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Improving County-Based Science Programs: Bringing Out the Science Teacher in Your Volunteer Leaders

Abstract
4-H programs can play an important role in increasing children's exposure to, and interest in, science. To be effective, however, specialized training for volunteer leaders is needed. A method of training adult volunteer leaders to train 4-H teens to be cross-age teachers of an inquiry-based science program was designed and evaluated. Key components of this method were specific scaffolding strategies, including modeling, coaching, effective questioning, promoting group interactions, and encouraging independent investigation and thinking. Data from focus group interviews and quantitative measures showed improvement at all levels of project involvement: Adult volunteer leaders, 4-H teens, and participating 4-H youth.

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Introduction

There is a recognized need for improvement in science literacy among children and youth (Hiraoka, 1998; National Center for Education Statistics, 2000; Zinsmeister, 1998), and community-based education programs like 4-H can play an important role in meeting this need. The learn-by-doing approach used in 4-H provides an excellent opportunity for children and youth to gain an understanding of science concepts (Williamson & Smoak, 1999). However, in order to optimize the

impact of 4-H science projects on their youth audiences, volunteer leaders must be trained effectively.

In 2001/2002, the American Honda Foundation funded a research initiative directed at improving the abilities of adult volunteers as trainers and teen volunteers as leaders of a hands-on, inquiry-based science curriculum with 4-H youth. This project built upon the "Step-Up" Incremental Training Model (Smith & Enfield, 2002) by adding a Training of Trainers component for 4-H adult volunteers.

Project goals included:

- Increasing the competence and confidence of 4-H adult volunteers with respect to training teen leaders in a science curriculum;
- Increasing the competence and confidence of 4-H teen leaders in their roles as cross-age mentors; and
- Improving the science literacy of 4-H youth through the increase of their use of the Scientific Thinking Processes (Lowery, 1992).

Project collaborators included:

- The UC-Davis School of Veterinary Medicine,
- Veterinary Medicine Extension, and
- 4-H Youth Development Programs in Glenn, Marin, San Luis Obispo, and Tehama Counties in California.

Background

Adult volunteer leaders are at the core of county-based 4-H programs throughout the nation. In 2000, there were 495,152 adult volunteer leaders working directly or indirectly with 4-H teens and youth (USDA, 2001). Supported, and often led, by these volunteers, 4-H projects engage youth through a method of "learn-by-doing." Hence, it is critical that 4-H Youth Development Programs use training models for volunteer leaders that facilitate the transfer of specific program or curriculum content and methodology.

Effective volunteer training strengthens county-based programs (Snider, 1985; Hoover & Connor, 2001), and makes volunteers better educators and trainers (Hoover & Connor, 2001). Training that has a positive effect on volunteers' abilities increases their confidence while instilling a sense of ownership and responsibility with respect to the programs they lead (Snider, 1985). Furthermore, programs with highly trained volunteer leaders require less maintenance (Snider, 1985), which increases the potential for long-term sustainability.

Elementary school students are extremely interested in the world around them, and participation in inquiry-based science programs can catalyze this innate curiosity (Rillero, 1999). Thus, a rich and engaging elementary science experience is crucial for the intellectual development of all students.

However, a recent examination of elementary school classrooms revealed that instructional practices in science might not be meeting students' educational needs. For example, classroom teachers in grades K-5 report spending an average of only 25 minutes per day in science activities, which is less than one-quarter of the time spent on reading and literacy (Fulp, 2002). In addition, elementary school science is often taught using traditional methods such as whole class discussions and lecture-based instruction; only 41% of the teachers indicated that inquiry-based learning was heavily emphasized in their science lessons (Fulp, 2002).

The lack of teachers' subject matter expertise and formal training undoubtedly contributes to the under-representation of science in elementary classrooms. Because learning science is a cumulative process (Hinman, 1999) and requires an approach that stresses long-term process skills over one that emphasizes short-term, fact-based questions and answers, specialized training is required to teach the subject effectively. However, only 4% of the teachers at the elementary level have undergraduate degrees in science or science education, and most report low levels of participation in professional development opportunities related to science teaching (Fulp, 2002).

Non-formal educational experiences, such as those found in 4-H, can play an important role in increasing children's exposure to, and interest in, science. Science-related projects are the most common among the myriad of projects available to youth through their 4-H programs and account for nearly one-half of all 4-H projects administered nationally (USDA, 2001). Science project topics include environmental education and earth sciences, plants and animals, and technology (USDA, 2001).

