Evaluation of the BILL NYE THE SCIENCE GUY Television Series and Outreach

Submitted to
KCTS
by

ROCKMAN *ET AL*,
San Francisco, CA

July, 1996

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Executive Summary

BILL NYE THE SCIENCE GUY is a widely-viewed, children's television series on science. Designed for eight-to-ten year olds, this series is shown in late afternoons Monday through Friday on PBS stations and on commercial television over the weekends.

ROCKMAN *ET AL*, an independent research group in San Francisco, was contracted by KCTS, Seattle, WA, to undertake an evaluation of the BILL NYE THE SCIENCE GUY television series. The evaluation was charged with exploring the impact of the series on children at home, in school, and in other settings where children can watch television. Both the funders and the PBS station were concerned about science learning outcomes, attitude change, and the impact of the series on girls and minority children.

Background and Methodology:

The study was conducted in three sites—Sacramento, CA; Philadelphia, PA; and the Indianapolis, IN area—representative of the diversity of the viewing audience. At each site, we recruited school viewers and home viewers from rural, suburban, and urban settings for participation, as well as additional, equivalent classrooms who did not watch the series. School and home viewers received a monthly schedule of programs, as well as regular incentives to encourage a high level of viewing throughout the five month study. We provided both viewers in school and at home with twelve BILL NYE programs on videotape as a basic set of programs for viewing. In-school and at-home viewers were asked to watch at least the 12 programs provided.

Participants, both viewers and students in comparison classrooms, completed pre-viewing questionnaires in the early winter, 1995-96, and a second questionnaire in the late spring of 1996. We collected assessment materials from a total of 1,350 children in schools, approximately 800 among the viewing group and 550 in comparison classrooms. We included data from 45 classrooms in 22 schools. Approximately 400 children completed interviews with project researchers at the beginning and end of the study. Children selected for interviews were chosen so as to oversample girls and minority students. Teachers in the viewing and comparison classrooms also

completed questionnaires and interviews, as did parents of participating home viewers.

A study of target-age children viewing in afterschool care settings in the greater Philadelphia region was imbedded in this project. ROCKMAN *ET AL* placed combination television/VCRs into centers with the requirement that the BILL NYE show become a regular, optional activity at the centers. Staff from the centers monitored viewing and maintained the equipment.

Results:

There are substantial outcomes from the set of studies undertaken for this project. Most of our questions focused on critical thinking and the higher-order thinking skills related to exploring and explaining scientific phenomena rather than on children learning facts. Consequently, most of the impact that we were able to capture dealt with thinking skills and the ability of viewers to explain or to identify explanations of scientific phenomena. From the aggregation of findings, we can conclude that viewing the BILL NYE programs does enhance children's science understanding, especially in connection with higher order thinking skills and critical thinking.

Some of the more interesting outcomes are from the hands-on assessments included as part of approximately 400 child interviews undertaken before and after viewing. The improvements we found from these hands-on activities came through enhanced investigative efforts—playing with and observing objects, making hypotheses and trying them out—and with the quality of explanations that children provided to the researchers. On every one of the hands-on assessments, viewers from home or school, or both, increased their active exploration, observation, and hypothesis generation.

Many of our questions derived from demonstrations and experiments from BILL NYE programs and from the teachers' guide and many of the outcomes appear related to the viewing of specific episodes.

From this and from other assessments we can state that:

• Children who view BILL NYE were able to provide more complete and more complex explanations of scientific concepts than they were before viewing the series. But while BILL NYE viewers acquire basic scientific concepts and processes, they often can't transfer principles to other contexts.

• Comprehension and application of science facts and concepts did take place, often as a consequence of information being repeated within programs. Students were able to use facts they had gleaned from viewing as a basis for answering questions.

• There is little change in children's attitudes towards science as a consequence of viewing the BILL NYE series. However, students started with such positive attitudes towards science that little change was likely to appear.

• Girls may not always begin with the same knowledge-base as boys, but they often come nearer to closing the gap after viewing the series. When gains in science knowledge and scientific thinking are seen, girls improve as much or more than boys.

• Where improvements in knowledge and thinking were seen, minority students gained as much or more than majority students. However, these children, too, started with less knowledge than majority children and began to come closer to parity.

• Teachers usually showed the program without a well-defined instructional plan and built a lesson around it. Many of the programs match their curriculum needs and can be useful instructional tools.

• The match between school needs and the broadcast schedule is a barrier to more effective and widespread use in schools.

• According to parents, BILL NYE influenced their children's interests and participation in science activities. Almost all parents (95%) reported that their children undertook a science exploration, experiment or activity over the last few months of the study.

• Watching BILL NYE promoted family interaction; almost all parents (92%) reported watching it with their child at least once and 92% said their child talked to them about the show.

• There is a strong potential audience in the afterschool care setting, especially in structured programs with an emphasis on academics.

Evaluation of the BILL NYE THE SCIENCE GUY Television Series and Outreach A Report to KCTS

submitted by
ROCKMAN *ET AL*
San Francisco, CA

BILL NYE THE SCIENCE GUY is a widely-viewed, children's television series on science. Designed for eight-to-ten year olds, this series is usually seen in late afternoons Monday through Friday on PBS stations, and on commercial television over the weekends. The outreach effort for this series includes teacher guides to encourage and facilitate instructional use, as well as newsletters and materials for home and school viewers.

ROCKMAN *ET AL*, an independent research and evaluation group in San Francisco, was contracted to undertake an evaluation of the BILL NYE THE SCIENCE GUY television series and educational outreach effort by KCTS, Seattle, WA. The evaluation was charged with exploring the impact of the series on children at home, in school, and in other settings where children can watch television. Both the funders and the PBS station were concerned about science learning outcomes, attitude change, and the impact of the series on girls and minority children.

Background and Methodology:

The study was conducted in three sites, representative of the diversity of the viewing audience across the country. At each site, we recruited schools and home viewers from rural, suburban, and urban settings for participation. Additional classrooms who were not watching the series were recruited at each population-density area to participate as comparison classrooms. The comparison schools mirrored the viewing schools in terms of student population. Teachers in school, and children who were viewing the program at home, received a monthly schedule of programs, as well as regular incentives every two-to-four weeks, such as science toys, postcards, or

telephone calls in hopes of maintaining a high level of viewing throughout the five month study.

We provided both viewers in school and at home with a collection of BILL NYE programs on videotape. These served as a basic set of programs for informal and scheduled viewing, as well as rainy-day opportunities that might not otherwise be available. In-school viewers and at-home viewers were asked to watch at least the 12 programs provided on videotape. They were also encouraged to view other BILL NYE programs on a weekly basis or more frequently.

Participants, both viewers and students in comparison classrooms, completed pre-viewing questionnaires in the early winter, 1995-96, and a second questionnaire in the late spring of 1996. Some children—home viewers, school viewers, and comparison class students—completed interviews with project researchers at the beginning and end of the study. Children selected for interviews were chosen so as to oversample girls and minority students. Teachers in the viewing and comparison classrooms also completed questionnaires and interviews, as did parents of participating home viewers.

Sample:

The study was undertaken in three sites: Sacramento, CA, Philadelphia, PA and Indianapolis and Bloomington, IN. At each site, we recruited viewers from urban, suburban and rural settings, including school viewers, home viewers, and comparison classes. We collected assessment materials from a total of 1,350 children in schools, approximately 800 among the viewing group and 550 in comparison classrooms. We included data from 45 classrooms in 22 schools.

We selected a sample of one third of the questionnaires from the participating and comparison classrooms to obtain our student sample for analysis. Of those selected, we were able to analyze approximately 220 usable questionnaires for the viewers and approximately 140 for the comparison students. Interviews and hands-on assessments were conducted with

approximately 140 viewing students and 100 non-viewers both before the study and at the end of it.

We also selected home viewers to be representative of the diverse viewership of BILL NYE and they were located in all population areas. We recruited about 375 home viewers selected from participating schools, other schools, girl scout troops, afterschool clubs. We also recruited home schoolers, and children that had previously requested BILL NYE materials. We administered assessments to 331 children at the start of the study and 311 children at the end. Interviews and hands-on assessments were conducted with approximately 90 home viewers.

The total sample from which data were analyzed included approximately 540 home and school viewers and 140 comparison, non-viewing children, and we conducted an average of more than 400 interviews with children both before and at the end of the study.

An additional study was imbedded in this project, a study of target-age children viewing in afterschool care settings. Working with several provider agencies in the greater Philadelphia region, ROCKMAN *ET AL* placed combination television VCRs into the centers with the requirement that the BILL NYE show become a regular (though not central) optional activity at the centers. Staff from the center monitored viewing and maintained the equipment. Researchers applied the same measures as in the schools and for home viewers. We gathered information from about 50 afterschool viewers both at the start and the end of the study.

Questionnaire Design

We explored a large number of developmentally-appropriate science concepts with the children, both viewers and non-viewers. Many of the questions we asked focused on science knowledge and critical thinking skills, seeking to determine the degree to which viewing the BILL NYE series could contribute to learning. Other questions focused on attitudes towards science and scientists and awareness of science in the world, while still others dealt with science behaviors that children might engage in. Knowledge, attitudes, and behaviors were the three primary foci of the research study.

We used multiple forms of assessment to capture the outcomes and impacts of the BILL NYE series, including written instruments, individually administered performance items, and interview questions. We asked questions both of children who viewed the programs (in school or at home) and of those who did not (the comparison group children); we gathered information from teachers and parents, as well.

Given the range of audience abilities, with children from third through fifth grades, we developed abridged assessment forms for third graders and used a longer, common form for fourth and fifth grades. We gathered information in early winter and again in late spring. For the inschool study, the written forms were given to entire classes of viewers and comparison groups. Home viewers were assessed, sometimes individually and other times with affinity groups, at school, in afterschool settings, and in recreational groups. The performance items were given to individuals and, occasionally, to pairs of children, depending on the setting.

Cautionary notes for the reader:

The research described below is not a tightly controlled set of events. We had a willing collection of participants, both at home and in schools, yet BILL NYE THE SCIENCE GUY was only a small part of their lives during the period of this study. Teachers still had to focus on reading, writing, and 'rithmatic. This past winter (1995-6) provided a series of weather disasters to the east and midwest; snow days when schools were closed were frequent events in both Philadelphia and Indiana. Consequently, teachers often changed their instructional plans and focused on the basics to make up time; science did not always fall into the "basics." And parents reported that viewing in the late afternoon had to be balanced against other activities, from soccer to music lessons, to housework and homework.

The comparison classrooms for this study did not turn out to be well-defined, uncontaminated controls, in the experimental sense. In fact, there were many BILL NYE viewers among the students in comparison classrooms, before, during, and after the study. And in fact, we recruited many of our home viewers in each site from the comparison classrooms. Furthermore, there was contagion among the classrooms in schools where BILL NYE was

being used. We have reports of teachers in BILL NYE viewing classes sharing their videotapes with comparison classes. They obviously felt that they didn't want to withhold useful instructional materials, regardless of how it would affect the research study. We also found that, depending on site, between 60 and 80 percent of all children were already familiar with the BILL NYE series prior to the start of the project. Minority children were the least familiar with the television series; only 60 percent of the minority kids said they had watched programs in the past. Consequently, we chose to delete approximately 20 percent of the comparison students from the analysis because they were regular BILL NYE viewers.

In the evaluation design we used, the comparisons between BILL NYE viewers and non-viewers was only one of the comparisons we could make to study the impact of the series, only one of the relationships that could show change. As there was a great deal of contamination of the comparison classrooms, from individual students as well as entire classrooms that became viewers, the comparison between these children and the viewers is substantially less powerful than it might be.

That there were very few differences between viewing and non-viewing classrooms (either from teacher/classroom characteristics or from student pre-viewing data) at the start of the study is strong evidence that we were working with a common population. That there were many fewer differences between comparison and viewing groups at the end of the study, suggests two competing hypotheses: that the comparison schools are no longer good comparisons or that viewing made no difference. We believe the former is the case.

A second set of comparisons is permitted in this design—between viewers of the series before and after the more concentrated viewing of BILL NYE that this study involved. In fact, there are numerous differences in the knowledge and understanding of these BILL NYE-viewing children, comparing their answers before and after viewing. Thus, it is these differences that we focus on for this report, rather than the differences between viewers and non-viewers.

In addition, our initial analysis indicated that students in different grades did not respond differently to questions, except for a few science knowledge questions, and then only inconsistently. Therefore, we combined grades and ignored the rare grade difference in this analysis.

Impacts of Viewing BILL NYE THE SCIENCE GUY

We begin this report with two questions that reflect the objectives of our study:

- What did BILL NYE viewers learn?
- Did viewers change their attitudes towards, science awareness and science behaviors?

These guiding questions focus on the impact of the series on children in a variety of settings. In addition, we will suggest directions for further strategies for the BILL NYE series to consider in hopes of continuing, extending, and enhancing its impact on children, teachers, and families.

What did BILL NYE viewers learn?

- Children who view BILL NYE were able to provide more complete and more complex explanations of scientific concepts than they were before viewing.

- Children who view BILL NYE were able to provide more complete and more complex explanations of scientific concepts than they were before viewing the series. But while BILL NYE viewers acquire basic scientific concepts and processes, they often can't transfer principles to other contexts.

- While viewers may not always articulate the correct concept fully, they no longer give incorrect answers as frequently.

- Factual learning of science facts and concepts did take place, often as a consequence of information being repeated within programs. Students were able to use facts they had gleaned from viewing as a basis for answering questions.

• On questions that had concrete referents that were familiar to children (such as the physics of riding a bicycle), we found significant changes before and after viewing.

• Many of the concrete referents were ones that were shown on BILL NYE programs. The outcomes seem related to the viewing of specific episodes.

• In hands-on assessments, students who view BILL NYE regularly are better able to generate explanations and extensions of the scientific ideas.

• Girls may not always begin with the same knowledge-base as boys, but they often come nearer to closing the gap after viewing the series. When gains in science knowledge and scientific thinking are seen, girls improve as much or more than boys.

• Where improvements in knowledge and thinking were seen, minority students gained as much or more than majority students. However, these children, too, started with less knowledge than majority children and begin to come closer to parity.

