table** (episode is called Cardboard Furniture), average rating = 3.27 (standard deviation = 1.14, n=83)
- **Zip Line** (episode is called Backyard Thrill Ride), average rating = 3.42 (standard deviation = 1.02, n=122)
- **Helping Hand** (episode is called Water Dancing), average rating = 3.31 (standard deviation = 1.10, n=81)

We asked students to rate the **animations** that were included in each episode on the same scale of 1 to 5. The story ratings are summarized below:

- **Watercraft** (episode is called PVC Kayak), average rating = 3.28 (standard deviation = 1.24, n=72)
- **Paper Table** (episode is called Cardboard Furniture), average rating = 3.27 (standard deviation = 1.16, n=83)
- **Zip Line** (episode is called Backyard Thrill Ride), average rating = 3.29 (standard deviation = 1.05, n=125)
- **Helping Hand** (episode is called Water Dancing), average rating = 3.37 (standard deviation = 1.11, n=78)

We asked students to indicate whether they believed that the *Design Squad* activities were good for kids their age. Their responses are summarized below:

- Yes, the activities are good for kids my age (68%)
- No, the activities are good for older kids (6%)
- No, the activities are good for younger kids (6%)
- I don't know (22%)

Students also reported on whether they believed that their own friends would have fun doing the *Design Squad* activities:

- 30% said Yes
- 45% said Maybe
- 11% said No
- 13% Didn't Know

We asked students to indicate whether they believed the instructions were easy to follow. Students reported:

- I could follow most or all of the instructions (69%)
- I could follow some of the instructions (17%)
- I could not follow the instructions (5%)
- I don't know (9%)

We asked students whether the activities changed their attitudes towards engineering. Students reported:

- They made me more interested in engineering (44%)
- They didn't have an effect on me (39%)
- They made me less interested in engineering (7%)
- I don't know (10%)

Students also provided their opinions on the process of testing an idea and then revising their design during the activities (note: students were able to pick more than one response):

- 67% said, "It was important for improving my idea"
- 14% said, "It took too much time"
- 64% said, "It helped me think of different ways to solve my problem"
- 18% said, "It was confusing"
- 12% said, "It was tiring"
- 10% said, "I didn't learn anything new by testing my idea"
- 7% said, "I didn't test my idea"

We asked students to indicate how well the animations helped them to understand the engineering design process. Of the 198 students who reported that they saw the animations, students reported:

- They helped completely (9%)
- They helped somewhat (43%)
- They helped only a little (17%)
- They didn't help at all (11%)

We asked students to report on what they learned about solving problems using the engineering design process. Students reported the following:

- You need special training before using the engineering design process (14%)
- The engineering design process is an approach to solving problems (62%)
- The activities didn't have anything to say about the engineering design process (14%)
- The engineering design process gives people a step-by-step way to think about problems and come up with workable solutions (54%)

We asked students whether they would like to watch *Design Squad* again:

- 40% said Yes
- 31% said Maybe
- 23% said No
- 6% said they didn't watch it in class

We also asked whether students would tell one of their friends to watch *Design Squad*:

- 25% said Yes
- 36% said Maybe
- 32% said No
- 6% said they didn't watch it in class

We asked students to indicate what they liked *most* about the *Design Squad* activities. A subsample of 183 students responded to this item. Students who responded to the item reported the following:

- Nothing specific, just positive overall (18%)
- It was fun / funny / interesting (13%)
- Designing / building (12%)
- Team collaboration (8%)
- Seeing the final product (7%)
- Competition (5%)
- The cast / watching kids do the activities (5%)
- Brainstorming / solving problems (4%)
- Testing of idea (4%)
- Projects helped people (2%)
- Don't know / not sure (22%)

We also asked students to indicate what they liked *least* about *Design Squad*. A subsample of 117 students provided responses about things they did not like:

- It was boring / too long (36%)
- General dislike / did not like anything (26%)
- The cast / script (19%)
- Design process (10%)
- Competition (4%)
- It was too short (3%)
- It was confusing (2%)

Finally, we asked students to indicate whether there were interested in visiting the *Design Squad* website, watching *Design Squad* on television, or in watching *Design Squad* episodes streamed on the PBS website. Student responses are summarized in Table 8.