Purpose and Objectives

Goals and measurable objectives of this research effort included:

- Goal I: To provide professional development opportunities for 4-H adult volunteer leaders.
  - Objective: To increase the competence of adult volunteers with respect to training teen leaders in a science outreach curriculum.
- Goal II: To enhance positive development opportunities for 4-H teen leaders.
  - Objective: To increase the competence of teen leaders with respect to inquiry-based science teaching methods.
- Goal III: To increase the science literacy of youth ages 9 to 11.
  - Objective: To increase children's use of the Scientific Thinking Processes (observing, communicating, comparing, organizing, relating, inferring, and applying) (Lowery, 1992).

Methods

Animal Ambassadors Curriculum

The Animal Ambassadors curriculum is research based and is designed for use with school and community-based (e.g., 4-H) education programs. The curriculum is comprehensive in its content and aligns with California state and national science education standards. Using a concept-based approach, the curriculum is organized into five units that focus on introducing children to a variety of topics related to domesticated and wild animals. Instructional emphases include concept development through student exploration and the application of curriculum concepts to everyday situations. The curriculum targets upper elementary-aged 4-H youth.

Training of Trainers: Increasing the Capacity of Adult Volunteer Leaders

Project staff developed a series of three Training of Trainers workshops for adult volunteer leaders that built upon the "Step-Up" Incremental Training Model (Smith & Enfield, 2002). The workshops included the effective modeling of specific educational strategies (e.g., coaching, effective questioning, promoting group interactions, and encouraging independent investigation and thinking) by facilitators with the purpose of having the adult volunteer leaders develop competence and independence with respect to their roles as curriculum trainers (Holliday, 2001). As the participants' capacity and confidence grew with each successive workshop, their use of inquiry teaching and learning methods became more evident, and modeling of educational strategies by facilitators became less necessary.

Teen Training and Curriculum Implementation: Dissemination to County-Based Youth Development Programs

The training of teen leaders and implementation of the Animal Ambassadors curriculum with 4-H youth were designed as a repeating series using the "Step-Up" Incremental Training Model. Each series of trainings and implementations was coordinated with the training of adult volunteer leaders and occurred in the following sequence.

1. Training of Trainers Workshop: Adult volunteer leaders from participating counties were trained in curriculum content and methods by Animal Ambassadors project staff.

2. Teen Training Workshop: Using their Training of Trainers workshop as a template, adult leaders trained teen leaders who had been recruited as cross-age mentors in their respective counties.

3. Curriculum Implementation: Teen leaders implemented curriculum activities with youth in 4-H clubs and after school programs over a period of 4-6 weeks following their training workshop.

This series was repeated three times in order to complete the adult and teen trainings and implementation of the curriculum.

Data Collection and Assessment

Goals I and II

In post-project focus group interviews, volunteers were asked to reflect on how the trainings had changed their attitudes and opinions relative to the objectives listed for Goals I and II. Interviews were designed and data were analyzed using standard qualitative methods (Krueger & Casey, 2000). Focus groups were administered separately to participating adults and teens. Interviews were tape-recorded, and audiotapes were transcribed for analysis.

Goal III

To measure Scientific Thinking Processes, the language children used to describe objects pre-/post- curriculum was compared (Marek & Methven, 1991; Carey, Evans, Honda, Jay, & Unger, 1989). This tool, the Object Description Test (OBD), has been validated and reliability-tested with elementary school age students (Smith et al., 2002).

For the OBD test, each child received a bag containing either one item or three items. Some of the objects were familiar to the children, but all were unrelated to the curriculum content. Familiar

objects included items such as cotton balls (single item) and straws, pens, and pencils (multiple items grouped together for comparison). Unfamiliar objects included items such as obscure plumbing accessories and science laboratory supplies. The children were asked to describe the objects in writing and were given 10 minutes to complete this task. Each child received three object bags in the pre-test and three object bags in the post-test. The order in which the children received the bags was balanced using a Latin Square design.

All written data from the OBD test were coded by one of four independent scorers using scoring systems designed by project staff. Assessment of inter-rater reliability was conducted and reliability of .80 was maintained throughout the scoring process. Written samples were scored independently for observations, comparisons, and inferences.

Results

In this study, training adult volunteers as science curriculum trainers of 4-H teen leaders was effective. Outcome data showed positive results for all three stated goals.

