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Amy N. Spiegel
University of Nebraska-Lincoln, aspiegel1@unl.edu

S. Kay Rockwell
University of Nebraska-Lincoln, krockwell1@unl.edu

Deanna Acklie
College of Saint Mary, dacklie@csm.edu

Saundra Wever Frerichs
King's College London, sfrerichs3@unl.edu

Kathleen French
University of Nebraska–Lincoln, kfrench2@unl.edu

See next page for additional authors

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Wonderwise 4-H: Following in the Footsteps of Women Scientists

Amy N. Spiegel,[1] S. Kay Rockwell,[2] Deanna Acklie,[3]
Saundra Wever Frerichs,[4] Kathleen French,[5] and Judy Diamond[6]

1. Research Assistant Professor, Center for Instructional Innovation, University of Nebraska–Lincoln, Lincoln, Nebraska, email aspiegel1@unl.edu
2. Professor and Extension Specialist, Agricultural Leadership, Education and Communication, University of Nebraska–Lincoln, Lincoln, Nebraska, email krockwell1@unl.edu
3. Assistant Professor, College of Saint Mary, Omaha, Nebraska, email dacklie@csm.edu
4. Graduate Student, Department of Education and Professional Studies, King's College London, London, United Kingdom, email saundra.wever_frerichs@kcl.ac.uk
5. Education Coordinator, University of Nebraska State Museum, University of Nebraska–Lincoln, Lincoln, Nebraska, email kfrench2@unl.edu
6. Professor and Curator, University of Nebraska State Museum, University of Nebraska–Lincoln, Lincoln, Nebraska, email jdiamond1@unl.edu

Abstract
Wonderwise 4-H: Women in Science Learning Kits, recently included in the National 4-H Curriculum Collection and widely tested by 4-H leaders, have positively affected youths' perspectives on science, scientists, and scientific work. Adult leaders who used the multimedia, inquiry-based Wonderwise 4-H kits completed a Web survey describing the impact of the kits on youth. It indicated that the kits increased youth's interest and understanding of science, broadened their view of scientists, and opened their eyes to the possibility of science in their own futures. More information about Wonderwise 4-H and downloadable activities are available at wonderwise.unl.edu.

Introduction

Wonderwise 4-H introduces youth to contemporary female scientists in the real world. Women biologists, geologists, veterinarians, and others are featured in their labs, out in the field, and with their families in a series of nine interactive multimedia kits. Working with these kits, youth learn about nine different scientists' occupations and participate in

hands-on science activities similar to the actual work of each female scientist role model. Wonderwise 4-H, funded by the National Science Foundation (NSF) and selected for the Nationally Juried 4-H Experiential Learning Youth Development Curriculum Collection of 2003, was designed to encourage youth, particularly girls, to pursue scientific careers.

Girls lag behind boys in science achievement as they progress from elementary grades into high school (O'Sullivan, Reese, & Mazzeo, 1997); even those who are academically inclined and talented are less likely than boys to pursue scientific careers (Matyas & Dix, 1992; National Science Board, 1993, 1998). Youth from rural areas, especially those with few role models for scientific careers, have little knowledge about career opportunities and limited aspirations for scientific vocations (Crockett, Shanahan, & Jackson-Newsome, 1996; Haller & Vickler, 1993; Sarigiani, Wilson, Petersen, & Vicary, 1990). The lack of accurate information about science careers, along with gender role stereotyping, limit girls' career choices and expectations for success (Baker & Leary, 1995; Eccles, 1986). Scientists are usually portrayed, whether in textbooks or on television, as male (Steinke & Long, 1996), and most girls lack personal acquaintance with scientists, particularly those who are women (Hill, Pettus, & Hedin, 1990). Baker (1987) suggests that exposing girls to outstanding female role models may encourage them to pursue science as a career.

To address the issues of rural isolation and lack of role models for young girls, NSF funded Wonderwise 4-H, a major collaborative project between the University of Nebraska State Museum and the 4-H Youth Development program, to enhance nonformal youth education. Museums and 4-H have common educational goals, with long histories of using experiential methods for teaching science. Museums reach out to youth, using hands-on experiences for educational activities, and museum kits have long been a resource for teachers and other educators. 4-H curricula apply scientific principles in youth programs that build life skills as youth prepare for future vocations. The experiential learning model and the inquiry-based science approach link directly to two national guidelines that ensure quality youth programs: the *National Science Education Standards* (National Research Council, 1996) and Cooperative Extension's *Science Guidelines for Nonformal Education* (Carlson & Maxa, 1997).