Evaluation strategy and perspective:

We gathered information on children's understanding of scientific concepts in a variety of ways. We created four sets of questions and one hands-on activity to capture changes in scientific thinking and knowledge that might be related to children's viewing the series:

- demonstrations of phenomena, where the researcher demonstrated an experiment and asked children to select responses related to the **concepts underlying the events.**
- hypotheticals to gather information about **science knowledge and relationships among concepts**, such as explaining about aspects of biology and geology to a creature from another planet.
- defining the attributes and characteristics of animals to explore **factual learning and traditional scientific thinking**;
- applied science questions for children to problem solve as a way to explore **higher order thinking and scientific explanation**.

- interviews and hands-on activities to assess **children's ability to explore and explain scientific concepts.**

As it turned out, most of our questions focused less on children's learning facts and more on critical thinking and the higher-order thinking skills related to exploring and explaining scientific phenomena. Factual learning did take place, often as a consequence of information being repeated within a program and even in two programs about similar concepts. Students were able to use facts they had gleaned from viewing as a basis for answering questions. But most of the impact that we were able to capture dealt with thinking skills and the ability of viewers to explain or to identify explanations of scientific phenomena.

Children who viewed the BILL NYE series were able to provide more complete and more complex explanations of scientific concepts than they were before viewing and do significantly better than those children who did not view the programs. The results are not consistent or universal, since, for some questions, the home viewers did better when the school viewers did not; sometimes the opposite occurred; and sometimes both groups did equally well. Many of our questions derived from demonstrations and experiments from BILL NYE programs and from the teachers' guide and many of the outcomes appear related to the viewing of specific episodes.

And while viewers did better, on the whole, than non-viewers, sometimes minority children did as well or better than majority children; sometimes they did not. For gender, as well, the results are mixed; but often girls were less able to answer the questions prior to viewing and began to catch up with the boys by the end of the study.

Below are discussions of the results and a presentation of some of the data we collected.

Demonstration Questions: Understanding the Underlying Science Concepts

Children viewed two (of six possible) scientific demonstrations and were asked to select one or more explanations for the phenomena and make connections between the experiment and other scientific concepts. Possible answers ranged from restating the obvious to abstract connections of the principle. In addition, two incorrect answers were included for each item. The questions were scored for the number of correct answers reduced by the incorrect ones.

Summary:

Overall, there were significant changes in home and school viewer's ability to identify the principles underlying the demonstrations. The comparison group did not show significant changes for any of the demonstration questions. Both home and school viewers did well on a demonstration of Bernoulli's principle, which was presented in both the "Birds" and "Flight" episodes, two shows that both school and home viewers were encouraged to watch.

Only school viewers made gains on the principles demonstrated when letting air out of a balloon, presented in the program on Locomotion, which was not one provided to viewers on tape.

Home viewers, in contrast to school viewers, tended to make statistically significant gains on these demonstration-of-concepts questions. Often, the questions on which home viewers scored well were direct replications of experiments and demonstrations presented in BILL NYE programs, (e.g., using a fatty substance to insulate in Marine Mammals), and most of these were from episodes that children were encouraged to watch and for which they received copies. Children viewing at home also tended to watch more programs overall, and were more likely to have seen the demonstrations at least once.

Overall, girls tended to score lower than boys on demonstration questions. On the questions where children made improvements, both girls

and boys made gains, but in most cases, the girl's scores did not catch up with the boys' scores.

The demonstration questions and the results are displayed and discussed below. Each questions focuses on a scientific concept (and Big Idea) illustrated in one or more episodes of the series.

Concept: Bernoulli's Principle

See what happens when you blow on a piece of a paper.
This may help us explain...
(Circle as many answers as you wish.)

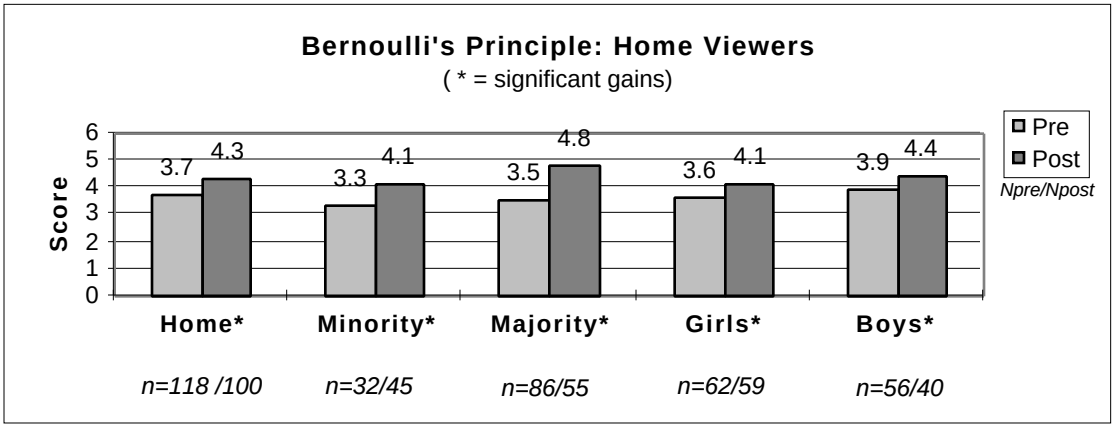
a) how an airplane flies +
b) what happens when you blow on a piece of paper +
c) how strong paper is-
d) air pressure +
e) how to change temperature-
f) how birds fly +

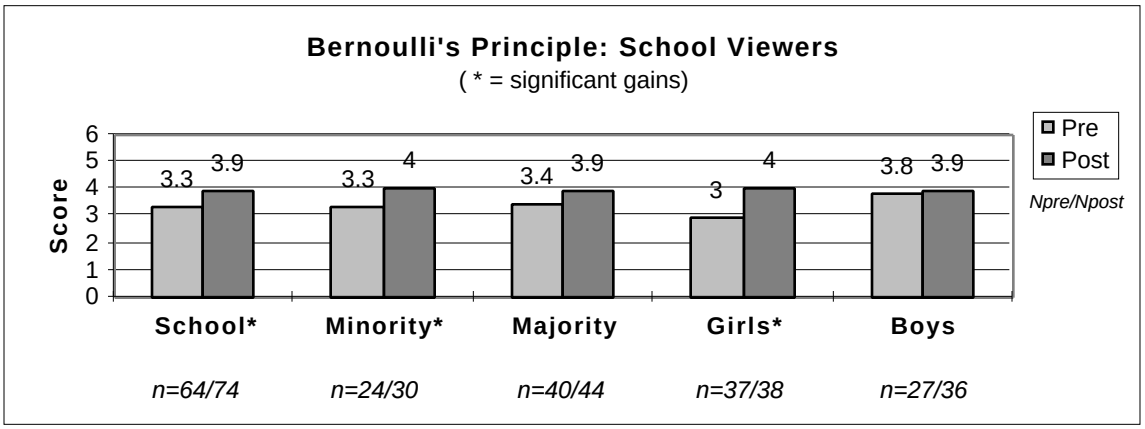
Both home and school viewers made significant gains on this question about Bernoulli's Principle. The concept was demonstrated twice over the course of the viewing period, both times on programs children were encouraged to view, "Flight" and "Birds." The improvements we found were evident for both majority and minority viewers (at home and in school), as well as for boys and girls.

Home viewers' scores increased from 3.7 to 4.3, on a scale of 0 to 6. Boy home viewers made significant gains (3.9-4.4) as did girl home viewers (3.6-4.1). However, the boys' pre- and post-viewing scores were higher than the girls' scores.

In schools, viewers' scores increased significantly from 3.3 to 3.9. Gains were seen in all grade levels, and among minority children (from 3.3 to 4.0); majority children did not show any gain. Boys viewing BILL NYE in school did not improve, while girls made significant gains, increasing their scores from 3.0 to 4.0, and "catching up" with the boys who started with a score of 3.8.

Classroom viewers increasingly connected this demonstration to "how airplanes fly," going from 31 percent to 51 percent from beginning to end. In addition, they portrayed a greater understanding of air pressure.





Concept: Air pressure/propulsion

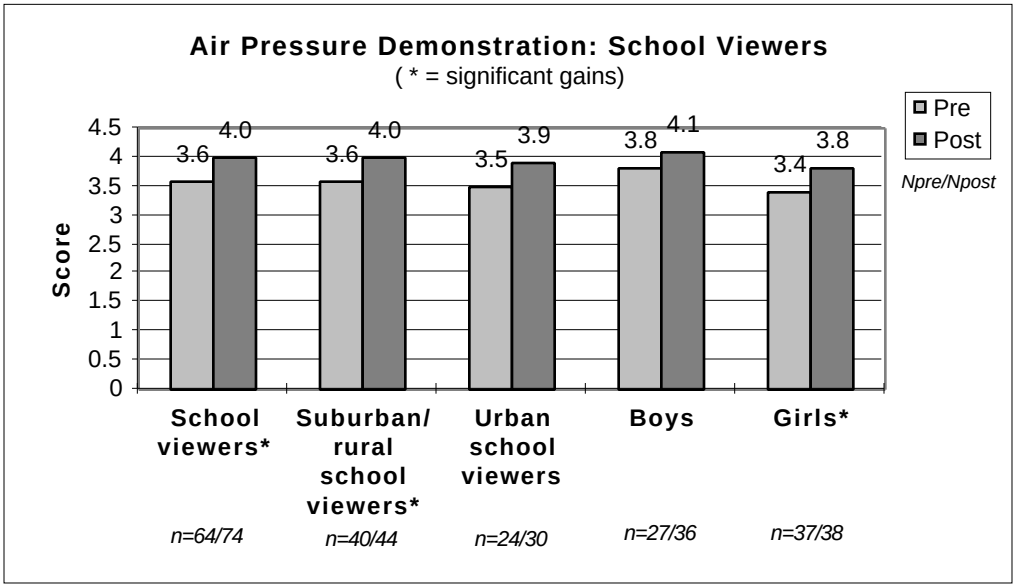
See what happens when we blow up a balloon
and let it go so the air comes out. This may help us explain...

a) what happens when air comes out of a balloon +
b) how a rocket works +
c) how a squid moves +
d) what air pressure is +
e) why muscles work -
f) how seeds fall from a tree -

Viewers in school improved significantly on this question (going from 3.6 to 4.0 on a scale of 0 to 6), many identifying the underlying concept of air

pressure. Majority children also made significant increases (from 3.6 to 4.0). While minority students did improve, increases in their scores did not reach significance.

Among students viewing the program in school, boys made no significant gains in this question (3.8-4.1); however, girls did (3.4-3.8), beginning to close the gap between genders. While few viewers were able to apply principles of air pressure to the animal kingdom, such as how squids move, girls were significantly less likely to pick the idea before viewing the series, yet their understanding did not differ from boys after viewing.



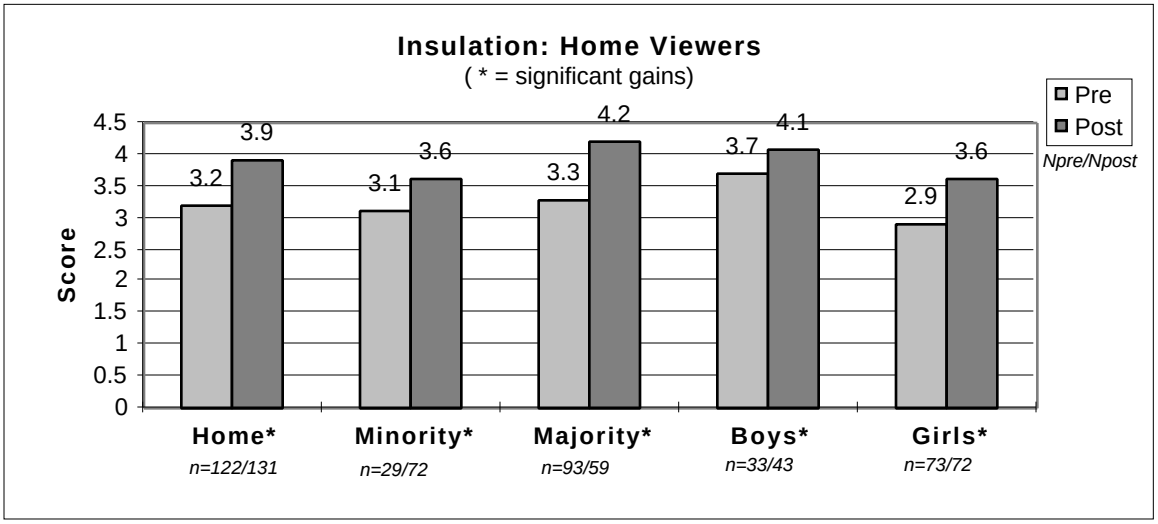
Concept: Insulation

> We will cover one hand with lard or shortening and not cover the other hand. We will then put both hands in cold water. The hand that is not covered will feel colder. This may help us explain... (Circle as many answers as you wish.)
>
> a) why it's hard to feel something through lard +
> b) how seals stay warm +
> c) how to keep your house cooler +
> d) how a blanket works to keep you warm +
> e) why oil and water don't mix -
> f) how mud is made -

We found substantial increases for home viewers for this question. On a scale of 0 to 6, home viewers went from 3.2 to 3.9. Both minority and majority viewers at home made significant gains, their scores increasing from 3.1 to 3.6 and from 3.3 to 4.2 respectively; the gains did not close the gap.

Both boys and girls at home made significant gains (from 3.7 to 4.1 and from 2.9 to 3.6 respectively). However, the girls' post-viewing scores remained substantially lower than those of the boys.

School viewers did not improve substantially for this item after viewing BILL NYE programs.



Concept: Plate tectonics

See what happens when we have a box filled with sand and we push the sides together. This may help us explain... (Circle as many answers as you wish.)

a) how mountains are made when earthquakes happen +
b) how to make a kitty litter box -
c) what happens sometimes when continents move +
d) how sand can turn into rocks -
e) how energy is transferred from one form to another +
f) what happens you put sand in a box and push the box together +

Only home viewers made significant gains on this question; their scores increased from 2.9 to 3.2. Majority children in the home-viewing condition did much better on this question than did minority children. The major improvement in understanding focused on recognition of this as an example of plate tectonics and earthquakes.

Two additional demonstrations questions, one illustrating the concept of water drainage and the other centripetal and centrifugal forces, did not result in identifiable changes for viewers and they are not discussed here.

