COMMUNITY BASED SCIENCE EDUCATION FOR FOURTH TO SIXTH GRADERS: INFLUENCES OF A FEMALE ROLE MODEL

by

Deanna S. Acklie

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Deanna S. Acklie

SUPERVISORY COMMITTEE:

	Approved	Date
Signature		
Typed Name	Dr. S. Kay Rockwell	
Signature	S. Kay Rockwell	July 29, 2003
Typed Name	Dr. Judy Diamond	July 29, 2003
Signature	Georgia L Stevens	July 29, 2003
Typed Name	Dr. Georgia Stevens	
Signature	John DeFrain	7-31-03
Typed Name	Dr. John Defrain	
Signature	Carolyn P Edwards	7-29-03
Typed Name	Dr. Carolyn Edwards	
Signature		
Typed Name		

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Deanna S. Acklie, Ph.D.

University of Nebraska, 2003

Advisor: Kay Rockwell

Women in the United States are underrepresented in science related careers. The *Wonderwise* curriculum was designed to encourage young women to become more involved in science and science careers. The *Wonderwise* kits have won numerous awards for quality science curriculum for formal educational environments. In 2000 the kits were adapted and new kits were developed to meet the needs of a nonformal learning environment (i.e., 4-H). The kits contain a video field trip with a featured female scientist demonstrating her work, an activity guidebook with five activities based on this scientist's work, and a CD-Rom serving as an additional resource.

This study contributes to our understanding of a group of 4-H youth who used the Wonderwise curriculum. It describes their view on science, their perspective about people who do science, the importance of role models within their lives, and their career visions.

This study was a multi-method case study design. The subjects were youth ages 9 –11 involved in 4-H events in a three state area. Events such as overnight camps, day camps, special events and after school programs featuring the *Wonderwise* curriculum were used as sites for this study. The subjects studied in the

Wonderwise 4-H project were primarily female youth who had some interest in science. Nearly half were Caucasian; the remainder were Hispanic, African American and Native American. The 25 youth involved in this study took part in a semi-structure interview process including four research methodologies: open-ended questions, drawing or writing a story about the featured scientist, a card sort activity and a relationship map drawn by the youth.

Youths' prior experiences in formal, informal and nonformal settings impacted how they made sense of and incorporated *Wonderwise* experiences in their frame of reference. Through the experiential learning process youth experienced science activities and connected to individuals with science backgrounds, particularly those individuals within their relationship network such family members, and teachers who "do" science. Girls within this study related to and identified with the female role models presented in the *Wonderwise* 4-H curriculum. Native American youth related to a Native American scientist based on a similarity in culture.

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This was a huge undertaking for a first research project. This project taught me the importance of role models within my life. The individuals involved with this evaluation team believe in experiential learning and the impact of role models. I was allowed to take the time I needed to understand all the research concepts and methodologies I was experimenting with. I had support from this group and a depth of knowledge and experience base to fall back on for support. This project would not have been possible without my co-researchers: Dr. Judy Diamond, Saundra Frerichs, Dr. Kay Rockwell, and Dr. Amy Spiegel.

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Deanna S. Acklie, Ph.D.

Lincoln, Nebraska

Chapter I

Introduction

It is a brisk morning. Youth from various 4-H clubs clamor out the door of an old brick building into the courtyard area. Their chatter fills the air. The children carry with them equipment needed for the next event. Individuals walking in the courtyard stop to watch as the children cluster in small groups throughout the courtyard area. Team discussions begin concerning the breakdown of tasks. Children stretch out transect lines and gather magnifying glasses and data recording sheets. Exclamations of new findings fill the air as children, on hands and knees, diligently search each area for signs of living organisms. Adults move from group to group, listening and facilitating discussion about plants and insects, answering questions and offering words of encouragement.

These children are participating in the Cool Tools activity and taking on the role of an ecologist much like Carmen Cid, the urban ecologist featured in the video they just viewed. This activity is just one which can be found in the *Wonderwise* 4-H curriculum. The activities are written to encourage youth's work through inquiry-based activities to heighten interest in science and scientists.

