



# Building Wonder in Math and Science

A joint collaboration between the  
Toyota USA Foundation and National 4-H Council



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## Executive Summary

***The danger exists that Americans may not know enough about science, technology, or mathematics to significantly contribute to, or fully benefit from, the knowledge-based society that is already taking shape around us.***

*(Rising Above the Gathering Storm, Pre-Publication Version, February 2006 Edition, p. 3-24).*

Building Wonder in Math and Science directly impacted this critical need.

Reaching **2,294 middle and high school youth** and **453 teen and adult mentors**, Building Wonder in Math and Science successfully impacted the math and science skills of young people in diverse after-school programs located throughout **Hawaii, Maryland, New York and Wyoming**. Of the participants, nearly **50% resided in low-income neighborhoods** and most did not have science and math opportunities in their after-school programs. The program also spanned the Pacific Ocean. The Hawaii site reached nearly 400 youth in seven military installations located in Hawaii, Alaska and Japan (Appendix A).

The results of the program were remarkable. Program participants increased their scientific inquiry, mathematical reasoning and decision making skills through hands-on discovery in experimenting and observing, gathering and analyzing data, identifying characteristics and classifying information. Using the *Wonderwise* curriculum (Appendix B), the program used youth-initiated inquiry to encourage participants to generate their own investigative questions and form their own hypotheses, giving them an opportunity to develop core math and science skills.

Building Wonder in Math and Science also leveraged high school teenagers as mentors for middle school youth. Using the proven Teens Reaching Youth (TRY) 4-H model, 453 high school teens and their adult partners were trained on both the content of *Wonderwise* and the context of youth development principles appropriate for middle school youth. The teens and adults were then placed into teams of three and taught more than **300 Wonderwise lessons** to middle school youth in after-school programs. The high school teens gained self confidence through the mastery of concepts while recognizing the importance of being mentors for middle school youth. The middle school youth increased scientific inquiry, mathematical reasoning and decision making skills through hands-on discovery.

The results were noteworthy. Twenty-five state 4-H programs vied for only four available awards – a testament to the critical science needs of after-school programs. 4-H exceeded all program goals, reached underserved and diverse populations and successfully increased the math and science skills of middle and high school youth. An overview of the results follows. Furthermore, an in-depth description of each state project can be found in the appendix.

## State 4-H Programs Reached:

Hawaii (plus military bases in Alaska and Japan), Maryland, New York, Wyoming

## Program Numbers Exceed Goal:

	Middle School Youth Served	High School Youth Served	Number of Teens as Teachers	Number of Adult Mentors
Goals	1,440	-0-	72	36
Actual Impact	2,108	186	177	276

## Racial Demographics of Youth Served:

Caucasian	African American	Hispanic	Native American	Asian	Other Racial Background
34%	25%	16%	9%	5%	11%

## Socio-Economic Level for Families of Youth Served:

Low Income	Medium	High
49%	48%	3%

## Participant Outcomes:

1. Youth participants increased their scientific inquiry and mathematical reasoning abilities in hands-on learning environments (see Appendix A for state summaries)
2. More than 300 *Wonderwise* lessons were taught by Teen/Adult teams (see Appendix B for a description of the nine *Wonderwise* modules)
3. Youth learned that people of all backgrounds and with diverse interests, talents, qualities, and motivations engage in fields of science and engineering.
4. Youth used technology (including computer hardware and software) and techniques to gather, analyze, and interpret scientific data.

## Participant Feedback:

- *“Wow!! Building Wonder in Math and Science has definitely brought many endless opportunities to our Youth. . . it is a program that will continue to live on and multiply with endless opportunities of learning and discovery and the most important is that of having FUN!!!! It has given so many individuals a whole new insight to Science and Math...it’s everywhere and fun!”*(HI adult volunteer)
- *A teacher from Star Valley (Lincoln County - WY) said that “Building Wonder in Math and Science was the best book he had to interest middle school youth in science.*

## Participant Feedback (continued):

- *“Overall this program was great. I learned a lot with interacting with the middle school kids. . . The kids were having a great time and most importantly, they were having fun while learning. . . This program allowed the students to mature and gave these students a thought of what career to pursue when they group up . . . this program greatly increased the motivation of the students to learn and gave the students an idea of what to expect to be done in the future years of their education.” (NY Teen Teacher)*
- *One of the youth leaders from Weston County (WY) is a top academic student there. She said that her experience with Building Wonder in Math and Science . . . “was a primary reason for her personal interest in science and her intended choice of a scientific career.”*

## Program Sustainability:

All states reported plans to sustain the program by continuing to use the teens and adults trained to teach the *Wonderwise* curricula and by training additional 4-H professionals, teens and adults to deliver the program to youth in after-school and summer programs. Many of the collaborators, like school teachers, have also expressed interest in using the curriculum.