Hypotheticals: Science Knowledge and Relationships Among Concepts

To further capture children's science knowledge and ability to understand and explain scientific concepts, we asked 4th and 5th graders to respond to three variations of a question that posed the open-ended opportunity: "If you met a creature from another planet, what would you tell it about land (or water or living things)?" This question elicited information about conceptual knowledge and about relationships among concepts.

Answers were scored as scientific or non scientific and whether they were basic or complex. For example, if a child was asked about living things, the response "living things grow," would be scored as scientific and basic. If he or she responded, "most living things need water to grow," that answer

would be scored as a scientific and complex. If she or he responded, "some living things have fun," this would be scored as an non scientific answer.

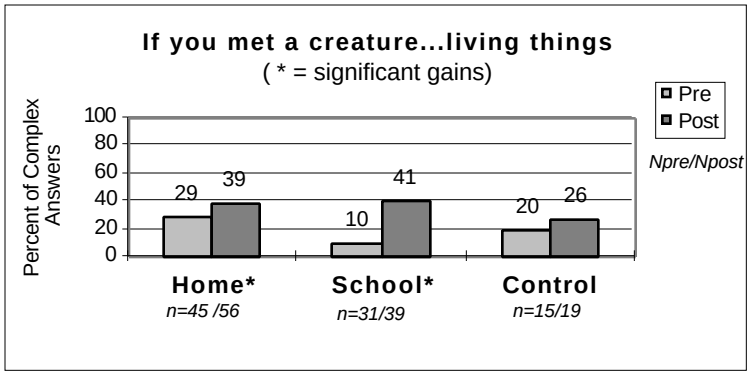
Summary:

We saw substantial evidence that children were increasingly able to provide both facts about water and living things on earth, as well as developing more complex connections among the elements they mentioned. The results seem to be related to the opportunity of viewing programs about the issues; programs about water and living things were more available and more widely viewed (in total) than programs about the earth.

The hypotheticals are discussed below.

Water: Children were asked to describe one or two things about water on earth. There was a significant increase in the more complex answers for the home viewers. Before viewing the programs, only 31 percent of the home viewers gave complex answers, while by the end of the study, 53 percent of the home viewers gave complex answers. There were no significant before-and-after differences for the school viewers or the comparison group students.

Living things: Children were asked to talk about living things on the earth. Both school and home viewers made significant gains for this question. Prior to the start of the study, 29 percent of home viewers gave a complex answers, while at the end, 39 percent of the children gave complex answers. Only 10 percent of the school viewers gave complex definitions to begin with, while, 41 percent of the school viewers' answers were complex at the end of the study. There was no statistically significant change for the comparison group.



Land and continents There was no measurable change for home or school viewers or comparison children when children were asked to explain the land and continents to a creature from another planet. It may be that since the set of videotapes provided to schools and homes included four programs about water, several about animals, and only one about land, there is less likelihood that we would see an improvement.

Attributes of Animals: Factual Learning and Traditional Scientific Thinking;

To capture what children learned about the characteristics of animals—a subject frequently presented in the BILL NYE series—we asked them a general question about the attributes that make some type of animals unique. These answers were graded on a two part scale for accuracy of attributes and complexity. For example, for animals, children were asked to explain what makes a mammal a mammal, or a fish a fish, or a bird a bird. Their answers were then graded, based on number of correct attributes they listed specific to that animal. We looked for traditional scientific concepts and vocabulary rather than generalities. For example, if a child mentioned that a mammal is "warm blooded," she received one point. If a child noted that a mammal is "warm blooded and breathes air," he received two points. If a child mentioned that a mammal is "scary", he received 0 points.

Summary:

On the pre-viewing questionnaire, children's scores were very high for the "What makes a bird a bird?" and "What makes a fish a fish?" questions. Most children (at least 85%) were able to respond appropriately to these questions. Even when gains were noted, the pre-viewing scores were so high, that statistically significant improvement was not likely at the end of the study.

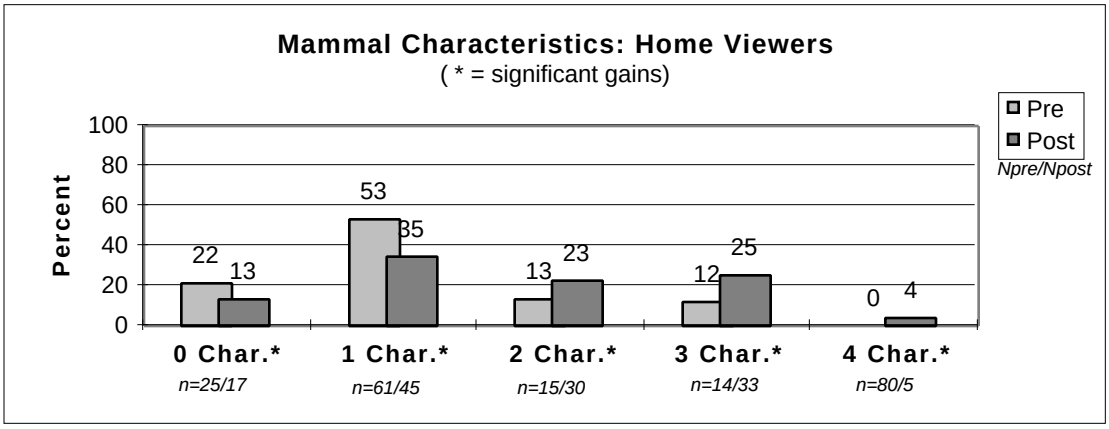
However, the pre-viewing scores were significantly lower for the "What makes a mammal a mammal?" question. Consequently, we found significant gains for this question for both home and school viewers. There were no significant changes in the comparison group.

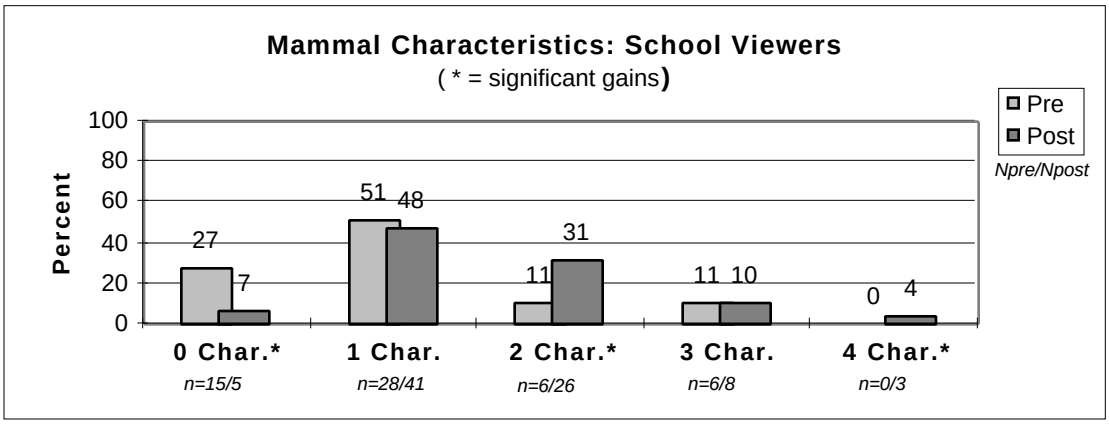
Mammals: The gains in viewers' knowledge of attributes about mammals may be due to various phenomena. "Mammals" was one of the most

frequently watched episodes for both home and school viewers. This episode continually reiterated the attributes of mammals—they are warm blooded, have hair, feed their babies milk and give birth to live young" (about ten times throughout the episode). In addition, children were also encouraged to watch "Marine Mammals," in which Nye repeated many of the facts from the Mammals episode. This repetition in the mammals programs was much more evident in comparison to the presentation of facts on the other two animal shows, "Birds" and "Fish" even though children knew the definitional attributes of these two animal groups.

For home viewers, the percentage of correct answers increased from 78 percent to 87 percent. Additionally, home viewers provided an increasingly higher percentage of correct answers at the end of the study. The percentage of children who gave two or more characteristics significantly increased from 25 percent to 52 percent.

For school viewers, the percentage of correct answers increased from 77 percent to 93 percent, and the percentage of children who gave two or more correct answers significantly increased from 22 percent to 45 percent.





Applied Problem Solving: Higher Order Thinking and Scientific Explanation

We also gave children several applied science problems with multiple-choice answers that might serve to explain the phenomena. The alternatives ranged from the improbable to the complex, and children were asked to circle all the answers that could solve the problem. For example, when asked how they could go faster downhill on a bicycle, the options included "making the road wet, pedaling faster, changing gears, leaning forward so that the wind doesn't stop you."

Summary:

With questions that had concrete referents familiar to children (such as about the everyday physics of riding a bicycle), we usually found significant changes between the start of the research and after viewing.

For each of the more concrete questions, one or another of the viewing groups improved significantly by the end of the study; there were gains in either the home viewers or the school viewers. Sometimes the home viewers had the largest increase, sometimes the school viewers did.

Girls consistently had significantly greater improvement. Usually starting below the boys for each question, they gained sufficiently to have final scores equivalent to the boys.

The results of the scientific explanation questions are displayed and discussed below. Each questions focuses on a scientific concept (and Big Idea) illustrated in one or more episodes of the series.

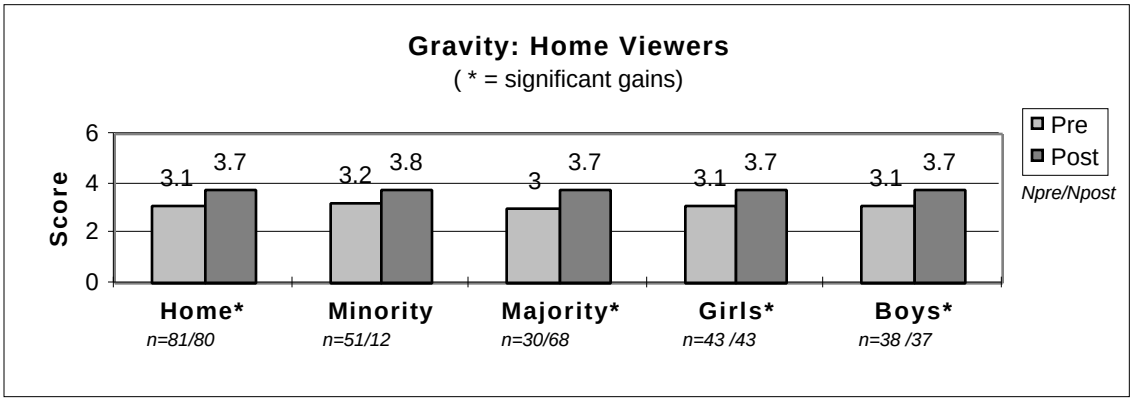
Concept: Gravity

When you are riding your bicycle, why is it easier
to go downhill and harder to go uphill?
(Circle as many answers as you wish.)

a) because up is hard and down is easy -
b) because of gravity +
c) because it's harder to do things when you are higher up -
d) because hills are steep +
e) because the earth pulls on you -
f) because there is more wind going downhill +

To portray the concept of gravity, we posed a problem of riding a bike down or up a hill. Both home and classroom viewers dramatically decreased their initial "simplistic" answers and moved towards reporting a more complex understanding of the concept of gravity. Students who viewed at home were significantly more likely than non-viewers to identify gravity as the culprit.

We found a significant increase in scores for the home viewers, going from 3.1 to 3.7, on a scale of 0 to 6. Most of these gains were made by majority viewers, their scores increased from 3.0 to 3.7; minority home viewer's scores increased from 3.2 to 3.8, but this change was not statistically significant. Both boys and girl home viewers made significant increases (from 3.1 to 3.7 and from 3.2 to 3.7 respectively).

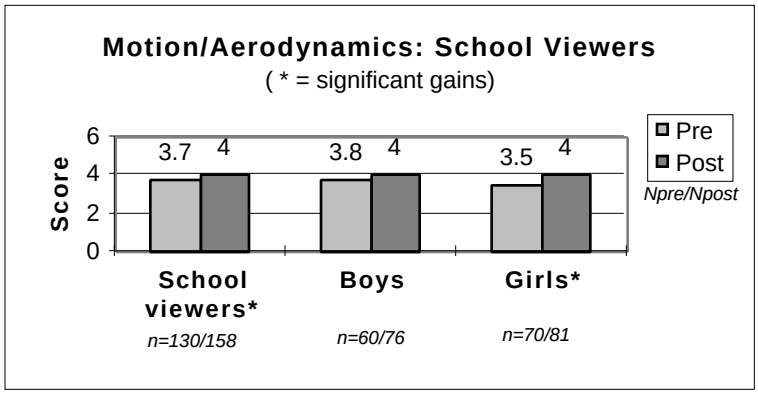


Concept: Motion/Aerodynamics

Explain how you can go faster downhill on your bicycle.

a) lean forward so that the wind doesn't stop you
b) make the road slippery by getting it wet
c) pedal faster
d) change gears
e) sit upright so that the wind pushes on you
f) lean to the side of your bicycle

For this question, only the school viewers made significant gains, increasing their scores from 3.7 to 4.0, on a scale of 0 to 6. Minority viewers in school improved more than majority viewers, who did not gain at all (from 3.4 to 4.3 versus from 3.8 to 3.9). There were no significant gains for the boys (3.8 pre-, 4.0 post); however, girls did make significant gains (from 3.5 to 4.0) catching up to the boys.



Two other questions, one about the value of rivers to the environment and an abstract problem about the disappearance of boats on a lake, did not elicit any real change from pre-viewing to post-viewing among any of the audiences. Students scored near the maximum at the start and at the maximum at the end of the project.

Interviews and Hands-on Questions: Ability to Explore and Explain Scientific Concepts

We also conducted pre-viewing and post-viewing interviews with children and asked them to explore and explain certain scientific phenomena and general science concepts. The materials for these explorations were presented by the researcher and given to the student for further observation and study.

Methodology

These one-on-one or one-on-two interviews were designed to determine how students see science as exploring phenomena. We also wanted to examine how children develop hypotheses based on evidence from observation and prior knowledge, as well as how they make connections to science concepts in their everyday lives. We did this by providing children with science materials and asking them to model how they think BILL NYE (or another science show for the comparison group children) would use them on TV. To do this effectively, students would have to observe, explore and investigate.

In some interviews, we probed children's thinking about "big ideas" in science that could very likely have been enhanced by viewing BILL NYE THE SCIENCE GUY episodes. In two different questions, we looked for general understandings of scientific ideas by having children group animals by various characteristics that determine classes of animals, and searched for a more sophisticated awareness of shared characteristics. We also looked for increased awareness of earth structures and processes based on existing knowledge.