Research indicates that children need hands on experiential activities to gain science skills, and to create interest in science and scientific careers. Nonformal educational settings, such as 4-H, have the potential to offer children a different kind of classroom. Gurian (2001) credits any environment a child is in as a learning environment. Diamond (1999) places emphasis on the benefits of inquiry based learning in nonformal settings. She describes nonformal learning as an intensely

social experience which occurs within the context of family or peers. This learning is built on prior knowledge characterized by unconscious imitation which results in new learning. A large part of nonformal learning involves play and requires different thought processes than formal learning. Understanding these thought processes and learning connections could open the door to better understanding children's learning. This study opens a window into this understanding.

Cultivating Scientific Interest in Youth, Particularly Girls

Women in the United States, as well as certain minorities, are proportionately underrepresented in most scientific and technological disciplines (Lee, 1998; AAUW, 1992; NSF, 1999; Oakes, 1990). Despite recent advances, females continue to be underrepresented in the sciences, and their attrition rates are higher than those of men (National Science Foundation, 1982). Disparities, such as lack of role models, are often said to result from background factors that put children at a disadvantage in quantitative disciplines (Hardin & Dede, 1973; Koch, 1992; Sloat, 1992; Lee, 1998). Accumulating research suggests that girls' disadvantages may lie in the way educators cultivate interest, rather than how they ration or restrict opportunities to learn (Fennema, 1984; Fox, 1980; Oakes, 1990; Reyes, 1980; Wilson & Boldizar, 1990; Lee, 1998).

To address the needs and encourage women to become more involved in scientific careers, a multi-media program, *Wonderwise*, was developed. The *Wonderwise* curriculum is a series of kits developed through a partnership between University of Nebraska State Museum and Nebraska Educational Television. Initial development began in 1992. Original kits contained a 10 to 15 minute video,

consumable materials needed to complete five curriculum activities, an activity guide, and a bibliography of the featured scientist. The kits used real women scientists as potential role models and provided inquiry-based curriculum activities modeled on the actual work of these living scientists. *Wonderwise* was originally designed for formal education in elementary classrooms to supplement science curricula in grades four through six. *Wonderwise* emphasizes the learning of science through identification and experience. Identification happens with women scientists by closely following their lives and activities. Science experiences are developed by engaging children in related inquiry-orientated activities (Speigel, Diamond, Dethlefs, n.d).

Previous studies of *Wonderwise* curricula have established its effectiveness in formal elementary classroom settings. Based on the findings of a pilot study, Spiegel, Dethlefs and Diamond (1997) found that using the *Wonderwise* curriculum had a positive impact on children's view of scientists and science. These results suggested that *Wonderwise* kits might indeed impact children's thinking about scientists and science.

Expanding Wonderwise to Nonformal Youth Education

Because science education lends itself to out-of-school experiential experiences at camps, museums and after school programs, there was an opportunity to expand *Wonderwise*'s utilization base. Cooperative Extension's 4-H youth program has a long history of success in educating youth through nonformal educational processes. The development of a partnership between the 4-H program and a nationally recognized science curriculum (i.e., *Wonderwise*) seems to enhance the

opportunities for youth in rural and urban areas. It exposes youth to science through a unique delivery system.

Therefore, 4-H programs in land grant universities were chosen as the test site for expanding *Wonderwise* use as a nonformal youth educational experience. The 4-H youth program uses the knowledge of the land-grant university system to help youth reach their full potential through developing life skills and learning by doing. In 4-H, youth have fun, meet new people, learn new skills, build self confidence, learn responsibility, and set and achieve goals (National 4-H, 2002). As the largest youth organization in the United States, 4-H builds its programs on local clubs, fairs and shows, camps, state 4-H youth gatherings, special events, national 4-H congress, national 4-H conferences, international 4-H youth exchanges, school enrichment and collegiate 4-H (National 4-H, 2002).

