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Training 4-H Teen Facilitators in Inquiry-Based Science Methods: The Evaluation of a "Step-Up" Incremental Training Model

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Training 4-H Teen Facilitators in Inquiry-Based Science Methods: The Evaluation of a "Step-Up" Incremental Training Model

Abstract
A "Step-Up" Incremental Training Model for teen curriculum facilitators implementing inquiry-based science activities was designed and evaluated. This model involves a sequence of three training workshops that alternate with curriculum implementations. The model was evaluated using data from focus group interviews, surveys, and direct observations. Key elements in the model's design include: workshop organization; introductory session; multiple increments; effective modeling and practice; "safe" environment for reflection and review. The teens trained during the development of this model were effective in implementing curriculum activities with young children. The authors believe that this method would be transferable to other teen-led Extension programs.

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Introduction

Animal Ambassadors is a youth science education outreach program of the School of Veterinary Medicine, Veterinary Medicine Extension, at the University of California, Davis (UCD). Animal Ambassadors uses the world of animals, both domesticated and wild, as a "bridge" to help youth develop an interest in science while emphasizing important critical thinking and life skills. The program's concept-based curriculum stresses awareness and understanding while fostering animal care and responsibility.

Funding was received from the American Honda Foundation in 1999/2000 for a project titled "Animal Ambassadors--A Science Education Outreach Model," a collaborative effort between the UCD School of Veterinary Medicine and the 4-H Youth Development Program in San Luis Obispo (SLO) County, California. One goal of this project was to develop a state and national training model for the dissemination of the Animal Ambassadors curriculum through county-based 4-H Youth Development Programs using cross-age teaching strategies. This article describes a "Step-Up" Incremental Training Model for teen curriculum facilitators, which was designed and evaluated by the authors.

Background

Engaging children in science activities at an early age is crucial to developing a scientifically literate population. In order to accomplish this, we must train and support science educators (Dana, Campbell, & Lunetta, 1997). However, according to the National Education Association (NEA), current science training programs for educators fall short of what is needed to keep pace in

an increasingly more scientific and technological world (*NEA Today*, 1993).

Most educators who work with elementary age children feel unprepared to teach science (Cannon & Sandler, 2000), and science education at the elementary age level has been viewed as weak (Dana, Campbell, & Lunetta, 1997). Hurd (1999) reports that findings from the Third International Mathematics and Science Study (TIMMS) demonstrate that professional development of science educators in the United States is not as well supported as it is in Germany and Japan. Hurd also states that the study's results showed a lack of common vision for science education in the U.S.

Surveys show the value of hands-on training programs in which teachers experience the curriculum components in a manner that models how the children will receive them (Konen & Horton, 2000). Teachers' anxiety level decreases, their confidence level increases, and their interest and curiosity about the subject matter increases. Overall, the more familiar they are with the subject matter and the materials, the greater their comfort level is. Lopez and Toumi (1995) report that in order to deliver a successful hands-on, inquiry-based curriculum, educators require:

a. Research-based, age-appropriate activities;

b. A science kit with relevant materials; and

c. Ongoing professional development in inquiry methods.

Methods

Curriculum

The Animal Ambassadors curriculum activities are age-appropriate and use a hands-on, interdisciplinary, inquiry-based approach that follows the Learning Cycle (Exploration, Concept Invention/Introduction, Concept Application) and emphasizes the Scientific Thinking Processes (observing, communicating, comparing, organizing, relating, inferring, and applying) (Marek & Cavallo, 1997). The content and instructional methodology of the curriculum align with the National Science Education Standards (1996) and the Life Science and Investigation and Experimentation strands of the California Science Content Standards (2001).

The Animal Ambassadors curriculum is subdivided into five units based on major animal-related concepts:

- Animal Habitats and Geography;
- Structure and Function;
- Dietary Needs and Habits;
- Animal Communication; and
- Human/Animal Interactions.

The curriculum is designed around these animal concepts, but does not use animals in its activities. To make the curriculum interactive, hands-on materials (e.g., foot molds, tooth molds, imitation animals coats) are integral to the activities and are organized into learning kits.