The NSF grant in 2000 was the catalyst for the museum and 4-H to form a consortium, with the museum leading the development of the Wonderwise 4-H kits. The 4-H state leaders from 10 states (Illinois, Iowa, Michigan, Minnesota, Montana, Nebraska, North Dakota, Oklahoma, South Dakota, and Wyoming) agreed to participate in the project by engaging staff and volunteer leaders to (a) field test six classroom-based Wonderwise kits developed in the early 1990s in a nonformal educational setting and provide suggestions for altering the kits, (b) participate in workshops to learn how to use the Wonderwise 4-H kits, (c) disseminate kits in their states, and (d) participate in evaluating Wonderwise 4-H. In return, each state received grant dollars to purchase kits and kit supplies, as well as museum resources to learn more about the kits.

Wonderwise 4-H: Its Design, Development, and Dissemination

Six Wonderwise kits were developed for classroom use in the mid-1990s through funding from the Howard Hughes Medical Institute. Thorough field-testing and extensive evaluation during development documented their utility before kits were widely disseminated to elementary school teachers in Nebraska (Spiegel, Dethlefs, & Pytlik Zillig, 1997). In 2000, the University of Nebraska State Museum collaborated with 4-H Youth Development to redesign Wonderwise into Wonderwise 4-H for use in nonformal educational settings. Wonderwise 4-H was designed as an interdisciplinary, experiential learning activity to:

a. Motivate 8- to 12-year-old youth, particularly girls, to pursue an interest in science and an awareness of scientific activities and careers,
b. Create a positive image of women and minority scientists for 4-H youth,
c. Improve diversity and quality of 4-H's out-of-school science materials by offering materials that are inquiry-based and multicultural and tie science activities to the work of real scientists,
d. Help youth connect agricultural topics and their underlying scientific principles, and
e. Instill in youth a better appreciation of empirically based knowledge and enhance children's ability to use scientific reasoning.

Pedagogical Approach and Curriculum Design

There are many reasons for using hands-on activities in nonformal youth education programs (Carlson & Maxa, 1998). The *National Science Education Standards* (National Research Council, 1996), reports from Project 2061 (a biological and health science project) funded by the American Association for the Advancement of Science (Clark, 1989), and lessons learned from a 1993 W. K. Kellogg Foundation project on *How to Unravel Science Mysteries for Young Minds* all emphasize that curricula for science education should use participatory, inquiry-based activities. Such activities enable students to explore and then work independently or collaboratively to construct their own meaning and knowledge about scientific career opportunities. Consequently, the experiential learning model was selected as the pedagogical approach for Wonderwise 4-H.

The packaging of the six original Wonderwise kits was redesigned after 4-H youth and 4-H leaders suggested ways to make the kit contents more appropriate for their use. Their suggestions on format, topics, materials, and kit structure called for keeping content much the same but integrating more user-friendly technology into one slipcover that would fit on any bookshelf. In addition, the "Think it over" assessment tool was added, in part because of the 4-H emphasis on the experiential learning elements of processing (analyzing and reflecting), generalizing (linking to a real world example), and applying (using in a new situation) new learning (Carlson and Maxa, 1998). Three integrated components comprise each Wonderwise 4-H kit (table 1): (a) a videotape, (b) five hands-on, inquiry-based scientific activities, and (c) a CD-ROM.

Table 1. Wonderwise 4-H Kit Components

Kit component	Description
Videotape	A 15- to 20- minute video profile of the scientist and her work. This "virtual field trip" takes youth around the world, into the scientist's laboratory and out on field site activities as she explains and goes about her work.
Youth activities	The five hands-on, inquiry-based science activities are closely related to the scientists' work. They are printed on loose 8½ × 11" sheets and each section takes approximately 30 minutes to complete; they can be used in 60- or 90-minute educational sessions and include assessment materials. These activities are also available on-line free of charge. Consumables required are readily available in any classroom or field office.
CD-ROM	An interactive CD-ROM contains a biography of the scientist, downloadable and printable versions of the activity sheets in both English and Spanish, a copy of the video with narration in English or Spanish, an interactive glossary, and additional resources and activities.