Table 8:
Student Interest in Viewing *Design Squad* in Different Media

	Yes, and I already have	Yes, I plan to	Maybe	No, I'm not planning to
Design Squad website	9%	15%	40%	37%
Design Squad on TV	8%	25%	34%	33%
Design Squad episodes streamed on PBS website	7%	15%	37%	43%

Teacher Findings

Experience with Engineering Activities and Supplemental Curricula

We asked teachers for some general information about their backgrounds and experience teaching engineering. Teachers reported that they get their ideas for engineering activities from multiple sources, including:

- Curriculum guides or activity books (4 out of 8)
- From the Internet (6)
- From other teachers (5)
- At workshops (4)
- Textbooks (1)
- From TV (1)

In addition to the selected multiple choice responses, four teachers indicated that they get ideas regarding engineering activities from "other places," including "professional experience." Another teacher indicated that she gathers materials from overseas (England) to supplement her curriculum.

We also asked teachers to indicate which of the following factors were essential to them in choosing supplemental curriculum materials to try in their classrooms:

- The materials must be appealing and attractive to me and my students (8 out of 8)
- Recommendations from other teachers (6)
- The materials must align with state or district standards (5)
- I need to be able to see all the materials first--I can't decide based on promotional information only (4)
- My principal, department head, or curriculum head have to approve all supplemental curriculum materials -- it's not my decision (3)
- I need to know, up front, how much time the curriculum will require (3)
- If I received the curriculum in the mail, I would use it (2)
- I need to see research-based evidence that the materials are effective in the classroom (0)
- The curriculum cannot require me to collect extra materials or equipment for my classroom (0)

We asked teachers to describe the ways in which they usually integrate engineering into science in their classrooms. Three teachers commented that they engage their students in hands-on activities, similar to *Design Squad* to integrate engineering into the curriculum.

One teacher reported:

> *"We build solar cars, robots, design theme parks, we research transportation and build balsa wood bridges."*

Another responded:

> *"My students work on projects all day…ranging from LEGO Mindstorms to drawing blueprints …and testing efficiency."*

One teacher indicated that a major problem with integrating engineering into the science curriculum is the lack of resources and physical space:

> *"….major problem is having enough material especially for low income students and how to store or display what is being produced…"*

Teachers told us that the engineering process requires that students work in teams and learn by "hands-on" discovery. In addition, two teachers stressed how engineering activities allow for their kids to be more creative than they would in other types of activities. Some teachers reported:

> *"(Engineering activities) require students to be creative and problem solve. They can also work with materials."*
>
> *"(Engineering activities) tends to allow for more creativity, differences in thinking than science labs."*
>
> *"It involves problem solving and a lot of hands-on discovery."*
>
> *"As a teacher for 31 years, the only thing that really excited middle school students is hands-on activities. All other activities for about 90% (are) considered boring to them."*

How Teachers Used the Design Squad Materials

We asked teachers to indicate the number of times that they referred to the Leader Notes during the *Design Squad* activities. Two teachers reported that they never looked at the Leader Notes during the activities. One teacher reported reviewing the Leader Notes only before the activity began. Another teacher reportedly reviewed the Notes only once after the activity began. The remaining four of the teachers reported reviewing the Leader Notes 3-5 times.

Teachers reported using various tools to reinforce the steps of the design process. All the teachers used classroom discussion to reinforce the steps. Five teachers used the episodes. Two teachers used other, available classroom materials. Only one teacher reported using the animations within the episodes to reinforce the steps.

All teachers indicated that they read the activity description prior to starting the projects. One teacher indicated that she watched the DVD prior to starting the project. With only two exceptions, teachers reportedly did not try out the challenges on their own before doing them with their classes. All teachers reported that it was easy or very easy to gather the materials for the challenges. Teachers reported that the activities generally required an hour or less of prep time.

Teachers reported that their students generally spent more than one hour doing each challenge. Two teachers reported that they had an assistant for one or more of the activities. The other teachers did not.