Goal I

- Goal I: To provide professional development opportunities for 4-H adult volunteer leaders.
    - Objective: To increase the competence of adult volunteers with respect to training teen leaders in a science outreach curriculum.

Fourteen adult volunteer leaders began the project; nine completed all three trainings. Data from the focus group interviews indicated that the adult trainers' understanding of the curriculum training process they used when training teens in their counties increased over the course of three Training of Trainers workshops.

Adult leaders reported that the Training of Trainers workshops were imperative. They stated that they would not have been able to train the teens without them. The adult leaders described that, through the series of Trainings of Trainers workshops and through reflective practice in their counties, they learned how to use open-ended questions and facilitate the inquiry approach effectively. Adult leaders found it helpful to practice and understand the curriculum activities before training teens in their counties; they stated that it was useful to observe other trainers and discuss methods; and they reported that the trainers helped them learn how to communicate effectively with teens.

Goal II

- Goal II: To enhance positive development opportunities for 4-H teen leaders.
    - Objective: To increase the competence of teen leaders with respect to inquiry-based science teaching methods.

4-H adult volunteer leaders who participated in the Training of Trainers workshops trained 4-H teens in the Animal Ambassadors curriculum in their respective counties. Nineteen teens began and completed the project. Results from the post-project focus group interviews showed that the teens' understanding of inquiry-based teaching, effective questioning, and Scientific Thinking Processes improved over the course of the study. Specific focus group results included the following.

Understanding of Inquiry-Based Teaching Strategies

The teens reported that it was easier for the children to learn concepts they thought of themselves rather than ones that they are merely told about. One teen commented that it helps to know the process rather than only the answer. Another teen said that if she were a teacher, she would use the inquiry teaching methods because she thinks they help the students really understand what they are learning.

Understanding of Questioning Strategies

The teens reported that open-ended questioning helped them facilitate the curriculum and that this approach to questioning allowed the children to learn rather than memorize. They stated that open-ended questions made it easier for the children to understand concepts because the knowledge was their own and not something someone else told them. Furthermore, the teens reported that open-ended questions made more sense to them in terms of learning science concepts and that such questioning strategies allowed for more elaboration concerning these concepts.

Understanding of the Scientific Thinking Processes

The teens reported that it was important for children to have their own thinking incorporated into their learning, and that the emphasis on the Scientific Thinking Processes in the curriculum and

through instructional methods facilitated this.

Goal III

- Goal III: To increase the science literacy of youth ages 9 to 11.
    - Objective: To increase children's use of the Scientific Thinking Processes.

A total of 17 students (7 males and 10 females) participated in both the pre- and the post-test administrations of the Object Description tool. The mean age of the participants was 9.52 years. The 4-H teen leaders were effective as cross-age teachers of science. The 4-H youth improved their science literacy through an increase in their use of the Scientific Thinking Processes from pre- to post-intervention.

A repeated measures ANOVA was used to analyze the OBD data and to compare performance on the pre- and post-administrations. Statistically significant results ($p \leq .05$) were achieved relative to the improved use of the Scientific Thinking Processes in three areas. Specifically, the participating 4-H youth:

1. Improved the number of senses that they used to make observations from an average of 0.74 to an average of 2.15 ($p = .01$). In the pre-test, most observations were visual; in the post-test, students incorporated more tactile and auditory senses into their observations. See Figure 1.

2. Increased the number of descriptors (e.g., color, shape, texture, weight) they used in making observations from 2.87 to 5.11 ($p = .033$).

3. Increased the number of inferences based on observations from 1.51 to 3.73 ($p=.009$). See figure 2.

Figure 1.
Change in the Number of Senses Used in Observations from Pre- to Post-Administrations of the Object Description Tool