Nine Multimedia Wonderwise 4-H Kits

The six original Wonderwise kits were redesigned, and three new kits were developed for Wonderwise 4-H. As with the original kits, Nebraska Educational Television (NET) was instrumental in the production and development of the revised and new kits. The three new topics were Space Geologist, Vet Detective, and Genetic Counselor.

Each kit focuses on a different woman scientist's research. The women's scientific specializations range from wildlife biology to genetic researcher to planetary geologist; the wide-ranging topics are explored through diverse activities (table 2). A Wonderwise 4-H Web site (wonderwise.unl.edu) includes a complete set of free, downloadable activities for every kit in both English and Spanish, brief previews of the videos, and additional resource information. Links of the activities to the particular National Science Education Standards to which they pertain are also available at the Web site.

Table 2. Scientists, Topics, and Kit Contents for Wonderwise 4-H

Scientist and Scientific Topic	Summary of Videos and Supporting Activities[1]
1. Brenda Ballachey: Sea Otter Biologist Brenda Ballachey, Ph.D., a wildlife biologist, studies sea otters in Alaska and their survival after the Exxon Valdez oil spill.	**Video:** Dr. Ballachey takes youth into her laboratory and along on research trips throughout the Alaskan waters. She describes how she first became interested in working with animals as a rancher's daughter in Montana. **Science Activities:** • *Otters in Action* – observe and record sea otter behavior • *Kelp Critters* – create a kelp forest community • *Fragile Waters* – learn about Exxon Valdez disaster and conduct an oil investigation • *Otter Smorgasbord* – figure out how much food a sea otter pup needs in its first year • *Tracking Otters* – discover how scientists track sea otters

2. Peg Bolick: Pollen Detective Peg Bolick, Ph.D., a botanist, examines the important role pollen plays in our lives, including how it causes allergies.	**Video:** Dr. Bolick hunts for tiny grains of pollen in ancient bone beds and operates a rooftop laboratory to count pollen grains in the air. **Science Activities:** • *Pollination* – learn about plant parts and play a role in pollination • *In Search of Pollen* – dissect a flower to find pollen • *Medical Mystery* – analyze a pollen sample to find out what triggers allergies in some people • *Flower Engineers* – design and build flowers to attract pollinators • *Pollen Tracks* – dig for ancient pollen in artificial rocks
3. Jannalee Caldwell: Rainforest Ecologist Jannalee Caldwell, Ph.D., explores the world of poison frogs in the Amazon.	**Video:** Dr. Caldwell treks deep into the rainforests. She counts and collects frogs and insects to learn more about the rainforest and the fascinating life it supports. **Science Activities:** • *Nutty Investigations* – test the strength of different nutshells and the fat content of different nuts • *Frogs Up Close and Personal* – design backgrounds to camouflage poison frogs • *Build a Tree* – construct a sturdy rain forest tree from scratch • *Rain Forest in Your Room* – create a rain forest community of plants and animals • *Life in a Nutshell Game* – grow your critter from egg to larva to adult in the Brazil nut board game
4. Judy Sakanari: Parasite Sleuth Judy Sakanari, Ph.D., works with parasites to understand how these "guests" survive inside another animal.	**Video:** Dr. Sakanari visits fish markets in search of worms and other parasites harmful to marine animals and humans. She takes her "catch" back to the lab and conducts experiments on the live worms found inside the fish. **Science Activities:** • *Classy Parasites* – create a parasite classification system • *A Model Parasite* – make and dissect an Ascaris worm • *Pet Parasite Detective* – examine a pet for ticks and fleas • *Parasite Sleuth* – solve mysterious diseases by finding the problem parasites • *Traveling Tapeworm* – unravel the states of a developing tapeworm in a life-size human gut
5. Fatimah Jackson: African Plant Explorer Fatimah Jackson, Ph.D., works with plants and people to learn more about the way certain foods prevent or cure human diseases.	**Video:** Dr. Jackson travels to Africa to study local plants that serve as food and medicine. She takes samples of cassava, a remarkable plant, back to her laboratory to study. **Science Activities:** • *Everyday Poisons* – discover the poisons in everyday foods • *Investigating Starch* – examine the chemical properties of starch • *African Arts* – use cassava to batik African symbols onto cloth in a two-day activity • *Green Travelers* – follow the world travels of common foods throughout history