Teens as Cross-Age Teachers

Teens as cross-age teachers of younger youth are used commonly within 4-H Youth Development Programs (Lee & Murdock, 2001). Twenty-four teens from three different geographic locations and three 4-H clubs in San Luis Obispo County were recruited for the project. Fifteen teens continued to work with the Animal Ambassadors program in its entirety, attending all training sessions and implementing the program with younger youth. The teens worked in two groups and divided themselves further into teams depending on the nature of the sessions and activities.

Training Model

The "Step-Up" Incremental Training Model designed in this study involves a sequence of three training workshops that alternate with curriculum implementations to ensure mastery of content and methodology while providing the opportunity for group reflection and feedback. Each subsequent training is a "step up" from the one preceding. 4-H teens from San Luis Obispo County were trained as cross-age teachers of the Animal Ambassadors curriculum. Their target audience was primary 4-H members (5-8 year-old children) and young children (5-8 years old) at the local YMCA.

Key elements of the "Step-Up" Incremental Training Model included the following.

Introductory Session

Held on the Friday evening before the first Saturday training workshop, this 3 1/2-hour session began with an ice-breaker activity, followed by an agenda that focused on introducing the fundamentals of inquiry-based learning, including the Learning Cycle, science process skills, and questioning strategies. This introduction was crucial to the success of all subsequent curriculum trainings, laying a foundation of instructional methodology upon which curriculum content was applied during three training workshops.

Teen Facilitator Training Workshop I

During the subsequent full day of training, facilitators concentrated on activities from curriculum Unit I. The limited amount of curriculum content covered was designed to help the teen facilitators develop confidence in their abilities to implement the activities using inquiry methods. This approach is supported by Lee and Murdock (2001), who caution against overwhelming teens during the initial training, recommending an incremental approach instead.

Workshop facilitators modeled the first activity for the teens, placing an emphasis on the instructional methodology from the previous evening's Introductory Session. Subsequently, each team of teen facilitators planned and presented at least one additional activity from Unit I.

After each presentation, a significant amount of time was dedicated to group reflection. Facilitators and trainees spent time reviewing and discussing each activity presented as it related to inquiry methods, curriculum content, and age-appropriateness. Fundamental logistical challenges (e.g., room size, group size) the teens might expect to face during implementation with their target audiences were also discussed. Upon completion of Teen Facilitator Training Workshop I, teams of teens were charged with implementing the activities with young children in 4-H clubs or at the local YMCA.

Teen Facilitator Training Workshops II and III

Teen Facilitator Training Workshops II and III were 1-day curriculum trainings that focused on reflections from field experiences, review of methodology, activity modeling by workshop facilitators, and practice facilitation of activities by trainees. Significant time for group reflection also remained as a major component of both agendas.

Training II, covering curriculum activities in Units II and III, was scheduled approximately 4 weeks after Training I in order to provide the teen teams sufficient time to schedule and implement all activities from Unit I with their target audiences. Curriculum Training III also emphasized methodology and included the activities from Units IV and V. This training was scheduled at an even longer interval (approximately seven weeks) to allow for the larger number of activities to be implemented by the teen facilitators with their target groups. More curriculum material was covered in Curriculum Trainings II and III because of the higher levels of abilities and confidence of the teens gained through their experiences in previous trainings and during curriculum implementation.

Evaluation

In order to strengthen the evaluation design, a method using multiple tools known as triangulation was adopted to assess the training model. This method reduces threats to validity and allows a fuller and richer explanation of a given construct (Denzin, 1970; Coehen & Manion, 1980). The efficacy of the training model as it related to the teens' familiarity with the curriculum materials, their understanding of inquiry-based teaching methods, and their understanding of questioning strategies was measured. Two main tools were used to evaluate the training model: post-training surveys and a post-project focus group interview. Direct observations of teen facilitators during curriculum implementation with the target audience were also used to measure the use of effective questioning strategies. This tool was used as a supplement to questions asked during post-training surveys and the focus group interview.