All but one teacher showed the DVD to their students—the one who did not show her students watched it herself to prepare to lead the project. One teacher indicated that she only showed ten minutes of the DVD because things quickly got "chaotic (which may be a classroom management

issue independent of *Design Squad*)." The other teachers reported that they showed the DVDs **prior to beginning** each activity.

Teacher Impressions of Design Squad Materials

We asked teachers to indicate the extent to which they observed specific behaviors during the activities on a scale of 1 to 4, with 1 = None and 4 = A lot. The results are summarized in Table 9.

Table 9:
Teacher Observations During Activities

	Watercraft	Paper Table	Zip Line	Helping Hand	Overall
How much **learning** did you observe amongst kids?	4.00	3.67	3.67	3.75	3.77
How much **teamwork** did you observe amongst kids?	4.00	4.00	4.00	4.00	4.00
How much **engagement** did you observe?	4.00	4.00	4.00	4.00	4.00
How much **communication** did you observe?	4.00	4.00	4.00	4.00	4.00
How much **redesigning** did you observe?	3.00	3.33	3.33	3.75	3.35
How much did the kids **enjoy** the activities?	4.00	4.00	3.50	3.80	3.83

Teachers indicated that students learned from the trial and error that activities required. One teacher reported:

> *"Students attempted several design changes to "fix" the problem with boats and the helping hand. They observed other students trials and created new prototypes in an attempt to resolve problems their peers experienced. They were also able to explain why they needed these changes."* ***Watercraft /Helping Hand***

Teachers also responded favorably to the teamwork that the Design Process required from their kids. They commented:

> *"I planned groups so that they could help each other. They also watched other groups and determined what seemed successful."* ***Zip Line, Helping Hand***

> *"(Teamwork) creates a better learning experience for them and allows them to discuss designs as they work."* ***Watercraft, Helping Hand***

Teachers observed a high level of engagement with the activities. They commented:

> *"(They) stayed on task for entire lesson".* ***Zip Line, Helping Hand***

> *"Students were fully engaged."* ***Watercraft, Helping Hand***

Teachers observed a high level of communication amongst the kids. They reported:

> *"Students were discussing the designs with partners and other groups the entire lesson."* ***Watercraft, Helping Hand***

Another said that she observed:

> *"Lots of communication and (kids) on task."* ***Zip Line, Helping Hand***

Teachers responded that the activities gave students ample opportunity for a significant amount of redesigning. Some teachers reported:

> *"Students redesigned several times for the Helping Hands activity. The Watercraft designs varied…."*
>
> *"Only 1 group out of 20 was successful on the 1st try; a lot of redesigning."* ***Paper Table***

Teachers reported a varying mix of kids' enjoyment with the activities. One teacher reported that her kids found it challenging (**Paper Table)** and another commented that it was difficult to keep her kids engaged the entire time:

> *"…In general it engaged them for about 15-20 minutes but as soon as they finished it was difficult to motivate them to work on the extension."* ***Zip Line, Helping Hand***

Other teachers reported a high level of enjoyment:

> *"Several told me that they wish all our labs were on engineering design."* ***Zip Line, Helping Hand***
>
> *"They loved both!"* ***Watercraft, Helping Hand***

In addition, for each of the separate *Design Squad* components, we asked teachers to rate the usefulness on a scale of 1 to 4, with 1 = Not useful and 4 = Very useful. The results are summarized in Table 10.

Table 10:
Perceived Usefulness of *Design Squad* Components

General Components	**Average Rating (sdev)**
The Activity Guide, in general	3.57 (0.53)
The Introduction	3.14 (1.07)
Introduction to the Design Process (pp. 2-3)	3.50 (0.84)
Talking to Kids about Engineering (p. 4)	3.29 (1.11)
Fit *Design Squad* into any Program (p. 5)	3.57 (0.54)
Web Resources (p. 6)	3.40 (0.55)
Science & Technology Content Standards (p. 8)	3.00 (1.27)
Accompanying DVD (video clips)	3.43 (0.79)
Leader Notes	
The Challenge statement	3.71 (0.49)
The "Introduce the challenge" section	3.57 (0.54)
The "Brainstorm and design" section	3.57 (0.54)
The "Build, test, evaluate & redesign" section	3.57 (0.54)
The "Discuss what happened" section	3.57 (0.54)
Challenge Sheets	
The kids' Challenge Sheets directions	3.50 (1.23)
"Take it to the Next Level" challenges	3.00 (1.27)
The "Engineering in Action" stories	2.83 (1.17)
The online suggestions	2.67 (1.53)
The illustrations	3.14 (1.07)
The Challenge statement	3.43 (1.13)