Summary:

Approximately 387 children participated in these interviews as the study started and another 462 at the end of the research project. The participants engaged these hands-on activities with enthusiasm and usually developed more complex and comprehensive responses following the viewing period. Most of the improvements came through enhanced investigative efforts—playing with and observing the objects, making

hypotheses and trying them out—and with the quality of explanations that children provided to the researchers.

The overall outcomes were quite supportive of the impact of the BILL NYE series. On every one of the hands-on assessments, viewers from home or school, or both, increased their amount of active exploration, observation, and hypothesis generation. We found the home viewers doing better than school viewers in some cases and worse in others. Several time, both groups of viewers made quite substantial gains from the start of the study to the end.

Viewers were much more likely to undertake a variety of science processes in figuring out what the object might be used for and how it might be demonstrate a scientific concept. Viewers also had more powerful strategies for classifying animals in ways that used the observable characteristics of the animals. Children who viewed BILL NYE also had more science facts at their disposal to deal with both animal classifications and with characteristics about the earth.

Scoring the Exploration and Explanation Questions

We administered two of the following four interview questions to children, both viewers and non-viewers. These questions were:

Question 1: The bouncing problem

BILL NYE (or another science show for kids) has been looking for things to show and do on TV. We recently found some things that we think may be interesting, but we are not sure what to do with them on TV. Let me show you these balls that we found that look alike but, as we found out, are very different. (Demonstrate by bouncing each ball twice on a hard surface. Then hand the balls to the children and have them play with them.) [NB: one ball bounces on hard surfaces and the other does not.]
First let's see what we can we find out about them.
Do you think these would be good to show on TV? Why?
How would they be used?
What else would you say about them or do?
Let's pretend you are the host of the show. What would you say / do?

Question 2: The spinning top/slinky/periscope

BILL NYE (or another science show for kids) has been looking for things to show and do on TV. We recently found some things that we think may be interesting, but we are not sure what to do with them on TV. Children are given one of the three items and asked to demonstrate how it would be used. For example, researcher shows children the top; spin the top, then asks :
Do you think it would be good to show on TV? Why?
How would it be used?
What else would you say about it or do?
Let's pretend you are the host of the show. What would you say / do?

Question 3: Animal classification

We provide children with a set of cards with images of animals including a person, cat, bat, whale, shark, fish, lobster, duck, song bird in flight, butterfly, ant, and spider. We tell them that some scientists organize animals into groups called classes, orders and families based upon how they are alike and different. In this activity, we want them to be scientists and invent ways of putting these animals into 3 or more groups based upon ways they are alike and different. Have the children proceed and then have them give as many reasons as they can about why they chose the system they did. Then probe their thinking and ask them if they can organize them in other ways. Finally, introduce an imaginary animal and ask the kids to put it into one of their groups and defend their choice.

Question 4: Earth science

Provide children with a globe of the earth. Tell them that some scientists study the earth to find out about earthquakes, rivers and streams, the water cycle, wetlands, and also the earth's seasons, climates, atmosphere, and oceanography. Do they know about some of these things and which ones would they like to tell about if they did a science project? Probe for some basic ideas that are the main concepts from BILL NYE shows.

We scored these questions using grounded rubrics developed and piloted prior to implementing the research study. For the first two questions, on exploration and explanation, we noted whether students made observations, comparisons and experiments, and whether they derived explanations based on their observations.

In these questions, children received a composite score based on three separate scores for: investigative effort, quality of explanation and connections to BILL NYE viewing. In the investigative category, for instance, children received points based on their theories and their ability to make multiple observations, compare objects to other things, and do and suggest experiments. For example, in the materials question, a child would receive one point in the investigative section if she bounced the balls on the ground, but she would receive two points if she bounced the balls on different surfaces.

Children received points in the explanation category if they presented evidence or suggested or did an experiment. For example, in the periscope task, if a student noted that the periscope worked because of the mirrors, he would receive one point. However, if he explained the positioning of the mirrors and conducted an experiment, he would received three points.

Children received points in the BILL NYE category if they were able to relate the phenomena to a BILL NYE episode. For example, if a child mentioned that the top continued to spin just like objects on "Spinning Things," she would receive a point.

For the classification question (Question 3), we based our scoring on categories of attributes used for sorting. For example, a child who had scored low in this category, might place the animals in categories based on the number of legs. A child who placed the animals in categories such as mammals, fish, insects, and birds, would receive four points, the highest score. For the earth science question (Question 4), we looked for factual information from prior knowledge or connected to BILL NYE programs. A child with low scores would have non-scientific answers, such as "we have four seasons" or "earthquakes happen in California." Higher scores would

come from answers such as, "the earth takes one year to go around the sun and it tilts on its axis and sometimes it's closer to the sun."

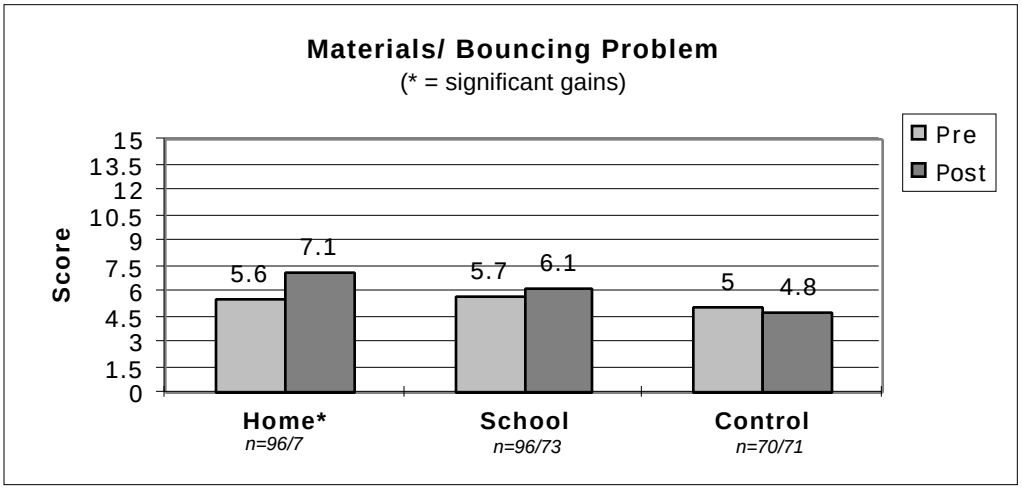
The results of the exploration and explanation interviews and hands-on activities are displayed and discussed below. Each questions focuses on a scientific concept (and Big Idea) illustrated in one or more episodes of the series.

Concept: Materials/The Bouncing Problem

Home viewers made the most significant gains in this category. While home and school viewers started about the same, at 5.6 and 5.7 respectively, home viewers' composite scores increased to 7.1, on a scale of 0 to 15. These home viewers made the most improvement in exploring the phenomena, and in connecting it to BILL NYE programs they had seen.

Both boy and girl home viewers significantly increased their scores. Girls went from 5.3 to 6.0, and boys increased their scores from 6.00 to 7.69.

School viewers increased their score, too (to 6.1), but this was not statistically significant. There were no significant gains for the comparison group.



Concept: Motion/gravity/The spinning top

In every group—viewers and non-viewers, home and school—there were statistically significant gains. However, these gains were largest in the school viewing and home groups. School viewers' composite scores increased from 4.6 to 8.1, (based on significant gains in all three analysis categories) and home viewers increased their scores from 4.6 to 8.1(also based on significant improvements in all three categories). For these viewers, many of the gains came from children making more observations and comparisons, and suggesting more experiments. In the post-viewing assessment, viewers often talked about concepts such as gravity and force, and frequently mentioned the episode, "Gravity".

The comparison groups' composite score increased from 3.6 to 5.0; non-viewers were able to make a few more observations and comparisons then they had at the time of the pre-viewing assessment.

Concept: Light/optics/periscope

We found significant gains in all three sets of children, though home and school gains were larger than those of the comparison group. Home viewers' composite scores doubled, increasing from 3.4 to 7.0 and showing improvement in all three analysis categories. School viewers' composite scores also more than doubled, increasing from 3.5 to 8.0, and showed improvements in all three analysis categories. Scores in the comparison group increased about 70 percent, from 3.4 to 5.8.

For school viewers, many of these gains came from an increase of observations, comparisons to other things, and more experiments. At the end of the study, when describing the periscope, children talked about the angles and mirrors. One child noted, "They reflect. You look at the mirror and it shows you the
other mirror."

Concept: Waves/Slinky

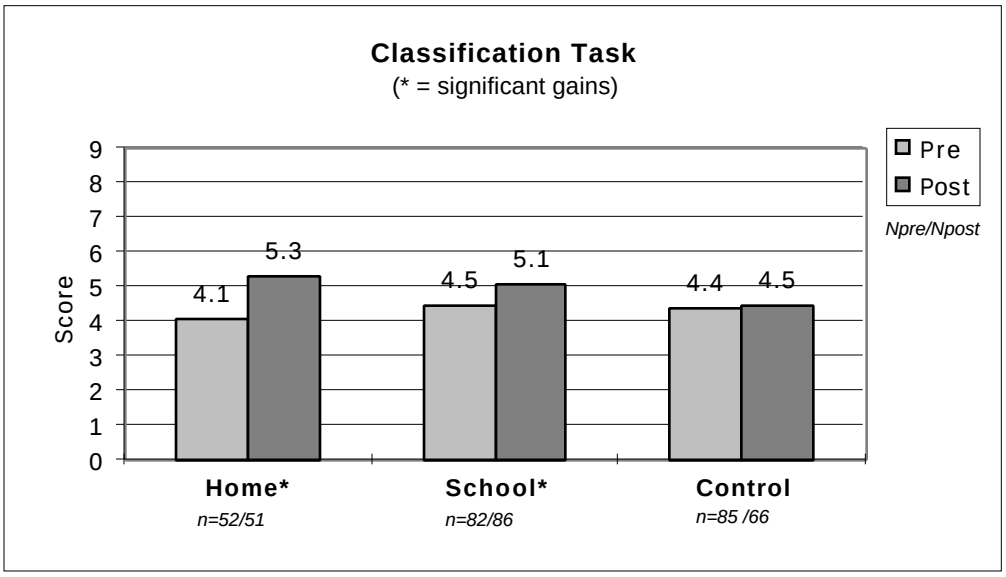
School viewers made significant gains, their composite scores increasing from 5.4 to 7.7. Some of these gains came from an increase in

observations, investigations, and suggesting more experiments, many related to making waves. Home viewers did not increase their scores significantly after viewing the programs.

Concept: Animal Classification

Both home and school viewers made significant gains on this task. On a scale of 0 to 9, home viewers' scores increased from 4.1 to 5.3, with improvements on all analysis criteria. School viewers' scores increased from 4.5 to 5.1. There were no significant gains in the comparison group. Home viewers did especially well on this task.

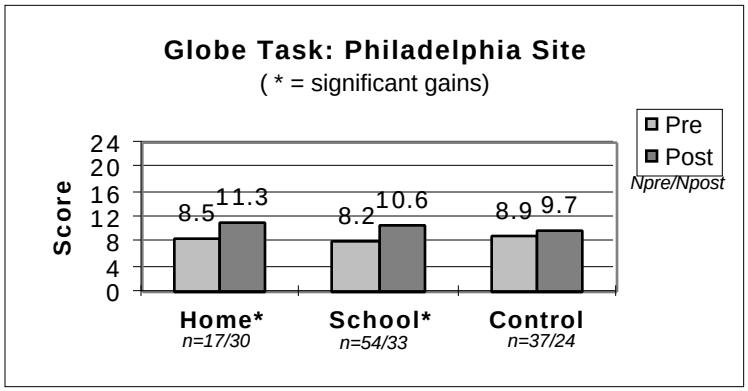
Increases in the school-viewing group tended to be from the minority viewers, who "caught up" with their majority counterparts. Minority viewers increased their scores from 3.6 to 5.3, a statistically significant amount. Girls viewing at home had composite scores that increased from 4.4 to 5.6, and girls viewing in school increased from 4.2 to 5.1. Boys viewing at home increased from 3.9 to 4.9 and boys in schools increased from 4.9 to 5.3.



Concept: Earth science

Often when children were given a globe and asked to talk about what they knew about the earth they responded with social and political issues as well as information from earth sciences. Most of the children based their knowledge on topics from social studies (i.e. there are seven continents, there are different countries, there are different seasons). Very few were able to explain the concepts behind seasons and climates.

Only in Philadelphia do we have reliable and constant data on this question and it points to the increased abilities to explore and explain among the BILL NYE viewers. School viewers made significant gains (from 8.2 to 10.6 on a scale of 0 to 24), as did home viewers (from 8.5 to 11.3).



How did viewers behave about science?

While we did not look directly at science-related behaviors, we did ask children about the kinds of actions they might choose if given an opportunity. Our questions explored children's behavior *preferences* by asking them to choose between a variety of non-science and science activities they would like to do or study, as well as their favorite books or television shows. We also asked whether they did any science related activities in the last two months, and why they would or would not want to do science.

We found that, overall, at-home and in-school viewers' behavior preferences did not change substantially over the course of the study. However, most of their responses reflect a positive attitude toward science and an interest in doing science. Viewers' parents and teachers report that these children have a great interest in science and science activities, and that this was enhanced by participation in the study. Approximately half of the children report a willingness to partipate in science activity such as studying the ocean as opposed to swimming in the ocean and that proportion did not change over the course of the study. (It may also have been that the non-science alternatives in many of these questions were more appealing than we initially thought.)

Among the tendencies we noticed were that:

- Children report, as do their parents and teachers, a great interest in science and in doing science activities.
- BILL NYE viewers are more likely to choose science activities over other alternatives for the summer.
- BILL NYE is the most popular selection for both boys and girls for making a personal appearance on TV.

When we asked if students had "done any cool science stuff at home," we found a very high percentage (more than two thirds) of children who could identify that they, in fact, had been doing science at home. Much of this activity was associated with science homework and extension of activities initiated at school. Parents of home viewers also noted the substantial

amount of experimentation and science activity among their children. (See Parent and Teacher sections, below, for further information.)