Post-Training Surveys

Participating teens were asked to respond to post-training surveys developed using a Likert scale of 1 to 5, with 5 being Strongly Agree (SA) and 1 being Strongly Disagree (SD). A category for Not Applicable (NA) was also included. Survey content focused on workshop organization and facilitation, as well as on skills acquisition and use. Data were collected, and results were calculated and compared as percentages.

Focus Group Interviews

Participating teens were asked to take part in a focus group interview after all trainings and the implementations of the curriculum were completed. Two focus group sessions were held, one for each of the two groups. There was a group facilitator and a recorder for each of the interview sessions. In addition, the focus group interviews were audiotape recorded, and the tapes were transcribed. The focus group interview followed a standard format (Krueger, 1994) with four sections:

1. Welcome and thanks,
2. Overview of the focus group topic,
3. The ground rules, and
4. Questions (12), including some very open-ended questions such as "Have we missed anything during this focus group that you want to add?"

The moderator also gave a brief 2- to 3-minute summary of questions and asked for any changes or additions to the summary.

Direct Observations

A Site Observation Data Sheet was developed that was used twice at each site during actual implementation of curriculum activities. Members of the research team counted and rated (low, medium, and high) the instances of scientific thinking processes during set time intervals. The number of closed and open-ended questions posed by teens was also tallied. The open-ended questions were rated as low, medium, or high. Additionally, the observers answered two summary questions relating to how well the teens implemented inductive teaching methods and how well the children responded to the activities.

Results and Discussion

The 4-H teen participants in this project were effective in their roles as cross-age facilitators of inquiry-based science activities with younger youth. Data from 20 pre-/post- matched sets (nine boys; 11 girls) of children between the ages of five and eight were analyzed for changes in critical thinking skills through the use of the Science Thinking Processes.

Critical thinking skills were measured using a performance-based object description assessment tool. Children were given two different objects (pre- and post-test) that were independent of the curriculum content and asked to describe them. Data were quantified using a scoring rubric that measured the types of Scientific Thinking Processes and the manner in which they were used. Positive changes were seen, particularly among girls. These results were paralleled by other data that showed the children used more senses to observe and describe the objects during the post-test and that the children were far more inquisitive about the objects after project intervention, asking 75% more questions in the post-test than in the pre-test.

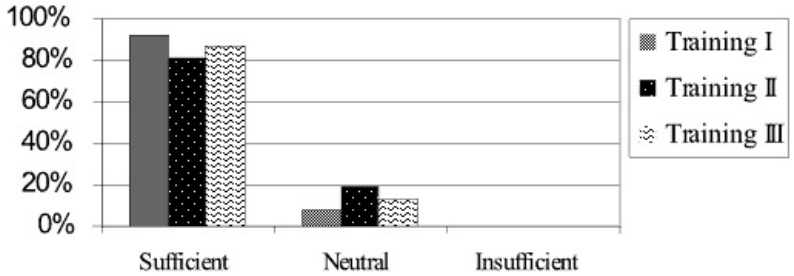
Elements integral to the design of the "Step-Up" Incremental Training Model provided the teen facilitators with the theory, skills, and practice necessary to achieve success during curriculum implementation. The results of survey and focus group interview data with teens were compared, consolidated, and analyzed. Outcomes and discussion related to these data are presented below.

Time to Practice Animal Ambassadors Curriculum Activities

Becoming familiar with all aspects of any curriculum (content, materials, and methods) is critical to the successful implementation of activities (Loucks-Horsley, Hewson, Love, & Stiles, 1998). Therefore, sufficient time must be allotted during trainings for effective modeling, in-depth investigations, reflection, and guided practice (Pottle, 1993; Loucks-Horsley, Hewson, Love, & Stiles, 1998; Lee & Murdock, 2001).

Post-training surveys were used by participants to rate the amount of practice time they had for curriculum activities during workshops I, II, and III (Figure 1).