6. Carmen Cid: Urban Ecologist Carmen Cid, Ph.D., a plant ecologist, learns what keeps wetlands healthy.	**Video:** Dr. Cid trudges through mud in her waders to investigate life in a pond. She records her observations, collects plants and seeds, and conducts experiments in the greenhouse. **Science Activities:** • *Sound Sense* – use your ears and eyes to sharpen your observation skills • *Cool Tool* – using sampling transects, learn how to test the diversity of your environment • *Seedy Travelers* – predict and test strategies seeds use to travel • *Walk on Water Bugs* – create a water bug and use it to explore the effects of water pollutants • *Drain Game* – make a watershed to learn about toxic runoff into lakes and streams
7. Adriana Ocampo: Space Geologist Adriana Ocampo, Ph.D., helps determine the surface outline of the buried impact crater at Chicxulub, Mexico. Her discovery helps prove that an asteroid caused the extinction of the dinosaurs.	**Video:** Dr. Ocampo searches through Belize and neighboring Mexico for evidence of an asteroid that hit Earth 65 million years ago. She compares craters that exist on other planets and moons with ones on Earth. **Science Activities:** • *Meet Adriana* – learn what a space geologist does and the anatomy of a crater caused by an asteroid impact • *Crater Maker* – make an impact and investigate how craters take shape • *Vanishing Craters* – test the effects of weather on the surface of craters • *Big Time Tour* – explore Earth's history from your shoulder to your fingertips • *Digging Into the Past* – create a strata, take a core sample, and learn how to read the past
8. Tolani Francisco: Vet Detective Tolani Francisco, DVM, works in veterinary medicine to help native people and others all over the world protect their wild and domestic animals.	**Video:** Dr. Francisco travels around the world to check the health of large animal populations. As a USDA vet, her challenge is to stop the spread of animal diseases. **Science Activities:** • *Meet Tolani* – explore the "Flight Zone," how close people can safely get to animals • *Bison Behavior* – learn how to make sense of bisons' behavior • *Vital Signs* – take your vital signs and compare your data to the vital signs of other animals • *Ruminate* – compare animal digestive systems and then simulate the process of digesting grass • *Disease Detective* – investigate how the disease brucellosis spreads among different herds of elk

9. Cathy Burson: Genetic Counselor Cathy Burson, MA, helps scientists learn more about the genes that cause disease and how they are passed from generation to generation.	**Video:** Ms. Burson traces family medical histories and counsels the family about diseases caused by inherited genes. **Science Activities:** • *Meet Cathy* – explore your genetic features • *Alike and Different* – discover what's different and the same about you and your group • *Mating Game* – meet mom and pop Smiley Face genomes and mate some genes to make a new baby • *What Sort?* – meet a cheek cell, say hello to chromosomes, and complete a human chromosome chart • *Inside DNA* – build a model gene using gumdrops and licorice and learn some secrets of DNA structures

1. CD-ROMs are part of every kit and include the video, science activities, biography, glossary, supplemental activities, and additional resources.

Dissemination

The field testing of the classroom-based Wonderwise kits for nonformal educational purposes in the 10 consortium states initiated the dissemination by introducing the kits, albeit in unrevised form, directly to adult leaders. As the revised kits and newly developed kits became available, the formal dissemination plan was implemented. This consisted of a series of workshops for 4-H leaders and took advantage of existing 4-H networks to encourage participation. Kits were usually distributed directly to adult leaders in these workshops, which ranged from 1 hour to several days. Wonderwise was also disseminated through the Web site (wonderwise.unl.edu), where individual activities could be downloaded at no cost. In addition, the publisher, Great Plains National (GPN), was involved from the beginning to ensure that the kits would be widely available. Finally, Wonderwise 4-H underwent the rigorous National 4-H Experiential Learning Youth Development Curriculum Review to place it within the 4-H official curriculum.

During the dissemination phase, 499 adult leaders participated in Wonderwise 4-H workshops led by the Museum's Educator; another 582 participated in Wonderwise 4-H workshops led by 4-H staff in their state (Frerichs & Spiegel, 2003). Voluntary reports from adult leaders, workshop and conference enrollments, Web site visitors and downloads, and records on Wonderwise 4-H kit sales and broadcast rights sold indicated that over 2.5 million youth and 43,000 adults were potentially reached by Wonderwise 4-H in the 2002–2003 fiscal year (Spiegel, 2004). Kits are available from GPN through the Wonderwise 4-H Web site www.wonderwise.unl.edu.