Among the findings from student questionnaires were that in both pre-viewing and post-viewing assessments, the most popular response to selecting books, for all students, is "Science Things to Do at Home." The second most popular choice for all students, both before and after viewing, was another science book, "Things that Live in the Sea."

At the end of the school year, when asked which television show they would like to be on most, both boys and girls selected BILL NYE more than any other show (including Carmen Sandiego, Ghostwriter, Wishbone, Family Matters, Beakman's World). Boys (49%) selected BILL NYE first followed by Family Matters (20%). Girls selected Ghostwriter (21%) as their second choice.

School viewers also chose BILL NYE as the show they wanted to be on most (going from 18% before viewing to 44% after viewing). Comparison, non-viewing students, on the other hand, selected Family Matters as their number one choice (about 50% at the beginning and end of the study).

Children who viewed BILL NYE in school were more likely than their peers to select a science activity as a preference for the summer. They often chose fossil hunting, rock collecting, and computer-controlled robots, in contrast to sports, art, and drama.

Did viewers change their attitudes towards and awareness of science?

Our questions were designed to explore children's attitudes and beliefs about science and scientists, as well as student's perceptions about the use of science in the world around them. Some questions focused on children's perceived stereotypes. Children were asked where you could do science, what types of occupations used science, and what types of attributes scientists possess.

- We found little change in student attitudes towards science as a consequence of viewing the BILL NYE series. However, students started with such a positive attitude towards science that little change was likely to appear.
- Children seem to be moving away from traditional stereotypes about science and scientists.
- Gender differences seem well established. Boys almost always draw boys or men as scientists, while girls tended to draw girl scientists; few girls drew women scientists.
- Viewers increasingly draw scientists as active, engaged, individuals (possibly themselves or even BILL NYE), who are not tethered to the laboratory.
- Minority students who viewed the BILL NYE series increased their perceptions of the use of science in a variety of professions.

Overall, there were few indicators that showed substantial change in children's attitudes towards science. However, children's attitudes towards science were already very positive and little growth was possible on the scales we were using.

When children were asked to fill in the question, "I want to learn science" or "I don't want to learn science," an overwhelming majority (well over 90 percent) of both home and school viewers—as well as the comparison group— wanted to learn science. The most popular reason given for wanting to learn science were positive statements such as "it's cool, it's interesting, it's fun." The second most popular reason was that "I want to know how things work."

Science and the World of Work

Some viewers seemed to have broadened their perspectives on the role of science in a variety of occupations and jobs as a consequence of viewing the BILL NYE series. We asked children if knowledge of science was a necessity for various occupations. To a significant degree, minority students who viewed the BILL NYE series made gains (their scores going from 3.7 to 4.6), increasing their perceptions of the use of science in a variety of professions. Majority students who viewed made also significant gains, as well (going from 4.5 to 5.2). Note that the minority students started with lower scores and, while making a larger absolute increase, did not "catch up" with their majority cohort.

People who use science

Which of the following people use science in their jobs? (Circle as many as you wish.)

a) a person who plans the lunch menu
b) a science teacher
c) a principal
d) a school nurse
e) a person who takes care of the plants and trees
f) a veterinarian
g) a mailman

We also asked children a series of questions about people who use science. Girls were more likely than boys to think that scientists work outside (60 percent versus 52 percent). And this perspective increased for girls between the pre-viewing and post-viewing period from 49 percent to 60 percent.

Draw A Scientist Test

- Almost all of boys (95%) drew other males in both the pre-viewing and the post-viewing assessments.
- The majority of girls (67%) drew female scientists in both the pre- and the post-viewing assessments, and tended to draw other girl scientists; very few (less than 15 percent) drew women scientists.
- Children drew fewer adults in the post-viewing assessment that they did initially.

Among the ways we hoped to identify how children's perceptions of scientists might change after viewing BILL NYE on a regular basis was to have them draw a picture of a scientist at work. Research on children's drawings of scientists indicates a collection of stereotypical attributes, such as lab coats, test tubes, facial hair, and eyeglasses. Often these pictures are of wild-eyed men who are setting off explosions in the lab. The approach we took was to utilize a rubric based on the Draw A Scientist Test (DAST)[1].

We asked children to draw a person doing or using science and to name the person and give the drawing a title. All children who participated in the study completed a drawing as part of their pre-viewing assessment and again as part of their post-viewing assessment. We asked them to name the person, so that we could determine whether the scientist was male or female, and to give their artwork a title, so that we could have a better sense of what the scientists were doing in the pictures they drew. Sample drawings are appended to this report.

We then analyzed the drawings in two ways. Children received one point for stereotypical indicators including lab coats, eyeglasses, laboratory equipment, science products (such as light bulbs, boats, and airplanes) and stereotypical captions (such as "Eureka!" and "Kaboom!"). We also analyzed the drawings for other categories including the scientist's gender, whether the setting was indoors or outdoors, and whether the scientist was engaged in an active or passive activity. We also analyzed the subject of the drawing,

[1] "Stereotypic Images of the Scientist: The Draw-A-Scientist Test", David Wade Chambers, Science Education, 67, John Wiley & Sons.

looking specifically if the child drew him or herself, another child, an adult, BILL NYE, Beakman or a monster or some other "mad scientist" fantasy.

On the analysis criteria we used, we found no significant changes in the nature or content of the drawings. Just as earlier researchers had found, children continue to portray stereotypes about scientists and science activities. They include stereotypical attributes, such as a test tube, scale or beaker, doing lab science indoors , not real world science, and they are predominantly men, not women. Nevertheless, we did notice some trends that, while not statistically different from the study's start to finish, do portray some indicators of change.

For instance, when asked to draw someone doing science, almost all of boys (95%) drew other males in both the pre-viewing and the post-viewing assessments. While the majority of girls (67%) drew female scientists in both the pre- and the post-viewing assessments, they tended to draw other girl scientists; very few of them (less than 15 percent) drew women scientists.

On post-viewing assessment, viewers' choice of subjects also changed considerably and about 20 percent of the BILL NYE viewers drew pictures of BILL NYE himself. Bill was usually portrayed in a positive light, often in a laboratory or doing experiments seen on the show such as using a gyroscope or holding a Frisbee. Boys tended to draw more pictures of Bill Nye.

Interestingly, in the post-viewing assessment, children drew fewer adults and more kids than they had drawn at the start of the study. While 25 percent of viewers drew adults doing science at the beginning of the study, that number dropped to 16 percent at the end of the study. Similarly, 43 percent of viewers drew other children doing science at the start; that number increased to 52 percent by the end. It appears that children may begin to see themselves and their peers as competent and able to do science.

What did teachers think?
Teachers and BILL NYE

- Classrooms viewed about five times / month
- Teachers usually showed the program without a well-defined instructional plan and built a lesson around it.
- Teachers report that their students have a high interest in science and a great willingness to do science activities.
- Teachers note that many of the programs match their curriculum needs and can be useful instructional tools.
- The match between school needs and the broadcast schedule is a barrier to more effective and widespread use in schools.

Background

Forty five teachers participated in our school study, 27 of whom were viewing teachers and 18 of whom were part of the comparison group. They taught third, fourth and fifth grades in urban, suburban, rural and inner-city schools in and around Sacramento, Philadelphia, Indianapolis and Bloomington, IN. At each of the three sites, we recruited nine viewing teachers and six teachers from an equal number of comparable grades and settings.

We asked the teachers to complete a questionnaire at the beginning of the study and again at the end. Seventy seven percent of the viewing teachers completed the prequestionnaire; slightly less (70%) completed the postquestionnaire. Among the comparison group, eighty three percent completed the prequestionnaire; about two thirds (67%) answered the postquestionnaire.

The majority of both viewing (84%) and comparison-group teachers (83%) did not have a science background beyond the basic elementary education requirements, such as a major or minor in science or science education. Less than half of both viewing teachers (47%) and comparison-group teachers (45%) had taken any staff development courses in science over the past three years.

Almost all of the teachers (94% of viewing and 89% of comparison) watched science shows on television at home, such as National Geographic, the Discovery Channel and Nova. About three fourths of viewing teachers (74%) and half of the comparison-group teachers (55%) reported having living things in their classroom, such as guinea pigs, lizards and other class pets. Two thirds of viewing teachers reported having science fairs at their schools; over half (55%) of the comparison-group teachers reported the same.

Science Curriculum

Viewing teachers reported generally spending about 4.1 hours a week on science instruction; comparison-group teachers spent slightly less time, about 3.6 hours per week. Both viewing and comparison-group teachers taught a wide range of topics as part of their science curriculum, from astronomy and animals to the water cycle and weather.

Almost all teachers (95% of the viewing and 90% of the comparison-group) had a self-contained science curriculum; very few had a departmentalized science curriculum. When we asked them to select the sentence that best described their science curriculum, we received a variety of responses:

	Viewing Classrooms	*Control Classrooms*
I primarily use the textbook	11	11
I use a textbook series combined with hands-on projects	44	50
I use a hands-on, exploratory curriculum	28	11
I mostly use hands-on science kits	17	22
I mostly use multi-media projects	17	22

Teachers also reported incorporating many different activities into their science curriculum and there were very few differences between viewing and comparison groups. Teachers used demonstrations (51% viewing, 49% comparison), group projects (48% viewing, 51% comparison), hands-on experiments (50% viewing and comparison), and science fairs (56% viewing, 44% comparison).

We also asked teachers how often they used different materials in their science curriculum. Almost all of the teachers (94%) reported using television

and video as some part of their science curriculum; one fourth noted using TV and video regularly; about seventy percent reported using the medium occasionally. Half of the teachers regularly used textbooks and one third occasionally used them. About three fourths of the teachers reported occasionally using materials such as worksheets and magazines. Few teachers used computer technologies as part of their science curriculum. Over one third (37%) reported never using them and almost half (49%) reported occasionally using technology. Other materials teachers reported using included lab sheets and science journals; they also incorporated guest speakers and hands-on science projects into their curriculum.

Viewing patterns

Before becoming involved with this study, about one fourth of the teachers previously had used BILL NYE as part of their science curriculum. However, they had not used it with any regularity nor for a substantial length of time.

None of the teachers had ever participated in any teacher training sessions for BILL NYE. Only five percent of teachers had ever requested a BILL NYE teacher's guide, a broadcast schedule or an up-closifier.

During the course of the study, viewing teachers used BILL NYE in their classrooms, on average about five times a month. Almost half (45%) of teachers reported using BILL NYE once a week. One fourth of the teachers showed it twice a week or more. Twenty five percent noted showing the program two to three times a month. Another five percent stated that they watched the show once a month.

While the frequency of viewing the programs may be lower than the at-home viewers, five times per month may fit more easily into the science program of an elementary school classroom. There was also a great deal of variation among sites, and the snow days that were taken in the midwest and eastern sites caused havoc with classroom instructional plans. As a consequence of snow days, teachers were more likely to forgo science in favor of math and reading. Greater incentives might have generated greater viewing, but, the pace of use seems closer to what would occur normally.

We asked viewing teachers to explain how they used BILL NYE in their classrooms and provided them with the following choices: "We watched BILL NYE," "I introduced science concepts using BILL NYE," and "We did experiments or activities from BILL NYE." While some teachers failed to specify how they used the program, the majority (78%) provided some explanation. For the most part, these teachers usually showed the program to their students. About twenty percent of the time, they used the program to introduce science concepts. And they did experiments or activities from BILL NYE about sixteen percent of the time.

> *We burned different nuts and other foods from the video on digestion to observe the burning of sugars, non sugars or energy producing foods. The kids were awestruck.*

We also asked teachers what types of science activities, if any, they used to extend BILL NYE in their classroom. Teachers reported using a variety of science activities including hands-on experiments (50%), demonstrations (50%), group projects (49%) and science fairs (50%).

While in the study, teachers used BILL NYE in a variety of ways (teachers could chose more than one alternative):

	Teacher use
The class discussed BILL NYE video clips	85%
I introduced science concepts using BILL NYE	80%
We did experiments from BILL NYE video clips after viewing	70%
We watched the program when we had time	45%
I use BILL NYE as a reward for students	40%
I utilized experiments from BILL NYE teacher kits	35%
I used the BILL NYE Follow Me Home activity kits	15%

Teachers reported that their students were very interested in watching BILL NYE. On a scale of one to ten, they ranked their students viewing interest at an 8.5.

Science Interest, Knowledge and Skills

Teachers did not report significant gains in their classes' overall skill level in science. When asked to rank their class' skill level on a scale of 1 to 10, with 1 representing "not at all," and 10 representing "extremely," teachers

ranked their classes skill level at a 5.5. At the end of the study, we asked this question again and the number increased slightly to a 6.6, but was not enough of a difference to be statistically significant. Similarly, teachers ranked their classes' overall knowledge as a 5.8 in the pretest and a 6.8 in the post-test; again, however, the difference was not significant.

Teachers' perceptions of their classes' overall science interest also remained about the same over the course of the study. According to teachers, their classrooms had a fairly high interest in science overall, a 7.9 when the study began. This number increased slightly in the post-test, to a 8.2, and again, this was not enough of a difference to be statistically significant.

Teachers also perceived their classrooms to be very willing to try out science activities (9.2 on a scale of 1 to 10). With such a high pre-viewing score, it would be unlikely that students would increase even slightly; on the post-viewing questionnaire, teachers rated their students about the same, a 9.3.

Teachers' Interest and Comfort Level in Science

Overall, teachers were very interested in teaching science. On a scale of 1 to 10, with one representing "not at all," and ten representing "very," they rated their interest level at an 8.9.

Teachers' comfort level in teaching science changed significantly over the course of the study. Before the study, teachers ranked their comfort level at a 7.4 on a scale of 1 to 10; at the end, their comfort level increased significantly to an 8.4.

The number of hours teachers spent teaching science did not change over the course of the study. Viewing teachers reported spending on average, about 4.1 hours a week on science; comparison-group teachers reported spending about 3.6 hours per week on science instruction.

Bill Nye's Effectiveness as an Instructional Tool

Teachers felt that BILL NYE was extremely effective in conveying scientific concepts to their classes. On a scale of one to ten, with one

representing "not at all," and ten representing "very," teachers gave BILL NYE an 8.5. Over three fourths of the teachers ranked BILL NYE as a 10.

The majority of teachers (63%) felt that the topics of BILL NYE episodes only matched their curriculum "sometimes." One fourth of teachers thought that the topics usually went along with their curriculum; thirteen percent reported that the programs rarely matched their curriculum and no one felt that the series never matched their curriculum.