Figure 1.
Activity Practice Time



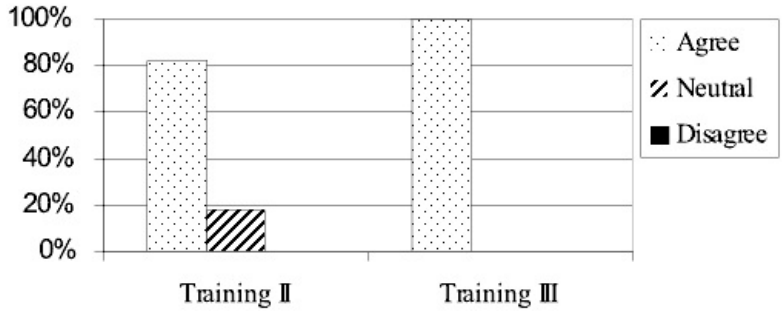
During the post-program focus group interview, several teens reported that they had sufficient time to practice curriculum activities during the trainings. After the completion of all three trainings, some teens stated that they had spent enough time practicing the curriculum activities during the trainings that they did not need their binders or notes during implementation. Some teens shared that practicing activities during trainings helped them learn and apply methods and techniques when working with children. Furthermore, although some participants from an outlying area who had to travel 90 minutes each way thought that the individual trainings were too long, they were also of the opinion that the length of time was necessary to cover the material adequately.

Understanding Inquiry-Based Teaching Methods

The Animal Ambassadors curriculum activities use a hands-on, inquiry-based approach. This method of science education is especially effective in arousing the curiosity of young children and holding their interest (Hinman, 1999). Hinman continues by noting that most science education is taught in a traditional manner that emphasizes the rote memorization and recitation of facts. Consequently, this is the method that is most familiar to facilitators.

After trainings II and III, participants were asked if they understood inquiry-based teaching methods. (This question was unintentionally excluded from the first training questionnaire.) Based on their responses, the teens' understanding of inquiry-based teaching methods improved from Workshop II to Workshop III (Figure 2).

Figure 2.
Understanding of Inquiry Methods



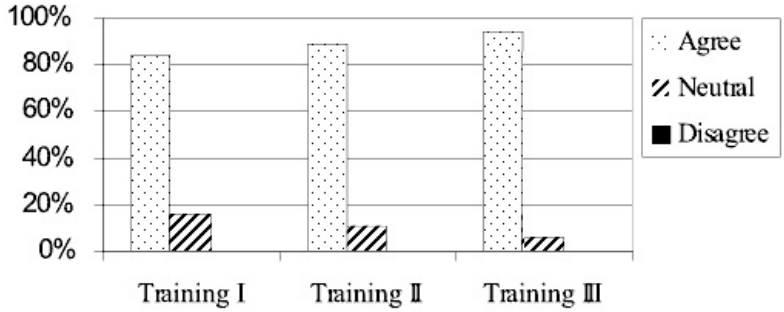
During the focus group interview, the teens reported that the inquiry-based training affected their lives. One teen indicated that she was applying the inquiry approach to her own life and had become much more observant of things around her. She also reported that she has become more curious about things as a result of her training. Another teen shared that she now felt "safe" to explore and that the inquiry approach puts everybody on an equal level.

Understanding Questioning Strategies

Open-ended questions are important to inquiry-based learning; they promote discussion and student interaction. By encouraging exploration, open-ended questions stimulate student thinking and promote ideas, speculation, and the formulation of hypotheses. Appropriate questions allow the learner to access information, analyze it, and draw sound conclusions. Furthermore, good questions stimulate thinking, creativity, and additional inquiry (Latham, 1997).

With respect to questioning strategies, participants were surveyed as to their level of understanding between open-ended and closed questions. Based on survey results, teens' understanding of questioning strategies improved with successive trainings (Figure 3).