Evaluation Plan

The evaluation plan for Wonderwise 4-H included multiple studies to examine project outcomes. It included (a) documenting the dissemination processes (Frerichs & Spiegel, 2003), (b) a case-study about the impact on youths' understanding of science and their identification with the scientist role model (Acklie, 2003), and (c) an adult leaders' Web survey to identify kit uses and perceptions of how Wonderwise 4-H affected youths' view of science,

scientists, and scientific work. As an extension of the classroom-based Wonderwise (Diamond, Hochman, Gardner, Schenker, & Langan, 1996), the Wonderwise 4-H evaluation focused specifically on nonformal learning experiences and how youth incorporated the information and ideas into their thinking. This article reports on the adult leader Web survey, which explores the implementation processes and how adult leaders felt the subject matter influenced youths' views of science, scientists, and scientific work.

Instrument

State 4-H representatives in the 10-state consortium and museum staff critiqued initial questions to clarify and help focus items to gather the most relevant data. The first draft included items used to evaluate the classroom-based Wonderwise kits. All items initially selected for the survey were pre-tested in a Web-based format. The final survey consisted of eight open-ended items on specific uses of the Wonderwise 4-H kits; perceptions of impacts on youth, including detailed examples of youth comments and behaviors; and opinions about the kits' usability. Adult leader demographics included occupational position and gender.

Purposeful Sample

The Web survey gathered data from Wonderwise 4-H kit users, defined as individuals who used at least one activity from one kit with youth in an appropriate educational setting. In Spring 2003, adult leaders and others who had requested a kit or had participated in a workshop or conference on Wonderwise 4-H were contacted via email or U.S. mail or both. The total number of these individuals for whom we had contact information was 671. However, not all of these individuals had actually used a Wonderwise 4-H kit with youth.

Users of the Wonderwise 4-H kits were instructed to access the survey electronically from the Wonderwise 4-H Web site, where a request to give feedback was displayed on the homepage. Follow-up e-mails and post card reminders were sent 2 weeks after the initial contact. Altogether, 217 adults, including a small number of individuals who had not been contacted directly by us, responded to the request in some way. However, only 150 adults fitting the criteria for the purposeful sample completed the survey.

Because not all 671 people contacted for the survey fit the sample criteria (used a kit with youth), an estimated response rate was calculated. Of those who replied to our request, 31% (67 of 217) had not used a kit. Because the request specifically asked for responses *only from those who had used the kits*, 31% may be a conservative estimate of those contacted who had not yet used the kits. Using 463 (69% of 671) as the estimate of those who fit the target response group, the estimated response rate was 32% (150 of 463).

Data Analysis

The Web-based survey was designed to drop data directly into an Access database as it was submitted. Responses were reviewed and emergent themes identified. Responses were then categorized by the emerging themes and coded accordingly. Codes and tallies were recorded on a spreadsheet. Because questions asked adult leaders to describe how Wonderwise 4-H affected "youths' thoughts and feelings about science," the results describe adult leader perceptions, not responses of the actual end user.

Findings Related to Wonderwise 4-H's Effectiveness

Adult Leaders and Ways They Used Wonderwise 4-H

Adult Leaders

Of the 150 adult leaders, 89% were female, and 92% were from the 10 consortium states. Their diverse occupational roles leaned more toward 4-H related responsibilities, with some having dual roles between 4-H and the elementary school system (table 3).

Table 3. Occupational Roles of Respondents

Occupational Role of Adult Leaders Using Wonderwise 4-H	% Self-Identifying with Role (n = 150)[1]
Extension Employees, including state specialists/campus faculty	73
Classroom teachers	15
Adult volunteers	13
After-school program staff	6
Other (4-H or Educational Program Coordinator, VISTA, community center)	15

1. Multiple roles could be identified.

Educational Settings

Wonderwise 4-H kits were used in formal classrooms and a variety of nonformal educational settings (table 4).