## Budget Report:

Expense	Total
State 4-H Program Grants (4 states @ \$30,000 each)	\$120,000
Program Leadership	\$ 5,000
Indirect Costs	\$25,000
	<b>\$150,000</b>

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## Appendix A

### Program Summary Reports from Grantees:

Hawaii  
Maryland  
New York  
Wyoming

## Hawaii

*Wonderwise* = Math and Science to Infinity Across the Pacific (“W = MS ∞ Across the Pacific”) has truly become a reality! Ten (10) youth/adult teams were trained and went back to their communities and taught the *Wonderwise* curriculum. In addition to offering the program on the Hawaiian islands (Oahu, Maui, Molokai, East and West Hawaii), the program successfully reached seven (7) military installations – Ft. Greely, Ft. Richardson and Ft. Wainwright in Alaska; Aliamanu Military Reservation and Schofield Barracks on Oahu; Camp Zama on Japan and on the tiny island of Kwajalein. The program served 22% African American; 16% Asian, 29% Caucasians, 7% Hispanic, 2% Native Americans, and 24% of youth from other racial background. The curriculum was taught to 395 middle school and 81 teens by 79 teen teachers and 124 adult mentors.

Kathy French, an expert in the *Wonderwise* curriculum, provided training to staff in the State 4-H Youth Development Program and the Military 4-H Program. With the many choices from the nine *Wonderwise* modules, teams were trained on some activities from each. Some teams preferred certain modules but found that there were topics that all the youth would enjoy doing and be able to learn a broad spectrum of science and math lessons.

With every session completed, the teams found that most of the youth were surprised that what they were learning dealt with science and math. They realized that the *Wonderwise* material can be fun using a simple and easy 30 minute activity. Most of the audience wanted to have more sessions with our high school teen trainers. And as with all of our 4-H projects, working in a non-formal educational setting, it provided the youth many “hands on” things to do. By assigning the group into teams, it provided them with leadership, sharing, responsibility and teamwork. Each team member was able to provide input in the activity, allowing them to come up with ideas and developing their own hypotheses on what will happen.

We also had plans to conduct community service projects to tie in with the *Wonderwise* modules, going back to our goals of adapting what youth have just learned into real life situations. Our Ft. Richardson site in Alaska did exactly this as a community service project. They had collaborated with Home Depot and developed Operation Flower Power. Teens and adults had a planting expedition at the front gate area of Ft. Richardson. It doesn’t end there with just planting the flowers; the teens also have the responsibility to water and tend to the plants until September. This is a great example of taking what you have just learned to apply it in real life.

In September, there are two opportunities where we will be using *Wonderwise* Program. One of these involves an exhibit at a four day event where last year’s attendance was over 90,000 people. Another upcoming *Wonderwise* Project will be a three-day October 4-H Staff Development Training that will include youth volunteers, teachers, after-school staff, and other youth agencies and organizations. We feel this is a way to sustain the program and get more youth and adult leaders trained with the *Wonderwise* modules to be used with their youth.

## Maryland

In Maryland, sites in six counties and Baltimore City worked with 35 teen leaders and 35 adult volunteers to engage 398 youth (15 elementary, 364 middle school, and 19 high school) in experiential learning, to improve their understanding of scientific concepts and to develop their skills of scientific reasoning and decision-making. The *Wonderwise* curriculum was taught to underrepresented youth in after-school programs, summer camps, and recurring weekend programs. The program reached a diverse audience of youth: 57% African American, 32% Caucasian, 4% Asian, 3% Hispanic, and 4% of youth from other racial backgrounds.