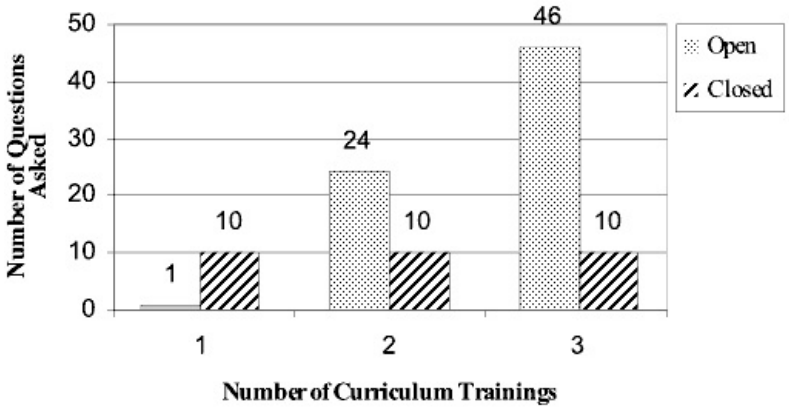
Figure 3.
Understanding of Questioning Strategies



Focus group interview data supported the results from the post-training surveys. Participants reported a deep understanding of open-ended and closed questions. Teens reported using more open-ended questions not only in their work with younger children in the *Animal Ambassadors* Program, but also in numerous everyday situations.

In support of the above data, during direct observation by project evaluators, it was noted that the ratio of open-ended to closed questions posed by teen facilitators during implementation with the target audience improved with more trainings and experience. The ratio of open-ended questions to closed questions was 1:10 after one training. This ratio increased to 24:10 after two trainings and to 46:10 after three (Figure 4).

Figure 4.
Questioning Strategy Comparison



Conclusion

Based on the results of this study, the "Step-Up" Incremental Training Model is an effective method to prepare teenagers as cross-age teachers of younger children for inquiry-based science programs. The elements of this model that are integral to its efficacy include the following.

- **Workshop Organization**: Good organization within a program is essential, as is creating a positive peer support network among participating teens (Lee & Murdock, 2001). Post-workshop surveys measuring workshop organization indicated a high degree of satisfaction among participants in this project. As a result of the structure of the training format, teens reported that the icebreaker activities used during the first training helped the teens to bond and contributed to their success as members of a team. Several teens said that the way trainings were organized enabled them to express their feelings comfortably.

- **Introductory Session**: The introduction sets the stage for the entire program. This session provides a foundation that subsequent workshops draw from and build upon through its emphasis on methods and processes.

- **Multiple Increments**: According to Loucks-Horsley, Hewson, Love, and Stiles (1999), in-service training that is "confined to short, discrete events is a wasted effort." The authors believe that to train teens most effectively, the training process must be planned in increments and occur over an extended period of time. The incremental design of this model is intended to help build individual capacity through improved competence and confidence in the teens.

- **Effective Modeling and Practice**: At the beginning of each training session, training facilitators model best practices in order to reinforce inquiry methods and processes. This is congruent with Pottle (1993), who emphasizes the importance of modeling during science in-service. Furthermore, in order for the teens to be effective in their roles as cross-age facilitators of inquiry-based science activities, it is crucial for them to practice the curriculum in front of their peers in advance of implementation with young children.

- **"Safe" Environment for Reflection and Review**: During curriculum training workshops, time is set aside at regular intervals to debrief activities and methods, providing teens an opportunity to share their thoughts, ideas, and experiences. Components necessary to create a "safe" environment for reflection and review include: a) ample time to discuss feedback from teen participants and b) effective facilitation by workshop leaders.

As a training model for teen-led science programs, the "Step-Up" Incremental Training Model is effective. Results from this project showed that the teen facilitators were able to apply inquiry methods and curriculum content in authentic settings and that they improved their abilities after each training increment. As their abilities grew, so did their motivation to extend the implementation beyond the initial project. One group of teens not only worked together to implement the curriculum in their 4-H club, they also worked in teams to deliver the program to children in a YMCA day camp and at a local zoo.

The authors believe that this method would be transferable to other teen-led Extension programs. Further research would be needed to confirm this, but the model's framework lends itself to being adapted to content areas other than science.

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