Table 4. Educational Settings in Which Wonderwise 4-H Was Used

Educational Settings in Which Wonderwise 4-H Was Used	% of Respondents Using the Setting (n = 150)[1]
Formal classroom (school)	40
Day camp	35
After school program	32
Overnight camp	20
4-H club meeting	20
"Other" settings (Girl scout meeting, spring break special program, summer library program, home schooling, teacher in-service training, museum event, day care setting, and school summer youth program)	20

1. Multiple settings could be identified.

Wonderwise 4-H Kits Used

Respondents used all nine Wonderwise 4-H kits. Genetic Counselor was only available a few months prior to the survey, but it was still used by 12%; each of the other eight kits was used by 20 to 40% of the adult leaders. Many used some of the individual kits multiple times; 27% used only one kit, while the rest used two or more kits in their youth programming.

End Users

Wonderwise 4-H kits were designed for 9- to 11-year-old youth. While 57% of the end users were estimated to be in the 9- to 11-year old category, adult leaders also used the kits for youth a couple of years younger or older (table 5). Adult leaders reported using the kits with up to 740 youth; the average number of end users per adult leader was 100.

Table 5. End Users of Wonderwise 4-H

	End Users	
Age Range	n	%
Grades K–3 (5–8 years old)	2,459	16
Grades 4–6 (9–11 years old)	8,479	57
Grades 7–9 (12–14 years old)	2,497	17
Grades 10–12 (15–17 years old)	451	3
Adults (18+)	1,004	7
Total	14,890	100

Perceptions of Wonderwise 4-H's Impact on Youth

Respondents were asked to describe the impact of each different kit component (activity, video, CD-ROM). However, because the components were frequently used together, there was often overlap across responses. With respect to the specific questions, 136 respondents wrote comments on the activities question, 118 wrote responses on the video question, and 79 wrote comments on the CD-ROM question. Generally, the themes that evolved were reflected in one-quarter to one-third of the respondents who had comments. Adult leader comments on how they felt Wonderwise 4-H affected youth with whom they worked clustered into two strong theme areas:

- It brought "real science" into the youths' lives by:
    - engaging them in actual scientific activities
    - increasing their understanding of what science is
    - broadening their view of who scientists are, what they do, and where they work.
- It introduced and encouraged youth to pursue science in their future by:
    - helping them become more confident and capable at scientific endeavors
    - increasing their understanding of the possibilities of a science career
    - connecting them in a personal way with scientist role models.

Bringing Real Science into Youths' Lives by Engaging Them in Actual Scientific Activities

Overall, the activities and videos were described as being effective in engaging youth's interest in real science through the scientific content. Adult leaders observed youth having fun with the activities, being interested in them, and getting engaged in the scientific topic (table 6).

Table 6. Typical Leader Comments About "Engaging Youth in Actual Scientific Activities"

Global comments about kits	"*Youth felt involved and connected with the activities.*" – County 4-H Representative, Montana
	"[The activities] had a positive impact on the way the youth look at, and feel about science." – Extension Assistant, Nebraska
	"In all of the programs we did using the Wonderwise Kits, the children were so absorbed in finding out the outcome of the activities. All of the children that participated in the programs really enjoyed the hands-on approach." – Americorp/Vista volunteer, Michigan
	". . . from pre to post test, students indicated that they enjoyed science more after participating in the program." – County Extension Agent, Montana
Comments on specific kits	"*Many of my students were much more interested in learning the concepts of DNA, genetics, and the counseling field after watching the video and doing the hands on team activities."* – County Extension Agent, Montana
	"[The youth] find the scientists intriguing, and watch [the videos] very carefully. They really like it when they find out the Genetic Counselor is from Nebraska." – County Extension Educator, Nebraska
	"Many of youth reflected in their journals on what they saw in the video. Youth articulated that the things they were doing were just like what Carmen Cid does. Youth asked if they could meet more people like Carmen. They were impressed and wanted to get more connected with science." – Elementary Education After School Program Coordinator, Minnesota

Bringing Real Science into Youths' Lives by Increasing Their Understanding of What Science Is
Many leaders noted how the videos showed real scientists in a variety of settings and that many of the youth had not had this opportunity to see a scientist at work before. With the activities, the leaders frequently described the realistic, relevant nature of the hands-on experiences (table 7).