One teacher commented that she encountered technical difficulties with playing the DVD. This teacher also suggested a stronger division between brainstorm and evaluation phases of the challenge in the guide.

Another teacher indicated the Leader Notes *"are probably fine for teachers who are new to engineering,"* but she did not find much use for them. She also reported that her students had trouble with the directions for Helping Hand, reporting:

> *"They were confused about how to use the materials at first."*

We also asked teachers to indicate their level of agreement with a series of statements about the *Design Squad* experience on a scale of 1 to 4, with 1 = Strongly disagree and 4 = Strongly agree. The results are summarized below.

Table 11:
Teacher Ratings of *Design Squad* Experience

	Average Rating (sdev)
a. The activities provided stimulating activities for the kids in my classroom	3.71 (0.49)
b. The activities presented science ideas in a meaningful context	3.71 (0.49)
c. The activities were a good tool for promoting kids' overall understanding of the engineering design process (brainstorm, design, build, test, evaluate, and redesign).	4.00 (0.00)
d. The activities and the leader notes were helpful in the *teaching* of science and engineering concepts	3.86 (0.39)
e. The activities and the leader notes made me feel *comfortable* leading engineering activities with the kids	3.71 (0.49)
f. The leader notes helped guide my discussions about science and engineering with the students in my classroom	3.29 (0.49)
g. The activities complemented the curriculum my students have been learning this year	3.67 (0.52)
h. The activities were easy to implement in my middle school classroom	3.86 (0.39)
i. The activities were appropriately challenging for the kids in my classroom	3.57 (0.79)
j. I will recommend the activities to a colleague	3.86 (0.38)
k. The challenges got my kids excited about engineering	3.71 (0.49)
l. The videos were a useful addition to the Activity Guide	3.57 (0.79)
m. The animations were a useful addition to the video episodes.	3.83 (0.41)
n. The reading level was appropriate for the kids in my classroom.	3.43 (0.79)

One teacher indicated that he will use Helping Hand again:

> *"I plan to use the helping hand at the beginning of next year. By June my classes are good at handling challenges. Very easy reading."*

We asked teachers to indicate which of the following enabled their kids to make strong links between science concepts and the engineering process. Teachers were able to choose more than one answer. The number of teachers who responded in the affirmative to each choice is indicated below (note: only 7 teachers responded to this question):

- The challenges (7 out of 7)
- The videos (the episodes on DVD) (5)
- The animations within the episodes (5)
- The discussion that followed the activities (5)

Some reported:

> *"Solving a real problem is a turn on, especially to kids that have learning problems."*
>
> *"The above 3 (discussion, animations, and videos) had my students starting to link the concepts to engineering process."*

Teachers responded favorably to the animations, commenting that they were "helpful" and "very well done." One teacher reported:

> *"(I) can use (the animations) to open discussions on group work about how people attack solving problems differently.*

Another commented:

> *"Someone on your staff (WGBH) is an excellent teacher and engineer."*

We asked teachers to tell us which units or topics in their year-long curriculum the different challenges fit best. Their responses are summarized below:

- **Watercraft** – Engineering, Technology
- **Paper Table** – Newton's 3rd Law, Pre-engineering, General Eighth Grade Curriculum
- **Zip Line** – Physics, Force, Gravity, Friction
- **Helping Hand** – Robots, Space, Earth Science, Engineering, Technology, Prosthetic devices, Design process, Levers, Fulcrum, Simple machines, Force, Bioengineering

Teachers reported the types of problems they encountered when doing the activities. The number of teachers who responded affirmatively to each problem is indicated in parentheses below (note: only 7 teachers responded to this question):