The State 4-H Afterschool Team supported the local sites initially with a distance education training on the curriculum, evaluation pieces, and working with teens in after-school settings. The initial goals of having the local sites recruit and train 18 teens and 9 adults to deliver the *Wonderwise* curriculum modules were surpassed. The sites recruited 35 teens and 35 adults to develop team teaching partnerships.

The *Wonderwise* program in Maryland used several of the *Wonderwise* modules to achieve the program objectives. All objectives were achieved. Some of the highlights of the findings include:

- Approximately 90% of the participants learned the following scientific words and could accurately explain or discuss the concepts: ecologist, surface tension, herbivore, urban, botanist, hypothesis, biodiversity, food web, carnivore, rural, hydrologist, transect, habitat, watershed, wetland, seed dispersal, entomologist, and erosion.
- Youth learned about investigation, performing measurements and calculations, writing a hypothesis, performing the research, and then finding the answer to questions. Youth developed a basic background in photosynthesis and made the connection that the starch in plants and other foods are complex carbohydrates that provide energy.
- Youth planned and conducted an investigation, learned to estimate, measure and interpreted data, and developed an understanding of biodiversity and of form and function.
- Youth learned about the scientific method – how to pose a question, make a hypothesis, test the hypothesis, gather results and information, and reach a conclusion.

Several of the sites have identified an interest in continuing the program in after-school sites in the fall. After completing one module, the youth/adult teams have interest in exploring some of the other modules with their youth. The Maryland 4-H Afterschool Team and the local offices will pursue funding opportunities to assist in sustainability along with the help of the Maryland 4-H Foundation. The Charles County team plans to continue the program in the fall and took a unique approach to recruit participants by presenting the Urban Ecology module to 23 public school teachers and administrators. Through a survey, 85% of these teachers stated that they would “definitely” utilize the activities presented by the teens in their classrooms.

## New York

The New York *Wonderwise* program was a success. After receiving funding, staff in the Cornell Cooperative Extension program of Westchester County recruited and trained teen/adult training teams. The *Wonderwise* curriculum was taught to 485 middle school and 41 high school youth by 44 teens and 55 adult mentors in 51 teaching sessions. The Yonkers School District partnered with 4-H to envision, develop and deliver the program. The program involved 38% African American, 30% Hispanic, 6% Caucasian, 2% Asian, and 24% of youth from other racial backgrounds. The program used all nine of the *Wonderwise* curriculum modules.

The teen leaders were very enthused about delivering the program. Student leaders seemed to get a sense of what teaching involved and indicated that they learned a great deal about the topic they taught to middle school students in an after school setting. The Pulling It All Together summary requested at the conclusion of each module was a burdensome task given the demographics and academic limitations of the urban bilingual participants. Even though teens were encouraged to request pictorial representations, the feedback was that the activity “felt too much like school work”. The Extension Educator worked with the staff to develop a compromise: a much simplified wrap up evaluation which was read to the students. They were given assistance in writing the short answers. The written comments from the teen teachers and program participants indicated that the youth increased their knowledge in the topics covered in the *Wonderwise* curriculum.

There is every reason to expect that Westchester *Wonderwise* program opportunities will continue to flourish and be extended in unique and special ways beyond the funded period. Already, several of the teen leaders from the high school in Yonkers have attended the 4-H Career Exploration Conference with other teen 4-H members; the enthusiasm and energy on the bus ride gives testimony to the power of youth. This trip to Ithaca provided an initial opportunity for youth in Yonkers to become familiar with 4-H in Westchester County through a fun and valuable experience with current 4-H teen members....yes, e-mail addresses were exchanged and there are plans to reconvene the larger county teen group and include these new acquaintances!

Cornell Cooperative Extension of Westchester County will continue to offer selected modules and topics from the *Wonderwise* Curriculum at the Cornell Cooperative Extension Environmental Educational Center at Hilltop Hanover, as well as for site programs for the Middle School Great Potential Sites in Westchester. It is anticipated that this program will continue to be offered and implemented as an after school option through Cornell Cooperative Extension. The program has proven to be easy to present, to implement in collaboration with high school teen leaders and in an after school setting. In addition, the New York State 4-H Office has made a commitment to host a 4-H Afterschool *Wonderwise* workshop at the State Educators’ Conference in October.