When asked if there were some BILL NYE programs that were particularly effective as instructional tools, teachers gave a variety of responses. They cited more than 25 different BILL NYE episodes that helped them teach a particular topic or unit:

> *Digestion . . . it helped when we were studying the human body and frog anatomy.*

> *Rocks and soil went right along with the curriculum.*

Only three teachers (13%) reported that there were some programs that were not particularly effective, naming The Brain, Earthquakes, Spinning Things, and Waves. These teachers felt that these episodes were too advanced for their students to understand.

Teachers also suggested many ways in which BILL NYE could be more effective as an instructional tool. Many of the suggestions involved making the series much more convenient for teacher use. Teachers asked if the programs could be shown during school hours, if they could have their own set of episodes, and if they could receive a schedule in advance so they would know when specific episodes would air.

> *I like to plan my science units at the beginning of the year so it would be nice to know in advance what show is on when so I can incorporate NYE into my planning.*

Teachers wanted the series to be more curriculum-based; they asked that the programs more closely match their textbooks. They also wanted the timing of the episodes to match their overall science curriculum scope and

sequence. One teacher felt that the BILL NYE experiments were not easy to do in the classroom:

> *Again, if curriculum-based, the BILL NYE presentations could be an invaluable instructional tool. He is able to demonstrate examples of concepts that are not feasible in the classroom.*

Several teachers also expressed a strong desire for more outreach materials such as curriculum correlations, as well as more of the existing outreach materials: newsletters, kits, and activities. A few wanted more literature sent to the schools; one asked for a teacher's kit that not only included a teacher's guide but a videotape as well.

When we asked teachers if there were any special incidents related to BILL NYE that occurred in their classrooms over the course of the study, teachers responded very positively and enthusiastically. Some reported how the series increased their students' science knowledge:

> *I introduced heat with a BILL NYE video and reviewed the unit with the same video. The students did extremely well on their test displaying an excellent understanding of conduction, convection and radiation.*

> *Vocabulary. I was amazed at the specialized vocabulary they learned. Tectonic plates, etc.*

Other teachers mentioned how excited their students were about the series:

> *Most of the class would show enthusiasm for BILL NYE if I mentioned his name.*

> *The class would join in unison to sing the introduction on every BILL NYE we watched.*

According to the viewing teachers, students did many activities outside of the curriculum—and outside of the classroom—that were related to BILL NYE. Children watched the series at home, often with their family members. They told their teachers about things they saw on the programs, brought in experiments from home to show the class, and brought in BILL NYE activities

for extra credit. Other students looked at the web site, and some did their science fair projects based upon what they learned on BILL NYE.

> *Several students made spinning things, several did a static electricity activity. One student taped the diatons program and brought it in so we could view it.*

Overall, teachers were very satisfied with BILL NYE as an instructional tool and wanted to continue using it as part of their curriculum. Eighty five percent of teachers who participated in our study plan to use BILL NYE next year in their classrooms. Fifteen percent said they were not sure if they would use the program again. Teachers were also eager to obtain any other existing materials related to the BILL NYE series and asked for teacher newsletters, CD-ROMs and books. When asked what message they wanted to pass along to program developers, they responded with much praise and enthusiasm for the programs:

> *I watch BILL NYE as often as possible. I regard this program as the best science show ever offered on TV for elementary students.*

> *I love what you are doing. I am thrilled with the way Bill uses humor to catch the students' attention. I am also impressed with seeing a female student to role model science experiments on the 'Try It' Sections. Great job. Keep it up.*

> *I found BILL NYE to be an excellent way of teaching science. Please make more videos.*

What did parents think?

• On average, BILL NYE home viewers watched 10 episodes per month.

• The majority of parents (61%) reported that their children's interest in science increased after watching BILL NYE.

• According to parents, BILL NYE influenced their children's interests and participation in science activities. [Almost all parents (95%) reported that their children undertook a science exploration, experiment or activity over the last few months of the study.]

• Watching BILL NYE promoted family interaction; almost all parents (92%) reported watching it with their child at least once and 92% said their child talked to them about the show.

Background

Our home study consisted of 351 children from urban, rural and suburban sites in Sacramento, Philadelphia and Indiana. The demographic breakdown by site, grade and gender is as follows:

	Urban	*Rural*	*Suburban*	*3rd*	*4th*	*5th*	*Boys*	*Girls*
Sacramento Total: 141	48	43	50	42	47	42	71	60
Philadelphia Total: 113	34	30	49	31	45	37	42	71
Indiana Total: 97	44	7	46	11	36	50	51	46

We asked our home viewers to submit monthly viewing schedules (See Appendix) so we could keep track of what they watched and how often they watched. We also asked our home viewers' parents to complete a pre-viewing questionnaire in December and a post-viewing questionnaire at the end of the study in May. (See Appendix) These surveys asked parents a variety of questions about their children's television viewing habits, and attitudes and behaviors regarding science. The following findings are based on data gathered and analyzed from these questionnaires.

Home Viewing Habits

According to parents, most of the home viewers (85%) watched BILL NYE on PBS. About ten percent did not specify where they watched the program. An additional one percent purchased their own BILL NYE tapes.

Over half of the home viewers (57%) watched other science-related programming such as Beakman's World (33%), the Discovery Channel (26%), National Geographic (19%), Nova (11%), Newton's Apple (8%), and the Nature Channel (5%).

We asked parents if their children regularly watch any of the following shows: The Discovery Channel, Beakman's World, Newton's Apple, The Magic School Bus and Ghostwriter. Half of the children watched The Discovery Channel, The Magic School Bus, and Ghostwriter on a regular basis; one third watched Beakman's World and about six percent watched Newton's Apple.

Viewing BILL NYE

On average, BILL NYE home viewers watched 10 episodes per month. The month of December had the lowest viewing average (7 episodes per month) and April had the highest average (11 episodes per month). The lower viewing in December was largely due to the Christmas holiday at the onset of our study.

Parents noted that their were a variety of circumstances that prevented their children from watching BILL NYE with greater regularity. The most frequently chosen response was scheduling conflicts (70%), followed by not enough time (29%), a change in the time in which BILL NYE was shown (13%); personal reasons (10%); the child or family members wanted to watch other programs (10%); lack of interest in watching (6%); and lack of access to television, VCR or cable (5%).

We asked the home viewers to watch one to two episodes per week and we also sent them 12 episodes on tape. Based on the viewing schedules that homeviewers submitted, the 12 episodes were watched with the following frequency:

Episode Name	%
Digestion	61
Water Cycle	61
Mammals	60
Birds	59
Waves	58
Earthquakes	55
Rivers and Streams	51
Fish	50
Spinning Things	50
Wetlands	49
Flight	49
Marine Mammals	48

Interest in Science

According to their parents, the children who participated in the home study appeared to be somewhat predisposed to science. They enjoyed science at school; when asked to choose their children's two favorite subjects, parents selected science, followed by math, reading, writing and finally social studies. From the student questionnaires, reported elsewhere, the students, too, report their substantial interest in science.

Despite their initial enthusiasm for science, parents reported that their children's interest in science increased after watching the BILL NYE show. Sixty one percent of parents reported that their children's interest in science increased to some degree; forty one percent stated that their children's interest in science moderately increased; twenty percent noted that their children's interest in science significantly increased.

> *My child has read more about mammals, reptiles, dinosaurs and outerspace after watching the show. He also spends his allowance money on related books.*
>
> *My son reviewed the episodes about Bernoulli's Principle and flying creatures like owls and then did a Science Fair Exhibit for school.*
>
> *My child was very curious about mammals. She took her tape to school, discussed it with her teacher and talked her into viewing it with her class.*

We also asked parents how interested their children were in watching BILL NYE on a scale of one to ten, with one representing "not at all," and ten representing "extremely." Over half (51%) of parents selected eight or above; one fourth of all parents selected ten, reporting that their children were extremely interested in watching BILL NYE. Only one fifth of all parents reported that their children's interest in science was at a 1, 2, 3, or 4.

> *I am thrilled my son could participate in the program! He watches the tapes you sent for entertainment. . . he really enjoys those tapes. He chooses them over any cartoon, video or movie.*

> *Watching BILL NYE got Ayreece up early some Saturday mornings.*

According to the parents of home viewers, BILL NYE had an influence over what children did and their interests in science activities. Almost all parents (95%) reported that their children undertook a science exploration, experiment or activity over the past few months. And they reported that their children's interest in participating in science activities over the past few months had also increased.

Children's science interest and activities according to their parents

Science Explorations		Science Activities		Science Interest	
Number	*Percent*	*Type*	*Percent*	*Type*	*Percent*
5+	23%	experiments	55%	experiments	55%
3-4	21%	made models	25%	museum	41%
few	41%	science homework	8%	television shows	41%
1	10%	mixing things	6%	other	56%
none/no answer	3%	other	20%		

Parents' Interest in Science and BILL NYE

During the course of our study, almost all (92%) of parents watched BILL NYE with their child at least once. One fourth of the parents reported watching BILL NYE with their children more than 10 times; another fourth watched BILL NYE more than 5 times; twenty percent watched in 3-4 times a week and another quarter watched it once or twice with their children.

Most of the parents also were interested in science or at least appreciated their children's interest in science. Almost two thirds (63%) reported that they had initiated science-related activities with their children. These activities were very diverse and included such things as: conducting science experiments (17%), going to science museums (14%), model building (11%), science fair projects (10%), going to a zoo or pet store (6%), planting a garden (5%) and participating in outdoor activities (4%).

We've gotten really interested in archeology and are planning some digs.

I enrolled her in and attended the Science Quest offered at the Indiana University School of Education. We visited three museums that had many science exhibits.

BILL NYE and Family Interaction

According to parents, children talked with them about a variety of things related to the BILL NYE show. Thirty five percent of parents reported that their children talked with them about the subject of specific BILL NYE episodes. Twenty two percent of parents noted that their children made references to specific BILL NYE trivia. For example, they sang the theme

song, said "Science Rules" or "Science is Cool." Sixteen percent of parents reported that their children made references to specific parts of the show. About thirteen percent made references to specific experiments they had seen on the BILL NYE show. Another ten percent talked about science concepts, such as how plants grow and how the earth spins.

> *She often asks me questions about science and tries to stump me.*
>
> *Both of my children (ages 6 & 8) and I . . . talk about all the episodes we watch and usually write stories about them-—to see how much we can recall from the shows.*
>
> *Every time Colby watches BILL NYE, he shares what he learned with our family.*
>
> *He was always singing the theme song. He even had me singing while I was fixing dinner.*
>
> *We watched two episodes of BILL NYE each day —the best example I have is that my 5 year old daughter also got to watch each day by default. While outside during the Blizzard of '96, she was sliding down a very tall snowbank and she said, "Look Mommy! It is my sliding board of science!" Just like BILL NYE says about his inventions.*
>
> *The eight year old will bring up what he's learned in conversation with adults. An example: How long do you think it will take water to break down these stones into sand?*

On the whole, parents were very satisfied with BILL NYE and how the program stimulated their children's interest in science. Not only did parents want their children to continue to watch, they wanted to watch with them, as well. When asked if they would watch BILL NYE with their children this summer, almost all of the parents (92%) said that they would.

> *I am so happy with the outcome since we have been viewing BILL NYE. It's amazing. I'm doing homeschool with my children and was lacking in things to do in science Not anymore. Thank you. And not only do the children enjoy and look forward to the BILL NYE programs, Mom and Dad do also.*
>
> *Thank you for interesting programs that I feel confident my son is learning and building on. You are doing a great job. Keep up the good work. How can we help keep the program going?*

Afterschool Care Settings:
The use of BILL NYE in other places

Rationale & Issues

Children are the primary audience for BILL NYE, THE SCIENCE GUY, and to study the effects of the series on children—and the potential of the series to influence children—it is necessary to go where the children are. While the majority of BILL NYE viewers are at home and in classrooms, many children are also in afterschool care settings for several hours a day. We chose to explore the impact of offering the BILL NYE programs as an alternative activity in afterschool settings in both urban and suburban areas. The study was conducted in Philadelphia.

In these settings, these cases illustrate both the limitations and the opportunities of using an educational and entertaining television series. First there is competition from organized and informal activities at the afterschool site, especially in warm weather. Second, these settings are social in nature and small groups form and disband depending on a variety of factors. Sometimes BILL NYE became a rationale for getting together, sometimes it divided a group. For instance, in some settings the girls who had become regular viewers, left the BILL NYE activity for more social interactions. Further, there may be a felt need for adult supervision and intervention. The belief of a demand placed on the professional staff may have created more problems than it solved, although most sites found it an easy activity to initiate and monitor.

For several of the afterschool care sites, children were expected to undertake academic as well as social activities. And here, BILL NYE found an easier place. Staff allocated time for academic efforts and places for academic pursuits; the television series became a supplement to homework or tutoring. In addition, the series attracted both younger and older children, who often joined an ongoing group of viewers. We may find that this is social rather than the appeal of a science show, but some of the younger children did become dedicated viewers.

The children in the afterschool care study took the same assessments as the school, home, and control viewers. However, the limited number of children—and the fact that participants shifted from viewers to non-viewers and back in a fluid fashion—prevented detailed analysis of the questions. However, we have some indications that the hands-on investigations seem to present consistent and substantial changes over time.

Outreach and outreach materials may be useful to extend the viewing opportunities for children and encourage and establish new viewers for home, school, and afterschool. The best materials may not be teacher guides, but rather simple experiments and observations that can be made indoors and out. Careful analysis of afterschool care sites can identify those which are among the better candidates for BILL NYE outreach.

Philadelphia Area Description

To view Philadelphia from above is to view a classic industrial city: center core, near a port and along a major rail line, a downtown, then urban row housing and aging, sometimes abandoned warehouses and industries of the 1900s, the heyday of the railroad. The heavily-used commuter rail lines extend from the center like spokes of a wheel. A Beltway of sorts—the PA Turnpike across the north, the Blue Route ringing the interior suburbs to the west. Outside the ring, the more affluent suburbs—the once-staid and horsy Main Line to the west, mall sprawl and newer suburbs to the northwest and north. Many of the nation's drug company giants lie near this ring, an arc leading right up into N.J. Beyond the arc, a mishmash of estates, farms, small towns, the odd city, and fast-food stores.