Table 7. Typical Leader Comments About "Increasing Youths' Understanding of Science"

Real science in the videos	*"Videos give youth an opportunity to watch real life scientists in their surroundings, both professionally and outside of work, giving youth a background in how the scientist chose their profession. This helps link their real life story to careers in science."* – 4-H Program Assistant, Iowa
	"The videos show scientists in their work environment. It provides students with a truer picture of what a scientist is and does. Students move away from the idea that science is done in a lab with a white lab coat and goggles. We had a few groans and yucks when the Vet Detective video showed the collection of fecal material but I didn't hear any 'I'm never doing that' comments." – Classroom Teacher, Missouri
	"Kids have watched the videos and said that they never knew or expected anyone to study some of these things." – Extension Educator, Nebraska
Real science in the activities	*"The hands-on activity (waterbugs) really helped the kids visualize and understand the effects of pollution/unnatural substances (soap) on the environment and animal life."* – Adult Volunteer, Iowa
	"I got the impression that the youth didn't realize how scientists arrived at their conclusions . . . and that is by doing actual experiments, gathering facts, and going into the areas and fields and conducting interviews, etc. They are much more interested now in the science fields seeing that it is not just sitting a lab." – Adult Volunteer and Classroom Teacher, Iowa
	"The youth have enjoyed the hands on activities and have been surprised at the variety of work scientists do. Most of them are interested in the work done in the field." – 4-H Program Assistant, Montana

Bringing Real Science into Youths' Lives by Broadening Their View of Who Scientists Are, What They Do, and Where They Work

Wonderwise 4-H dispelled myths and created appropriate and accurate pictures about science for kids. The activities provided an opportunity to experience a different kind of scientific work, one that was more real and more meaningful than what they typically might do in science class. It opened up youths' eyes to a wide variety of science fields and to what scientists really do. The videos were an important component in expanding youth's view of science, scientists, and, even more broadly, their world (table 8).

Table 8. Typical Leader Comments About "Broadening Youth's View of Scientists"

Overall kit comments	*"Kids report they have a lot of fun learning about different types of science . . . a number of kids say they had no idea there were so many different types of science."* – Adult Volunteer, Iowa
	"[I] had several comments [from youth] about how they didn't realize all these things were connected to science. [This is] not exactly the type of science they're learning in our [school] classrooms" – Extension Educator, Oklahoma
Video	*"The videos give kids a first hand look at a scientist at work, and kids can see places and things beyond their own experience."* – State Specialist/Campus Faculty, Illinois
	"[The youth] loved seeing the different locations and occupations that are connected to science." – Extension Educator, 4-H Youth Development, Oklahoma
Activities	"*Some of the girls told me they didn't like science very much, but they said later they had a really good time with the Space Geologist activities and the experiments were fun, even though they were messy."* – Extension Associate, Nebraska
	"The girls were amazed that there was a woman that was in the dirt and loving it. – Classroom Teacher, North Dakota

Youth Connecting with Science by Becoming More Confident of and Capable at Scientific Endeavors

Adult leaders highlighted how the activities helped youth learn to do science, use scientific methods, and become more confident of and competent at scientific endeavors. Some adult leaders mentioned specific skills or knowledge that youth acquired, while others talked more generally about how effective the activities were at involving youth in "real" scientific work that enabled them to learn by doing (table 9).

Table 9. Typical Leader Comments about "Becoming More Confident and Capable at Science"

Overall kit comments, including both video and activities	*"They realize that science is fun and creative. They also get the confidence that they can learn science."* – Extension Agent, Wyoming
	"The activities are good in that they give the youth a chance to become the scientist they just met through the video. The activities done in combination with the videos are empowering in that they link the youth to the reality that there are real women of color doing this work that they are doing right now. That makes science feel real and accessible." – Science Museum Educator, Minnesota
	"*I think that seeing the video of an actual scientist doing some of the same things that the youth do helps them to see that any of them could do that every day for a job. Until you see someone like a scientist do something and then you do the same thing, you think you can't do the task."* – Youth and Family Unit Educator, Illinois
	"They truly have to think and evaluate what is happening. They must use the scientific method of developing a hypothesis, doing the activity and collecting data and the reviewing the data to form a conclusion." – Adult Volunteer, Montana

Youth Connecting with Science via Increased Understanding of the Possibilities of a Career in Science

The format of the kits, with a real scientist at the core of each kit, affected the picture some youth had about their future interests. Many respondents specifically pointed out that the activities and videos affected the youths' perceptions of a career in science or that youth indicated an interest in or intention of becoming a scientist (table 10).