Following the development and distribution of the original *Wonderwise* kits, the University of Nebraska State Museum (UNSM) in partnership with the youth development section (i.e., 4-H) of the University of Nebraska Cooperative Extension Division sought funding to develop the *Wonderwise* 4-H Project. The National Science Foundation (NSF) funded the *Wonderwise* project to develop three additional kits and to reformat original kits for use in the nonformal educational setting of 4-H.

The goals of using *Wonderwise* in the 4-H program are to:

1. Motivate eight to twelve year old youth, particularly girls, to pursue an interest in science and an awareness of scientific activities and careers.
2. Create a positive image of women and minority scientists for youth participating in 4-H.

3. Improve diversity and quality of 4-H's out-of-school science materials by offering materials that are inquiry-based, multicultural and that tie science activities to the work of real scientists.
4. Help youth connect agricultural topics and their underlying scientific principles.
5. Install in youth a better appreciation of empirically-based knowledge and enhance children's ability to use scientific reasoning (Diamond & Heusel, 2000).

Integration of the 4-H *Wonderwise* kits into the 4-H science curriculum was tested in 10 states: Nebraska, Minnesota, Wyoming, Oklahoma, Michigan, Montana, Illinois, Iowa, North Dakota and South Dakota.

The Comprehensive Evaluation of Wonderwise 4-H

An evaluation team representing the NSF grant, the UNSM, and the 4-H youth development program implemented a comprehensive evaluation plan. It called for four evaluation processes:

1. End of session questionnaires for feedback on training activities. Adult 4-H staff were oriented to the *Wonderwise* curriculum and its use in a specially designed training series. Upon completion of each training series, end-of-session questionnaires assessed the ability of the 4-H staff to use the *Wonderwise* curriculum. Additionally, questions were asked which defined trainees' ability to train other adults in their statewide 4-H program.

2. A web survey to adults who used the *Wonderwise* curriculum. A web site survey gathered information about the usage of the *Wonderwise* 4-H curriculum. Questions were designed to find out what worked about the curriculum and the problems experienced by users of the curriculum.
3. Personal interviews with state contact personnel. Each state contact person in the 10-state pilot project was personally interviewed to gather information on their state's use of (a) training opportunities, (b) scheduled programming, and (c) dissemination of *Wonderwise* kits. The interviews helped establish sites for researching how youth synthesized the subject matter in a nonformal setting.
4. Research on how youth synthesize the subject matter in nonformal educational settings. Interviews, field notes and documentation of children's work was gathered at six research sites across the 10-state area. This research emphasis is the foundation upon which the study reported in this dissertation was built.

Study of Youth Synthesizing Wonderwise Content in Nonformal Setting

The Study Purpose

The purpose of this research was to (a) explore how children participating in an experiential learning module (i.e., *Wonderwise* 4-H curriculum) in nonformal educational settings connect to science and a scientist role model and (b) to better understand if children incorporated the subject matter into their thinking.

Research Questions

The grand tour question was: How does the use of *Wonderwise* 4-H kits in a nonformal educational setting affect the ways children think about science and scientists?

Specific sub questions include:

1. In what manner did individual children identify with the role models in the *Wonderwise* 4-H kits?
2. How did children use the activities and videos in *Wonderwise* 4-H as they incorporated subject matter into their thinking?
3. What patterns emerged as the children incorporated the subject matter from the 4-H *Wonderwise* kits into their current knowledge?

Significance of the Study

This research describes how children responded to one experiential learning process in a nonformal setting (i.e., 4-H). The research contributes to the evaluation of the experiential process to increase children's awareness and interest in scientific topics and careers. The perceptions of individual children about the context of this curriculum and its impact on their thinking, creative work, and future plans, offers a glimpse into their thoughts and learning about science. Based on this research, decisions can be made about (a) using experiential learning processes for science education in nonformal educational settings, (b) how to improve and use 4-H *Wonderwise* kits in additional nonformal youth education settings to encourage children to interact with science and science related materials and topics, and (c) the importance of scientific role models in the lives of pre-adolescents.