The mix of the city and surrounding areas is predominantly the result of old-style immigration and migration patterns: Welsh, German, Italian, Jewish, African-American, and WASP. Recent articles in the papers describe the area as fairly heavily segregated between black and white.

We identified three urban sites and two suburban sites in the Philadelphia area, focusing on those that served girls and minority children, to participate in the afterschool study. We provided these sites with both a

television and a VCR, along with a supply of BILL NYE videotapes. We asked that they show the tapes regularly and that watching be a listed, optional activity. Caregivers received a stipend for observing and identifying viewers on a daily basis. Urban sites included the Afterschool Program at St. Gabriel's, the Germantown Boys and Girls Club and the Parent Infant Center Afterschool Program at the University of Pennsylvania. Suburban sites included the Main Line YMCA Afterschool and the Garrettford Elementary School Afterschool Program

Our Philadelphia site coordinator administered both questionnaire and performance items as pre-viewing and post-viewing assessments and conducted interviews with the afterschool program coordinators.

Below is a summary of each of the afterschool care settings and their participation with the BILL NYE materials. Each can be considered a mini-case of the how the series might be used by different populations and in different settings. The generalizations to be drawn from these initial efforts are may be useful for outreach and a ways to extend the audience for this series.

After School Program at St. Gabriel's

Background

Housed in an Episcopal Church, the Afterschool Program at St. Gabriel's is actively involved in empowering a local northeast Philadelphia community, made up of the working poor. While the children speak English, their families speak more than 37 different languages at home.

Surrounded by a chain link fence, the children's playground consists of a four-car lot and a lawn next to the church. Cars speed by the church, located on a wide boulevard, the main drag into northeast Philly. Brownstones in varying conditions line the boulevard and side streets.

Thirty-three children from first to eighth grade attend the center and an additional 52 children remain on the waiting list. "We only charge $2 per week, which probably makes a difference," says Linda Alosi, the Homework

Coordinator for the center. "Other child care centers charge between $45 - $50 per child. . . Once kids get in, they stay."

The cost to keep the center going is about $80 per child per week. "Obviously, Jeannette Lew, our director, writes a zillion proposals, " says Linda. The program has since incorporated itself; while it physically remains in the church, it is a separate entity.

There are five paid staff members and approximately twenty volunteers (age 15-18) for 33 kids in grades 1-8. The number of volunteers—one for every five to six children—is much higher than the state requirement of a 1:10 or a 1:15 ratio.

St. Gabriel's has a more academic focus than the other afterschool sites in the study. "Basically, this was an arts program that expanded into academic assistance," explains Linda. "There is an older group and a younger group, and each group has an hour of tutoring (each day). Very few of our children are on grade level, and many of them have been labeled ADD (attention deficit disorder)."

BILL NYE Viewing

The St. Gabriel's staff gave BILL NYE a place within the program where it was self-contained and not competing with other choices. Afternoons at St. Gabriel's were divided into two parts: a one-hour academic period for homework and BILL NYE viewing; and a one hour period for a hands-on arts activity. The older and younger groups of children would trade places after an hour.

BILL NYE was shown during the homework hour period about twice a week. After viewing an episode, the children would discuss it for about 15 minutes and then would do homework. Children at St. Gabriel's watched 24 episodes over a three month period, an average of 8 episodes per month. On a weekly basis, Linda asked the children what their favorite show was and what they remembered from a week's worth of viewing. The children particularly enjoyed the digestion episode and came back to watch this one

again. According to Linda, the kids remembered a great deal from the BILL NYE episodes. She notes,

> *Things stuck. What's so strange is that the kids say they hate science, but this isn't the same. The science concepts became part of conversation. . . For instance, we have these sliding boards (plastic boards with wheels on them); kids would say, 'It's easier to go down because of gravity. Or the kids would mention, 'Well, it takes so many hours to get to the small intestine.'*

The staff at St. Gabriel's was very satisfied with the program and the role it played in science learning. Linda notes, "The science at the kids' school was too hard for them to understand, because they had to read it; now the kids' can catch the science on TV." They planned on using the program in the future. She explains, "I thought this was one of the greatest things. I'm definitely going to use this show next year."

Conclusion

St. Gabriel's is an example of a modest but well-organized, well-staffed afterschool center that gave BILL NYE a place within the program where it was self-contained and not competing with other choices. St. Gabriel's serves a low-income minority community, a group of children who would not be considered successful in science at school. Here, the BILL NYE program is able fill a gap by offering science to children who do not have strong science curriculum at school.

Germantown Boys and Girls Club

Background

Germantown is a low-income section of northwest Philadelphia where 50% of the populace lives in poverty. It has the highest rate of foster care in the city.

Located between a vacant parking lot and the campus of the upscale, socially-conscientious Quaker school, is the Germantown Boys and Girls Club, a four-story recreation center open from 3:30 p.m. to 9:00 p.m. The

center runs three programs that service 170 kids: a $10 membership recreational program, open from October to June; an afternoon child care program for children ages 6-12, with higher fees of $35-55 per week (which can be subsidized); and a teen program for grades 7-9.

The center has both a recreational program and a child care program. In the recreational program, there are activities offered, but kids can come and go as they please. One is left with a general impression that there is inadequate supervision. The child care program—a licensed day care program—appears to be more carefully supervised.

At the center, different floors present different activities. A fully-stocked game room offers pool and ping-pong. There are homework rooms, a computer room a TV room, a gym and arts and crafts rooms. The Power Hour—a homework period—runs from 3:00 PM to 4:00 PM and is followed by activities, including games, computer lab, arts and crafts and sports.

BILL NYE Viewing

The center showed BILL NYE during the Power Hour, the homework period. Children watched 20 episodes over a three month period, an average of about 7 episodes per month. The show had to compete with other priorities and staffing problems. Black History Month in February overwhelmed the schedule and vacations and snow days ensued. The large numbers of children and the varied schedules of the weeks kept BILL NYE from having a steady, predictable viewing schedule at the site.

Despite these obstacles, a core viewership developed, and after about a month and a half, the program became part of the weekly routine. Approximately ten children watched the show each time on a fairly regular basis.

However, about one month into viewing, girls began dropping out. They still appeared to like the show, but peer pressure reigned. In addition, other programs would sometimes pull them away from viewing. However, a group of boys became avid watchers. At the end of the study, we noticed that a couple boys had pulled in older friends or relatives to watch the show.

Yet while girls began dropping out, older children began dropping in to watch the broadcast. Several sixth and seventh graders took an interest in BILL NYE and started watching the program.

Rachel Clifton, the Child Care Coordinator, stated that she would definitely use BILL NYE again, because of its positive educational benefits. As a strategy for next year, she plans to place the BILL NYE viewing in the wintertime, so that it won't compete with baseball. Rachel also noted that she would alert kids to BILL NYE at the beginning of the year, rather than just try to work the shows into an already full schedule. The club structure also allows for creating incentives for viewing.

Conclusion

The Germantown Boys & Girls Club was definitely the most chaotic of the after school centers and encountered some obstacles to maintaining viewers, especially girls, since there were no incentives and there were competing activities during viewing. Yet the program coordinator intended to use the show in the future as long as it could be integrated into the program early on.

The Parent Infant Center (PIC)

Overview:

The Parent-Infant Center (PIC) is a day care and afterschool center, primarily serving the University of Pennsylvania, an urban campus in the western part of the city. The entire PIC complex is located in the outbuildings of a large and infrequently-used stone church. The afterschool center is separate from the day care center located on the same site. Two thirds of its clients are children of University of Pennsylvania faculty and staff; one-third are from families of working poor and are bused from nearby schools.

There are 45 kids at the center, from kindergartners to fourth graders. Some attend every day; others attend sporadically. There is playground equipment and ample fenced-in grounds for lots of outdoor play when the

weather is nice. When it's cold or rainy—or at activities time—all kids are upstairs in the center, spread among several small rooms:

"The most important philosophy of our center is that children have a lot of choice," said Brad Cogdell, afterschool director. "All day long, the kids are being told to do things. This place is for them to choose. We try to provide many things to do."

The center has an art teacher—and what appeared to be a strong art program with a structured activity each day. Aside from that, it appeared that the staff for the upper division of the afterschool consisted of Brad and an assistant.

BILL NYE Viewing

BILL NYE had a tough time competing in the PIC setup. "We try to provide free choice and many things to do," said Brad. "That's why it's harder here."

At first, the BILL NYE viewing was expected to fall in that activities slot three days a week—Monday, Tuesday, and Friday. However, as Brad Cogdell, the afterschool coordinator notes, "The honeymoon was over after about a month. It was competing with too many activities, and interest was spotty. I then began showing it during snack time, and made sure everybody knew about it."

From interviews with the children and with Brad, a picture of the snacktime viewing began to emerge. The show was on while children were having their snacks. Viewing and/or social discussion went on at the same time, so attention must have been spotty. Kids were not required to stay once they had finished snack, although they were encouraged to stay for at least 10 or so minutes.

Even right after snack, though, there was competition. The girls headed to the Homework Room (for reasons both academic and social) to play school. Others could head outside again. Brad experimented with viewing times, but snack time worked the best. Socializing was occurring at the same

time as viewing. Only a few children would stay through the entire show. Brad explains, "Remember, we give the children a lot of choice."

Overall, children at the Parent Infant Center watched 27 episodes, about 9 shows per month. The calendars show a marked decrease in viewership in March, and a pickup of viewership by about half the class during April. In performance post-interviews with the children, the Philadelphia site coordinator began to hear the phrase, "Bill Nye the Stupid Guy"—typical third and fourth grade stuff. Brad explained, "Kids would tell friends it's stupid. It became the in thing not to watch it, the cool thing to say it was silly—the Power Ranger/Barney effect."

Despite the pressure, something would still draw several of the kids. Boys watched the show significantly more than girls. "The fourth grade girls decided that they didn't like the show. Instead, they would go into another room and talk or play school. It's a social thing. Once the leader decides. . ." said Brad.

Brad thought that he would use BILL NYE again but not on a regular basis. "BILL NYE again?" he asked. "I would like to use it more during themed weeks."

Conclusion

The PIC site provides an opportunity to view a mismatch of educational programs and resources. At a center where free choice is the main priority and where there are a large number of activities from which to choose, introducing a regular viewing opportunity spells trouble. It brings too much competition and too much structure. A center like the PIC site would do well with just a tape or two, or a tape with theme-related materials, to use when desired.

Main Line YMCA Afterschool Program

Background

Ardmore is an old, middle-to-upper-middle class suburb out the Main Line (the name given to a series of suburbs along a commuter rail route that was once THE main line to the state capital). The YMCA lies across the street from Suburban Square, an old shopping mall that still houses Laura Ashley and other expensive stores. Fifty to sixty kids are in KidCare (day care) at the Y during the period from 7 a.m. to 6 p.m.; 25-30 children, kindergartners through fifth graders, are in the afterschool program. The group, like Ardmore itself, has few minorities.

The Afterschool program is housed in a couple of classrooms downstairs with easy access to the gym and to the outdoor playground. The Y program is loosely structured and includes lots of outside and inside play. Some of the play is organized; some is not. "It's mostly free choice," says afterschool coordinator Terrance Neal. "They've been in school all day, so they don't need to be forced."

Attendance varies from day to day, which also lends a loose feel to the program. Some kids are five day-a-week regulars; many come three or more days by parental choice. School sports, Hebrew school, and other activities intervene.

Arrivals begin at 3:30 PM; the program begins at roughly at 4:00 PM. The time of year has an impact on the shape of the program. Terrance explains, "In the winter months, we're more structured. In spring, we go outside." On sunny, warm days, kids head outside at 4:15 PM (or even earlier to have snack) and play until pickup at 5:00 PM on. In winter, it's indoor snack at 4:00 PM, then at 4:15-5:00 PM a choice among arts and crafts instruction, games to play in the gym, computers. BILL NYE became one of the choices offered at 4:15 PM.

It is not uncommon at this YMCA—or at its sister Y farther out the Main Line—for employees to wear several hats. Mike, the KidCare (daycare) supervisor, is also the Aquatics Director. Terrance runs the afterschool, works with the KidCare preschool during the day, and runs the vacation camps and

some of the summer camps at the Y. The staffing, or lack thereof, has an effect on watching BILL NYE; one cannot expect a high level of coordination when the staff is pulled in so many directions.

Children watched BILL NYE in the Block Room, which also housed the program's computers. The viewing group was called the Club. "The kids were not forced to be there, but encouraged to stay," explained Terrance. Other children could be at the computers, but with the volume turned off. Low-level discussion ensued as the children watched. When the show was finished, children moved onto other activities or play.

BILL NYE was shown a steady two to three times a week for the first month. Staffing changes occurred in March, creating a breakdown in record-keeping, but it appears that viewership remained steady at two times a week. In April, vacation camp kicked in, and overwhelmed the coordinator, who stopped showing tapes. When the camps ended—and after some intervention from the site coordinator—viewership normalized once more.

"The reaction was mostly positive once the kids were watching, but there was often resistance to begin the watching," said Terrance. He explained that several children became restless and the staff offered viewer incentives or lollipops as an enticement to stay. He notes, "But then they'd forget the treats and stay anyway. By the end, I just let them view as they wished." And continue to view they did.

Because the viewing was happening in a room close to the entire afterschool program, "the little kids wanted to watch, too," in particular a group of second-graders. A few of second graders remained BILL NYE viewers for the entire course of the study. "In fact, when I use BILL NYE again, I'll probably include the second graders," noted Terrance.

Overall, the children seemed to thoroughly enjoy the program. They constantly sang the theme song. Both Dinosaurs and Chemical Reactions were two of the most popular programs and Nutrition was one of the least popular shows.

News of the BILL NYE viewing filtered home as kids began talking about the show. Parents—all who had signed permission slips and thus knew of the program—became curious as to what their child was doing. This positive curiosity was noted among parents who arrived early to pickup children on the day we were completing post-viewing interviews.

Terrance said that he would use BILL NYE again noting, "It's a positive experience in contrast to shoot-em-up TV." However, he wanted to do more things to unite BILL NYE viewers by providing incentives for viewing, such as t-shirts and pennants. "I'd do more things that would make it a club," he explained.

Conclusion

The YMCA afterschool experience shows the potential of a BILL NYE program in a loosely structured environment. The club structure, with positive reinforcement and incentives, seems to have some value to maintaining viewing, although it would need underwriting. Use in the winter seems appropriate and actually helpful to the site. Use in the spring, when warm temperatures beckon, seems inappropriate for any TV show.