Table 10. Typical Leader Comments About "Increasing Youths' Understanding of the Possibilities of a Science Career"

Overall kit comments, including video and activities	*"They are able to see themselves doing science. The video allows them to see a scientist at work and also see that they are people. The activity book then lets them perform activities that mimic the scientist and learn science concepts in the process".* – State Specialist/Campus Faculty, Louisiana
	"It allows them to see how the interest and excitement that they hear existed in these scientists when they were young were able to be sustained and pursued into adulthood and into their career choice." – Youth Field Specialist, Iowa
	"[Youth have] really started talking about doing different jobs when they grow up. The information coming from them is really knowledgeable since they have seen these kits." – Adult Volunteer/Classroom Teacher, Minnesota
	"Most remarkably, both boys and girls see the career field as something THEY can do. Typically, more boys than girls would see it this way in other programs with which I have worked." – Adult Volunteer/Classroom Teacher, Nebraska
	"After using the Vet Detective kit, many female students commented on how they would like to be veterinarians." – Classroom teacher, North Dakota

Youth Connecting with Science by Connecting in a Personal Way with Scientist Role Models
Some adult leaders also commented on the youth connecting with the scientist or of the scientist serving as an important role model in the video. By seeing minority women who have families and who are also scientists, youth recognized that they, too, could become scientists one day. Some of these women scientists grew up on farms, live in the Midwest, and look like the youth themselves—that helped connect the youth with them (table 11).

Table 11. Selected Leader Comments About "Connecting with Scientists"

Video comments	*"The videos serve as a mentor. They make science REAL and ACHIEVABLE to girls and youth of color. The videos make science seem cool, and show that science is done by real people just like themselves—even people who grew up poor."* – Science Museum Educator, Minnesota
	"*As a result of this video I have one high school girl who volunteered at a veterinary office for several months and is now employed there. Although she has some learning disabilities she now believes that it is possible for her to become a veterinarian, which was her dream."* – Native American Education Coordinator, Oregon

Kit Design
Adult leaders commented on the kit components. The science activities were the strongest, most used component, and the videos were also widely used and highly praised. The CD-ROMs were used the least, with only one-third of the adult leaders using them. For both the videos and the CD-ROMs, lack of equipment was given most frequently for non-use. However, those who used the CD-ROM found it to be a useful tool. Table 12 illustrates typical comments about the different components. Overall, adults who used the kits generally found them "easy to pick up and teach" (Extension Agent, Illinois).

Table 12. Typical Leader Comments on the Different Components of the Wonderwise 4-H Kits

Activities	*"The activities give youth confidence and encouragement to learn more about science because the activities are hands-on and they understand what they are doing and the results."* – Extension Assistant, Nebraska
Videos	*"[The videos give] kids a first hand look at scientists at work, and kids can see places and things beyond their own experience."* – Extension Educator for Family and Consumer Science, Oklahoma
CD-ROMs	*"It allows the students to work on their own. The CD-ROM allowed my students to explore what really interested them."* – Classroom Teacher, North Dakota

Conclusions

The impact that Wonderwise 4-H had on youth was possible because of three, key, integrated components contributing to its success.

- First, the kits' video, hands-on activities, and CD-ROM were user friendly and adaptable to many different situations in nonformal education, including camp, club, and special use applications.

- Second, using role models in this multimedia curriculum proved to be an effective means of improving youths' attitudes about science through engaging activities and realistic videos that made science real and accessible. Leaders observed that Wonderwise 4-H allowed youth to engage in actual scientific activities, increase their understanding of what science is, broaden their view of scientists, become more confident of and capable at scientific endeavors, and increase their understanding of the possibilities of a science career.
- Third, dissemination of the project was extensive and was achieved primarily through the 4-H networks that already existed in the partner states. Wonderwise 4-H was selected for the Nationally Juried 4-H Experiential Learning Youth Development Curriculum Collection of 2003, creating even more opportunities for use throughout 4-H network.

Wonderwise 4-H serves as a model for how museums and 4-H can work together to improve nonformal science learning opportunities for youth. By collaborating on this project, 4-H youth and leaders were able to take advantage of a unique opportunity, and the museum was able to reach beyond its usual constituents. Together, 4-H and the museum were able to provide youth with science learning experiences that were unavailable without the collaboration. The need for more effective and integrated science experiences for youth is great, and the success of this project suggests that opportunities for science learning can be enhanced through innovative collaboration of nonformal science partners.

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