## Wyoming

Seven rural Wyoming counties and at least 22 different sites utilized the *Wonderwise* curriculum in either after-school or summer programs (or both) during the April through June period of 2006. The curriculum was taught to 864 middle school and 45 high school youth by 19 teen teachers and 62 adult mentors during 102 teaching sessions. The *Wonderwise* program served a diverse youth audience: 55% Caucasian; 24% Native American; 18% Hispanic; 2% African American; <1% Asian.

Four, full-day training sessions for youth and adult leaders were conducted during March and April. The training sessions focused on these objectives: 1) “Improved understanding of scientific concepts,” and 2) “Increased ability in scientific inquiry and mathematical reasoning.” Science-as-a-process was a major component of the leader training workshops, and as participants completed at least one activity from each module, emphasis was placed on formulation of hypotheses, prediction, experimental design, data collection and interpretation, etc...the “how to” and “so what” aspects of scientific investigation. Participants in the training workshops included adult volunteers and paraprofessionals, teachers, Extension Educators and high school-age youth.

The Wyoming *Wonderwise* project collaborated with many partners in counties all over Wyoming. In over half of the participating counties, *Wonderwise* was incorporated into existing after-school and summer programs funded by the local school districts. In addition, *Wonderwise* was utilized in programs overseen by Boys and Girls Clubs, 21<sup>st</sup> Century Learning Centers and several faith-based organizations.

Data were collected and reported from sites that used the *Wonderwise* curriculum. Almost universally, both adults and youth love *Wonderwise* because of its ability to personalize science and scientists, its emphasis on hands-on activities, and its demonstrations of how science relates to real-world issues. The not so subtle demonstration that women and people from all races, cultures and backgrounds can be scientists is also an extremely important aspect of *Wonderwise*. Teachers like *Wonderwise* because of the high interest activities that are also tied to educational objectives and standards. There is significant science content imbedded in the *Wonderwise* modules. Program participants speak to the success of the program: “Hey, I’m actually doing science, and it’s exciting and fun! I’d like to do more of this!” Similar responses were provided by many of the program participants, youth and adults.

The best news is that the project produced enthusiastic and trained leaders in many Wyoming communities and made *Wonderwise* materials available to them. Most of the adults and youth leaders are highly motivated to use *Wonderwise* in their various youth programs long after the short-term implementation/evaluation period of the Toyota-*Wonderwise* project in Wyoming.

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# Appendix B

## Wonderwise Program Background

## Wonderwise Information

*Wonderwise* was developed by the University of Nebraska State Museum and Nebraska 4-H Youth Development with funding from the National Science Foundation and the Howard Hughes Medical Institute. As a guided inquiry approach, *Wonderwise* provides hands-on experience in experimenting and observing, gathering and analyzing data, identifying characteristics, and classifying information.

A total of nine *Wonderwise* modules portray scientists through four mediums: a video, a written biography, a CD-ROM, and five interactive activities related to the scientists' field of study. With numerous progressive activities in each module, youth had the opportunity to delve deep into the content area over an extended learning period. Applicants had the flexibility to choose the modules that were geographically, culturally and educationally applicable to their youth participants. Below is a brief description of each module available to participants:

## Wonderwise Modules

- African Plant Explorer: Youth study African plants to learn how they are capable of preventing and curing certain diseases.
- Space Geologist: Through discovery of craters in Belize and Mexico, youth learn about asteroids and how they caused the extinction of dinosaurs.
- Vet Detective: Activities provide youth with an understanding of the science behind traditional Native American values. This scientific exploration will show youth how American Indians can protect their bison and elk herds by preventing common animal diseases.
- Parasite Sleuth: Youth will learn how parasites are able to live inside a host animal without being digested or expelled.
- Rainforest Ecologist: Through exploration of the Amazon rainforests, youth see first hand the importance of the rainforest and the fascinating life it supports.
- Sea Otter Biologist: Youth learn about wildlife biologists who study animals such as the sea otter to learn about the environmental impact of natural disasters on nature.
- Urban Ecologist: Through collecting, recording and conducting experiments in a greenhouse, the study of urban ecologists teach youth the qualities that keep wetlands healthy.
- Pollen Detective: Searching for pollen in ancient bone beds, scientists teach youth how these tiny particles impact our lives including pestering us with allergies.
- Genetic Counselor: Youth study genetic diseases and family medical histories to learn how they are passed from generation to generation.