The *Wonderwise* curriculum has been studied within formal classroom settings. The transition to nonformal educational settings presents new opportunities to look at its impact, beyond how it is used in a formal classroom context. The nonformal educational setting allows for immersion by the researcher into the child's experience and offers opportunities for rich qualitative study based on observation of a program in action.

Definition of Terms

Evaluation Team - Representatives from NSF, UNSM, and the 4-H youth development program who planned and implemented multiple methods to evaluate *Wonderwise* 4-H.

Formal Education - Education usually associated with schools. The hierarchy of a structured, chronologically graded educational system running from primary school through university and including, in addition to general studies, a variety of specialized programs and institutions for full-time technical and professional teachers (Coombs, 1973).

4-H Program - The youth education branch of the Cooperative Extension Service program of the United States Department of Agriculture. Each state and each county has access to a County Extension office for both youth and adult programs (National 4-H, 2002).

4-H Youth - Members of the 4-H program ranging in age from five to twenty-one years (National 4-H, 2002).

4-H Adult Leaders - Volunteers or paid Extension staff who have been trained to work with youth enrolled in 4-H.

4-H Teen Leaders - Youth specifically trained to use leadership skills in 4-H projects that include working with younger 4-H youth. Teen leaders must be at least 14 years of age.

4-H Camps - Refers to those 4-H camps taking place over several days and include a sleep away from the home component.

4-H Day Camps - Refers to those 4-H camp activities taking place during the daytime hours and do not include a sleep away from the home component. Day camps are either a series of days or one day events.

4-H Clubs - A group of youth ages 5 to 21 who meet as an organized entity enrolled in and using 4-H curricula. These clubs may be organized around a topic such as livestock, or by age with members enrolling in a variety of topic areas. Each club usually has a name, adult leaders and an organizational structure.

4-H Special Event - A one-time event organized around a central theme or activity. These events are sponsored by 4-H and are open to all youth, not just 4-H members. These special events are usually coordinated and led by 4-H adult leaders or Cooperative Extension staff.

4-H School Enrichment Programs - 4-H curricula designed to complement and expand elementary school curriculum. In some activities, such as Water Festivals, teachers plan educational activities before and after a day field trip where the children experience activities that teach them about waters' role in ecology. In other activities, such as *Wonderwise* Cooperative Extension staff may facilitate activities in an existing before/after school program.

4-H Experiential Model - A design by Pfeiffer and Jones (1981) which includes several stages within the model including the experience, time to communicate and share observations, process time to allow for analyzation and reflection, generalization which allows for relating the experience or activity to the real world, and application which allows for use of what was learned in a similar situation (Carlson & Maxa, 1998). Kolb (1984) notes that knowledge results from the interaction between theory and experience (Figure 1.1).

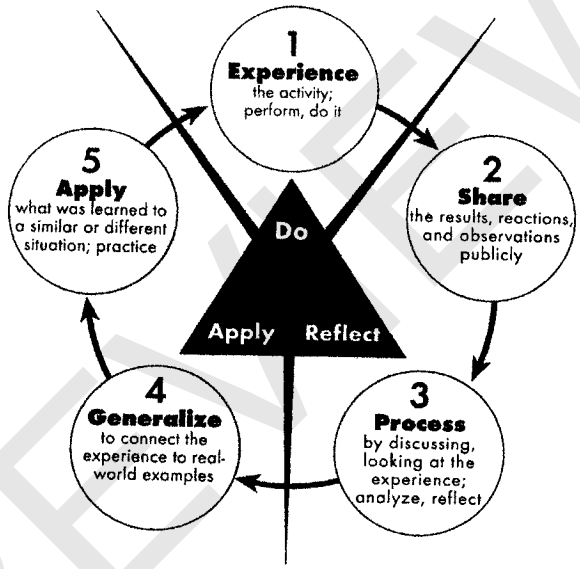

Figure 1.1. 4-H Experiential Model

Identification - The steps by which the ego grows in ever more mature interplay with the available models. The fate of childhood identification in turn depends on the child's satisfactory interaction with trustworthy representatives of a meaningful hierarchy of roles (Erikson, 1968). Josselson (1996) says that idealization and identification are ways of linking to powerful others and striving to become like them.