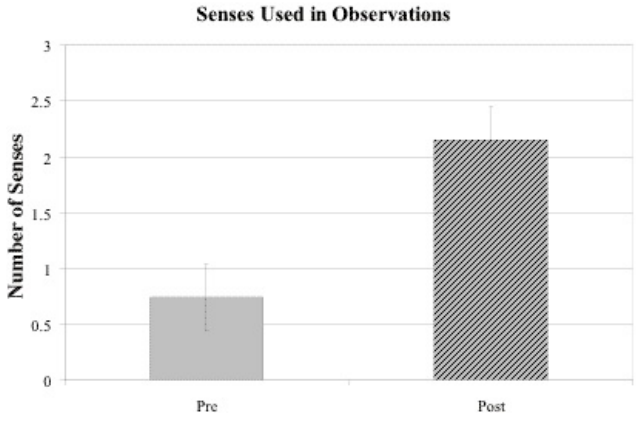
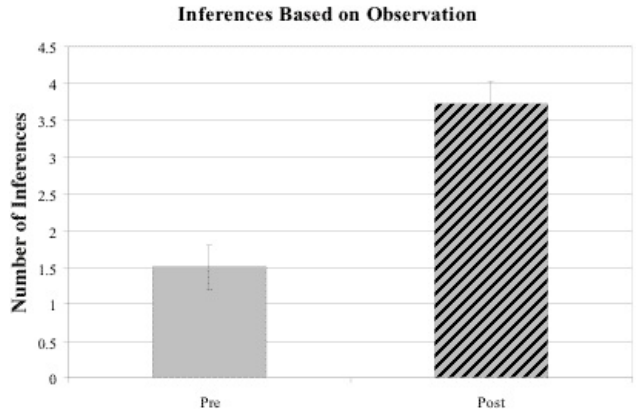


Figure 2.
Change in the Total Number of Inferences Based on Observation



Discussion

The central aim of educator development is to understand and facilitate student learning (Joyce & Showers, 2002). Hands-on training programs in which educators have the opportunity to experience curriculum components in a manner that simulates how children will receive them are most effective in reaching this goal (Konen & Horton, 2000). This approach improves educators' confidence and increases their interest and curiosity about the subject matter.

In the study discussed here, 4-H adult volunteers and teen leaders reported that they had improved their understanding of student learning and improved their skills in facilitating youth science curricula through a series of workshops that emphasized hands-on experiences. In addition, project staff observed improvements in the competence of leaders in all three counties during follow-up site visits. While these observational assessments were not formal in nature, they allowed project staff to witness volunteer leaders successfully using the techniques that had been the focus of the trainings.

Results from this study showed that multiple workshops provided sufficient time and practice for adult volunteers to fully understand the associated educational methodology and content. Time was also important to provide the adult volunteers a forum to reflect upon their experiences with one another and with their training facilitators. In turn, the teen leaders required recurring training workshops that included reflective practice to gain the skills and confidence necessary to implement an inquiry-based science curriculum effectively with 4-H youth. These essential requirements were achieved by organizing the project around an integrated series of adult volunteer workshops, teen training workshops, and curriculum implementations with 4-H youth that built capacity at each level.

The successes achieved in this project underscore the importance of effective training for 4-H volunteer leaders. The integration of the adult leader and teen trainings with the curriculum implementations to 4-H youth facilitated on-going skills development through authentic practice and regular feedback with project staff. This process allowed participants at all three levels--adult leaders, teen leaders, and youth--to build upon their experiences and increase their confidence, skills, and knowledge in a progressive fashion over time.

As mentioned previously, nearly one-half million adult volunteers are involved nationally working with 4-H youth (USDA, 2001). Furthermore, teen leaders are commonly used as cross-age teachers within 4-H Youth Development Programs (Lee & Murdock, 2001). In order to operate successful county-based programs, 4-H Youth Development professionals must not only recruit volunteer leaders who are committed to youth, non-formal education, and the goals of 4-H, but must also train them effectively. In doing so, volunteers' confidence is enhanced, and there is a greater balance of ownership and responsibility relative to county programs (Snider, 1985).

Conclusion

A scientifically literate population is essential to understand and address critical issues of the 21st century. Effective youth science education programs offered through county-based 4-H Programs can help realize this goal. To accomplish this, it is crucial to train and support the educators who work with youth (Dana, Campbell, & Lunetta, 1997); in county-based 4-H programs, this can be achieved by increasing the capacity of 4-H volunteers through effective training.

In order to build volunteer leader capacity and expand successful science program offerings within county-based programs, effective professional development opportunities are essential. Training enhances volunteers' effectiveness by improving their skills as educators and as trainers of others (Hoover & Connor, 2001). Training workshops should occur in increments (Lee & Murdock, 2001; Smith & Enfield, 2002), include educational methodology that addresses a diverse array of styles and techniques, and be subdivided into "teachable" parts in order to allow volunteers to comprehend content and processes fully (Hoover & Connor, 2001).

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