- We ran out of time to finish a challenge (4)
- It was hard to stop kids working to have a wrap-up discussion (1)
- It was hard to get the kids to look at a problem differently once they had gotten started doing things in one way (1)
- We did not have all the supplies we needed (0)
- We did not understand what we were supposed to do (0)
- We had too many kids in the class to do the activities correctly (0)
- I had difficulty explaining the instructions to the students (0)
- The activities were too hard (0)
- Our groups did not work well together (0)
- The students did not like the activities (0)
- The reading level was too advanced (0)
- Some steps were too dangerous (scissors, etc.) (0)
- The challenges encouraged kids to use materials in inappropriate ways (0)

All the teachers indicated that they were likely or extremely likely to do the *Design Squad* challenges again *and* that they would recommend the *Design Squad* Activity Guide to other teachers. Note that

in the follow-up interviews, we found that at least three teachers were using the *Design Squad* materials again since the Field Test.

Teacher responses varied when asked what obstacles might prevent them (or other teachers) from using the activities in the future. Responses included:

- Time constraints
- Teacher experience and enthusiasm

> *"Teachers need experience with project-based learning and they need training to do these activities."*
>
> *"(Some teachers are) unwilling to try new things."*

Teachers generally reported that future *Design Squad* leaders (other teachers) could benefit from more instruction and guidance on how to administer the activities. Specifically, some teachers suggested that teachers be provided:

- Examples of teachers using challenges in actual classrooms on DVD (2)
- A simple kit with DVD
- An instructional DVD training on project based learning
- All materials needed to complete the activity
- Booklet of all challenges

Two teachers thought that the resources did not need improvement. Others suggested:

- The DVD should be shortened to a maximum of 15 minutes.
- Provide support on how to illustrate connections between math and science.
- Include a DVD demonstration of the activities for teachers.

Impact of Design Squad on Teachers

Teachers uniformly reported that allowing students to engage in hands-on activities and to practice the open-ended process of brainstorming, design, and evaluation was the most important thing that they learned. Some teachers commented:

> *"Process is more important than product."*
>
> *"…students learn better when given hands-on activities."*
>
> *"(Important to) give time to redesign and evaluation (and) to lead a discussion at the end"*
>
> *"My students loved the hands-on aspect of this and really rose up to the challenges. I learned that I should not be afraid to challenge my kids and I should do more open-ended projects with them."*
>
> *"Let them go with it and enjoy the show."*
>
> *"The more active the project the better they like it."*

We asked teachers to indicate their level of comfort with certain activities before and after using the *Design Squad* materials. Teachers rated each activity on a scale of 1 to 5, with 1 = Not at all comfortable and 5 = Completely comfortable. The results are summarized in Table 12. We did not observe significant increases in comfort levels—primarily due to ceiling effects. Teachers reported a high comfort level at pre-test, so there was not much room to improve at post-test.

Table 12:
Teacher Level of Comfort with Specific Activities
Before and After *Design Squad*

How comfortable are you…	**Pre-Test Rating (n = 8)**	**Post-Test Rating (n = 7)**
a. with leading open-ended activities with children? (i.e., activities that have many possible solutions or answers)	4.63	4.71
b. posing to children questions that may not have one clear answer?	4.50	4.71
c. when children ask questions that you aren't sure you can answer?	4.13	4.57
d. learning more about doing design process activities with children?	4.88	4.71
e. in doing activities for which you may have little or no background?	3.88	4.14
f. talking with kids about general science	4.50	4.43
g. talking with kids about general engineering	4.38	4.43
h. talking with kids about electrical circuits	3.50	3.43
i. talking with kids about sources of energy for the things they build	4.00	4.14
j. talking with kids about potential (stored) energy	4.00	4.14
k. talking with kids about kinetic (motion) energy	4.00	3.80
l. talking with kids about gravity	4.25	4.43
m. talking with kids about force and motion	4.13	4.71
n. talking with kids about stability	4.00	4.43
o. talking with kids about levers	4.13	4.14

How comfortable are you…	Pre-Test Rating (n = 8)	Post-Test Rating (n = 7)
p. talking with kids about pendulums	4.00	4.00