Informal Education - Education that is voluntary and self-directed, life long, and motivated mainly by intrinsic interests, curiosity exploration, manipulation, fantasy, task completion, and social interaction. Informal learning can be linear or nonlinear and often is self-paced and visual or object-orientated. It provides an experiential base and motivation for further activity and learning. The outcome of an informal learning experience in science, mathematics, and technology, includes better understanding of concepts, topics, processes, and thinking in scientific and technical disciplines, as well as increased knowledge about career opportunities in these fields (National Science Foundation, 1982).

Nonformal Education - Any intentional and systematic educational enterprise; usually outside of traditional schooling; in which content is adapted to the unique needs of the students, or unique situations used to maximize learning and minimize other elements which often occupy formal school teachers (i.e., taking roll, enforcing discipline, writing reports, etc.) (Kleis,1973; Etling, 1993).

PIAT - The acronym used by the researchers for the final activity within each *Wonderwise* curriculum kit. This document called Pulling It All Together (PIAT) is a synthesis activity asking the youth to create a story about the kind of scientist just featured within the *Wonderwise* kit (See Appendix A).

Relationship Map - The name given to the final activity of the research interview process. Based on the work of Ruthellen Josselson (1996), the map is drawn by the individual being interviewed and included depictions of individuals important in their lives (See Appendix B).

Triangulation - Triangulation of information in qualitative research is the convergence of sources of information, views of investigators, different theories, and different methodologies, which represents the triangulation of ideas which help support the development of central themes (Denzin, 1970). In case study research, Stake (1995) places emphasis on sources of data and suggests that the researcher triangulate differently based on "data situations" in the case (Creswell, 1998).

Wonderwise - An inquiry based science curriculum developed for children age 8 to 12 by the University of Nebraska State Museum. Women scientists and their work are featured in video, CD formats and supplemental activity oriented materials which expand the video presentation so youth can experience activities related to the woman scientist.

Assumptions

It is not the intent of this study to generalize information gathered to the population at large. Rather, the intent is to understand how participants using *Wonderwise* kits in nonformal 4-H settings are impacted in their thinking about science and scientists through the videos and associated activities. The purpose of a case study is not to represent the world, but to represent the case (Denzin & Lincoln, 1994). A case study can usually be seen as a small step toward generalization, but generalization should not be emphasized in all research (Feagin, Orum, & Sjoberg, 1991; Simmons, 1980; Denzin & Lincoln 1994).

Limitations

Ethical considerations. It was projected to have a mix of ethnicities with a concentration of individuals representing minority population. However, the sites in

the Midwest offered only limited access, or skewed access, to minority populations. Additionally, language and cultural barriers were present when individual children had limited knowledge of English since the *Wonderwise* curriculum used in this research was in English only.

Generalization to all nonformal youth programs is not possible. This study is limited to youth who participated in *Wonderwise* 4-H projects, camps and special events.

Institutional review board implications. The Institutional Review Board (IRB) required that identity of the individual youth be protected. Children had to be referred to by an ID number rather than name or initials. The IRB limited the kinds of demographic information gathered from the youth to gender, age and ethnicity. Addresses and contact information could not be gathered. These limitations impacted the manner in which researchers could document validity from interview transcriptions, because member checks were not an option. In addition, longitudinal study follow-up in six weeks or six months to explore longer-term impact was not an option (Appendix C).

Youth age. Youth ages 8 to 12 can be difficult to interview. On some sites youth had very little time to get acquainted with the interviewers prior to the interview. Some children had limited patience with adult strangers asking multiple questions, especially when other youth were off doing something far more exciting such as swimming, playing ball or having free time.