Garrettford Elementary School Afterschool Program

Background

Garrettford is a nice, old-fashioned, two-story elementary school in Drexel Hill, an inside-the-Beltway suburb with a downtown strongly reminiscent of the 1950s. Its afterschool program is an extended-day program that is one of several in the Upper Darby school district.

The school sits between a body shop and a local convenience store. The obligatory green lawn and stone wall are out front; blacktop playgrounds and a ball field or so are out back. The afterschool program is housed in the school basement, and includes a cafeteria and a couple of small classrooms. Two side rooms house the Homework Room and the TV for BILL NYE, but it's mostly in the cafeteria, and outside, that the kids play.

Fifty-seven children from grade K through 5 participate in the program, but the core attendance is actually between 40-45. Parents pay $5.50 / day for the care. About eighty percent of the children come five days a week. The other twenty percent come sporadically. Three supervisors rotate overlapping duties; two aides work there daily.

The philosophy of the afterschool "is supervised play and day care," explains aide Nancy Biller. "There's a loose structure here; the kids are structured all day (in school)."

The children arrive at 3:30 PM. They then choose to go to the Homework Room or play outside. At 4:00 PM, all come back together for snack. Children are then presented with a number of choices: play, or gym, or a movie, or a craft. Some parents begin pickup as early as 4:30 PM—unusual for an afterschool—but most come between 5:00 PM and 5:30 PM.

BILL NYE Viewing

Students watched BILL NYE during the 4:00 activity time. The array of student choice was essentially to watch BILL NYE or play with friends.

The list of BILL NYE viewing volunteers was collected via parental sign-up. TV on, tape in, lights out was the drill. Some students who hadn't signed up would saunter in mid-show, out of curiosity. Once an episode was finished, the kids all went back out to play. Children watched 18 episodes over a three month period, an average of six episodes per month.

As observed in other centers, kids who signed up for the viewing were encouraged to stick with it. "At first, we said, 'you signed up, stick with it,'" commented Nancy. "Then we just let it go. That immediately weeded out a certain number of children. Those who stuck were mostly third grade boys."

As the study progressed, girls began backing out of watching to chat or play with their friends. The third grade boys became a social group all their own. "The boys discussed the shows as they watched. They sang the theme song. They were into it," states Nancy. Their favorite episodes included Dinosaurs and Reptiles.

There were several other effects of viewing. Younger children developed an interest in watching the show and several second graders became regular viewers. There was also a spin-off effect of home viewing. Some students were already home viewers; but others became new ones.

Nancy felt that they would definitely use BILL NYE again, but during the winter, and only for a couple months. She felt that short-term use kept the program fresh and put it to its best use. Long-term use, when the show was in constant competition with something else—or use in competition with the great weather outdoors—seemed detrimental to the experience.

Conclusion

Extended-day programs such as Garrettford's are common throughout this area. Despite their recreational nature, they may still have a place for wintertime viewing of BILL NYE. In Garrettford, as in three of the five afterschool settings, the social group appears to have pulled several of the girls away. It appears that for girls to watch BILL NYE in an afterschool setting, the show cannot compete against the social group; the trick is the time slot. Peer group interaction, particularly for 4th and 5th grade girls, is both necessary and enjoyable, and must be given its place.

ITV Study

We surveyed over 200 PBS stations across the United States and Commonwealths to determine if and how they use BILL NYE. We mailed questionnaires to the instructional television (ITV) director at each station and received a 72 percent response rate. The surveys were usually completed by the ITV directors themselves and sometimes by a member of the station's outreach staff.

Almost all (93%) of these stations carry BILL NYE THE SCIENCE GUY and carry it on a regular basis, Monday through Friday. The two most popular time slots are at 5:30 PM (31%) and 4:30 PM (31%). A few stations also block feed the program at various times throughout the year.

More than half (58%) of these stations include BILL NYE THE SCIENCE GUY as part of their outreach activities and almost all of these activities (92%) are directed at schools and teachers. Teacher guides are the most popular type of outreach materials and are either mailed upon request or given out as part of a teacher training package. ITV directors also reported some other alternative uses of the program. For example, one station uses BILL NYE in conjunction with a daycare outreach program and another uses it in combination with a parent education seminar.

Many stations noted that they use BILL NYE through the NTTI (National Teacher Training Institute). For example, at KLRU in Austin, several master teachers used the series in their teacher demonstrations at the Teacher Training Institute. They develop lesson plans integrating segments of the program into their curriculum.

A few stations noted that they no longer have the funds to conduct outreach programs. Some specifically mentioned that they wished they had the funds to conduct BILL NYE teacher trainings.

In 1995-96, only 14% of all these stations conducted any surveys of series use and impact that included BILL NYE THE SCIENCE GUY. We

received copies of these surveys from five different stations. In four out of five of them, BILL NYE THE SCIENCE GUY consistently ranked among the top three programs used most as an instructional tool. (Reading Rainbow and Magic School Bus were usually in the top, as well.) In the fifth survey, it was ranked as the fourth most used program.

Many stations noted the popularity of BILL NYE as a teaching tool:

• In a survey conducted by KLRN in San Antonio, Texas, 26 of 65 schools reported recording *BILL NYE the Science Guy* for classroom use.

• Forty eight percent of schools surveyed by KCOS in El Paso, TX reported using BILL NYE in the classroom.

• WGTE in Toledo, Ohio reported that BILL NYE ranked third in the list of programs used in the classrooms.

Many station managers would like more materials and more opportunities to present BILL NYE as part of an outreach program. Feedback about BILL NYE THE SCIENCE GUY was for the most part, extremely positive. Station directors noted:

> *Audience response is very positive . . . It has really sparked interest in science; we get phone calls requesting repeats.*
>
> *In our workshops, the teachers over and tell us how much they enjoy using BILL NYE. Parents tell us when the show is over, kids want to try the experiments* KLRU, Austin, Texas
>
> *I do a lot of public appearances through Maine and BILL NYE "anything" goes like hotcakes. The show is a big hit.* Maine PTV

There were, however, some exceptions:

> *We like BILL NYE and use it in our school services, workshops, etc., but we have one major complaint. We do not like that the series can be seen on a commercial network too . . . PBS stations across the country have been talking profusely about the importance of having PBS's identity remain unique . . . not meshed with the commercial networks. If BILL NYE continues to be identified with a commercial network, we may opt to drop it from our schedule . . . although we would prefer it to be a PBS exclusive series.*

We would love to carry BILL NYE, which is very popular. Due to the category that PBS puts this program in (NDS), combined with the PBS restriction on program acquisition, we are unable to carry it.

We use the TTI model and encourage legal use. BILL NYE is not used because of limited rights. Teachers need to be able to have materials recorded and duplicated at media centers. The 3-year off-air rights help but don't resolve the concerns about legal use.

Conclusions & Recommendations

The BILL NYE THE SCIENCE GUY television series was studied in three "natural" viewing settings, with only minimal controls and individual good-will as limitations on the audience's behavior. As with all field research, no matter how well-planned the controls and the conditions, there will always be imperfect implementation. In this study, too, there were problems in getting some classrooms and children not to watch and to get those who were supposed to watch to watch enough. Nevertheless, the design we used provided us with sufficiently large samples to arrive at supportable conclusions.

For some areas of exploration, we found many important and powerful outcomes that point to the impact of the series on children's science understanding. In other areas of inquiry, we found little impact, possibly because we asked the wrong questions, possibly because the amount of viewing and follow-up did not meet some minimum amount needed to produce a meaningful change, or possibly because the programs did not—by design or by execution—produce the results with these viewers. Some of the results are, upon reflection, quite reasonable; others are counterintuitive.

Many of our findings must be considered "tentative," since not all viewing conditions produced the outcomes. It may have been that contextual events beyond the programs had a significant impact. Sometimes the changes in students knowledge and understanding are statistically significant yet only moderately different in absolute terms. Other times we see large changes, yet because of the sample sizes, the changes may not be statistically different. But some of the outcomes are replicated from data on similar questions and elicited in several ways by the evaluation tasks, and in these areas we have greater confidence in the information we present.

Conclusions

Our conclusions are based on the data we collected from the three sites around the country and from our observations of children, classrooms, and afterschool care settings.

• BILL NYE the Science Guy influences children's understanding of science in a variety of environments, at home, in school and in afterschool settings. BILL NYE is an effective instructional tool that increases children's ability to interpret science information and reinforces their already-positive attitudes about science.

• The greatest effects were related to children's critical thinking and problem solving skills that use science knowledge. After watching BILL NYE, children were able to provide more complete and complex explanations of scientific concepts than before viewing and they increased their ability to identify and explain scientific phenomena.

• BILL NYE has an impact on girls and minority viewers, but this impact does not result in equal outcomes. When we see gains in science thinking skills, girls often improve as much or more than boys and minority students often improve as much or more than majority students. However, both girls and minority children start with scores below those of boys and majority children and, while reducing the performance gap, they do not fully catch up.

• While girls' level of viewership was similar to that of the boys in our home study (and, by definition, was equal in schools), in the afterschool settings girls' viewing tends to drop off when presented with alternative, more social activities such as doing homework with others and socializing.

Attitudes

• Students started with such positive attitudes towards science that little change was likely to appear. Viewers seem to be moving away from stereotypical attitudes about scientists, and we see more belief by girls that they can be scientists. Nevertheless, most children do not readily see women as scientists.

Teachers

While many teachers use the program as an instructional tool, the majority of teachers reported that BILL NYE only matched their curriculum sometimes. Some teachers requested that the episodes be grouped into thematic units that could either be broadcast in concert or sold as a collection. Teachers find the current broadcast schedule a barrier to effective use, as they often don't have access to needed episodes until their curriculum unit has ended.

Teachers often showed the program without a well-defined instructional plan and built a lesson around it; it became part of their science program by accident rather than by design. Many teachers reported that they did not engage in activities or experiments related to the programs, yet children's gains in science understanding were often directly related to concrete demonstrations of concepts they saw on the show.

Parents

Watching BILL NYE promotes family interaction—parents and children talk and watch together and talk about what they see. This is likely to increase learning from the program and potentially more involvement in science activities. Almost all parents in the study plan to continue watching with their children.

The majority of parents are initiating science activities with their children and report their children's interest in science increased after watching the broadcast and almost all report that their children undertook a science activity over the last few months of the study.

Afterschool Setting

Afterschool settings can be a good audience for viewership and outreach. Overall, BILL NYE attracted a core viewership in the afterschool centers and sometimes younger viewers joined in to watch. Viewership was higher in the wintertime and when it was not directly competing with more active alternatives such as sports. While in most cases social activities were competing more successfully for children's attention, in some settings, viewing became a social activity that drew cliques of children together. There were few opportunities for BILL NYE-based experimentation or exploration at the afterschool care sites.

Recommendations

This evaluation was designed to explore and assess the impact of the BILL NYE series on children's knowledge, attitudes and behavior about science. In the process of analyzing and interpreting the information we gathered, we could not avoid developing recommendations (or hypotheses) about ways to make the series more valuable to children, schools, and families. Below we offer some of ideas for the staff of the series and the outreach program to consider for future action.

Production Issues

Based on our findings, there are several content and production issues for consideration by the BILL NYE production team:

- Science demonstrations seem to be the most effective way of explaining scientific concepts to viewers. However, the demonstrations portrayed on the show are not always age-appropriate. Producers should consider more simple demonstrations and more explanations of those demonstrations.

- Viewers often have difficulty transferring scientific principles to other contexts. Thus, demonstrations should include multiple perspectives that illustrate a range of applications of the selected scientific phenomena.

- As the production staff already know, repetition works. For this age group, repetition of the same idea in different contexts—and connecting them to one another—would help children's understanding of the material. These issues are critical to getting kids to understand the "Big Idea" for the programs.

- Repetition across episodes is also powerful in helping children capture the Big Idea. Our data indicate that concepts presented across shows were more likely to be understood.

- Producers should consider showing the same science concept in both lab and non-lab settings to reduce stereotypical perceptions of scientists in the

laboratory. Although BILL NYE shows a range of scientists and science activities, the show reinforces the general stereotype of a scientist, by portraying Bill in a lab coat working in an underground laboratory.

• Special attention should be paid to the choice of female role models in the program. Segments such as Way Cool Scientist and The Animal Lady are excellent examples of positive female role models. However, the program also portrays women as stereotypes, such as the "Valley Girl" singer in "Mammals" and the recurring role of the '50s mom. Consider more guest shots with girls viewers (and minority viewers) as a way to encourage more girls (and minorities) to view the series.

Outreach

The viewers affiliated with our study had minimal interaction with "official" BILL NYE outreach programs; the newsletters, materials, and guides were rarely present. And while the amount of outreach we provided went well-beyond what might be reasonable for KCTS or PTV stations to provide, we do have some recommendations for the outreach program.

• To continue to interest and educate girls, in addition to changing production to reflect more positive interactions with girls / women, BILL NYE might consider specific outreach activities to encourage and maintain girls' viewership, such as a newsletter targeted to girl home viewers.

• More outreach with teachers and schools is likely to be beneficial. Making the program more compatible with the curriculum and packaging the materials to be more consistent with the curriculum as it is applied in schools, might encourage teachers to use the series as part of their curriculum, rather than as fill-in and ad hoc curriculum. Teachers would be more likely to use the series if the program schedules (or even the teacher guide, as is planned) brought together similar programs in curriculum units.

• With more educators turning to the Internet for information, and with the variety of sites that connect to the NYE LABS ONLINE, curriculum materials and lesson plans at the web site might be a useful addition to draw teachers in. The web site could also provide an opportunity for teachers to

add online resources, such as lessons and alternative materials for BILL NYE experiments.

• Additional outreach to homes would only enhance science learning and continue the family connection that BILL NYE helped establish. Possible outreach materials could include question-and-answer sheets on specific BILL NYE episodes, recommended science reading lists, especially biographies of women and minority scientists.

• Afterschool care settings can become valuable adjunct viewing opportunities for the BILL NYE series, and can facilitate more home and family viewing. It appears that more highly-structured afterschool programs with an emphasis on academics would be optimal for outreach intervention. The opportunity for children viewing in afterschool settings is greater in the bad weather months, and can be promoted as an "inclement day activity." The outreach should also include information for parents, so that kids can take something home that promotes family viewing.