The interview environment. Interviews needed to take place in a variety of settings with multiple distractions. Additionally, some interviews needed to take

place at the end of a long day. In some cases, the two interviewers completed an interview with youth who were tired and had a short attention span; this may have limited their thinking power. Interviews needed to be informal, yet they needed to be structured sufficiently to gather the needed data.

Chapter II

Literature Review

Introduction

Studying the effectiveness of a curriculum is often a difficult and challenging task. Understanding how specific materials are impacting children's thinking and their learning can be difficult at best. It is important to look at impact and current perceptions youth have in their thought processes when trying to know how children think about science. Questions are raised about what causes women to not choose science careers. What do girls say about science? How are female experiences in a formal setting different than that of their male peers? What do nonformal or informal settings look like for girls? Why choose these settings to study science learning?

Usually, children are tested in formal settings to measure what they have learned. Formal education generally takes place in a classroom within a standard school setting. Science is part of the regular curriculum, with everyone participating in the same lesson with the same expected outcomes. Measurement of learning becomes a matter of comparing test scores. This is not an option in a nonformal educational setting. This type of setting provide an individual with diverse and open-ended experiences. Assessment of learning in this format is a challenge. Formulating and understanding how learning takes place through experiences in this type of environment requires an understanding of experiential learning models.

The *Wonderwise* curriculum has been studied within formal classroom settings. The transition to a nonformal setting presents new opportunities to look at its impact beyond how it is used in a classroom context. This type of setting allows

for immersion by the researcher into the child's experience and offers opportunities for rich qualitative study based on observation of a program in action.

To better understand these questions in a nonformal educational setting for youth, several topics were explored in the literature. They are:

1. The history of the *Wonderwise* curriculum.
1. Woman's perception of science and scientific careers.
1. Significance of adult role models.

History of the *Wonderwise* Curriculum

The original *Wonderwise* science curriculum kits were a joint venture in 1992 by Dr. Judy Diamond, University of Nebraska State Museum (UNSM) and Nebraska Educational Television (NET). The original proposal was funded through grant dollars from the Howard Hughes Medical Institute. The *Wonderwise* project was designed as a series of museum outreach kits. The purpose was to motivate young girls to pursue scientific activities and careers. The *Wonderwise* project required establishing partnerships with educational institutions across Nebraska, evaluating teachers' uses of museum based science kits in formal classrooms, and creating multimedia kit materials.

Partnering with Educational Institutions

In 1991, preparing for the *Wonderwise* project, museum staff contacted educators across Nebraska to see if partnerships could be established. Nebraska has more small school districts than any other state; these districts are organized into 19 regional units called Educational Service Units (ESUs). Most school districts are

served by one of the 19 ESUs. All 19 ESUs agreed to become partners in the *Wonderwise* project.

The other significant partnership was established with Nebraska State Department of Education. The state department agreed to undertake a portion of statewide dissemination of *Wonderwise* kits. The department allocated federal Eisenhower funds toward teacher support, training workshops, and follow-up.

Formative Evaluation

The next step was learning the needs and constraints faced by Nebraska educators. Through extensive surveys, the museum staff learned what kinds of kits Nebraska teachers wanted and how *Wonderwise* project should organize activities to meet teachers needs (Diamond, Hochman, Gardner, Schenker, & Langan, 1996).

Selecting topics. Staff surveyed Nebraska teachers to learn what kits would be most useful. The survey sampled 183 K-8 teachers from rural and urban areas of Nebraska during November of 1992. Teachers surveyed showed interest in insects, geography, dinosaurs, rocks and minerals, Indian artifacts and Nebraska fossil animals (Diamond et al., 1996).

Learning about kit use. Next came a series of three surveys examining how Nebraska teachers use science kits within their classrooms. The survey results helped to shape the content and format of the *Wonderwise* kits (Figure 2.1).