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Timothy DePriest
Cornell University, td48@cornell.edu

Marianne Krasny
Cornell University, mek2@cornell.edu

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Engaging County Educators in Science Education Reform: The New York 4-H Environmental Inquiry Program

Abstract
We attempted to engage 4-H educators in facilitating science research experiences for youth. Through interviews and surveys of county educators and on-site observations, we determined that although nearly all educators implemented youth research projects, they faced challenges related to their own and their partner educators' lack of research experience and to fitting research projects into ongoing school curricula and county Extension programs. Future efforts might consider providing short research experiences for county educators and teachers to better enable them to facilitate research experiences for youth and thus to help schools meet inquiry-based science education standards.

Timothy DePriest
MS Student
td48@cornell.edu

Marianne Krasny
Professor
mek2@cornell.edu

Cornell University
Ithaca, New York

Introduction

In the late 1990's, scientists and educators developed the National Science Education Standards, which emphasize involving youth in open-ended inquiry learning, including authentic research (NRC, 1996). According to the Standards, instead of memorizing terms and conducting labs with pre-determined outcomes, students should become actively involved in "learning science as science is practiced." Furthermore, the Standards call for the involvement of community organizations (such as Cooperative Extension) to enhance students' research experiences.

In 2000, the Cornell University Department of Natural Resources embarked on a new program, 4-H Environmental Inquiry (4-H EI). The goal of the program was to build the capacity of Cornell Cooperative Extension (CCE) educators to play a key role in science education reform in their communities, through providing opportunities for youth to engage in authentic, open-ended research. The program drew on our 14 years of experience in creating opportunities for youth and educators to conduct research. That experience included:

- Summer research internships for high school teachers and students (Krasny, 1999),
- Research-based curricula (Barnaba, Krasny, Kasperek, Hoskins, & Hope, 2000; Carlsen, Trautmann, Cunningham, & Krasny, 2003; Krasny, Trautmann, Carlsen, & Cunningham, 2002; Trautmann, Carlsen, Krasny, & Cunningham 2001, 2003), and
- Workshops for educators who have then guided youth in local investigations (Krasny & Doyle, 2002).

Most of the Environmental Inquiry programs have taken place in high school and middle school classrooms, with only a few projects involving 4-H youth.

4-H has played an important role in education reforms related to school-to-work programs (Kraft, 1999), and a number of programs have engaged 4-H youth in science inquiry activities (e.g., In Touch Science, Youth Experiences in Science, Science Experiences and Resources for Informal

Education Settings). However, we felt that 4-H could also engage youth in authentic research, drawing on the historical precedent of the early 4-H clubs that involved youth in planting experiments with new varieties of vegetables. In addition, Extension could draw on its experience facilitating joint projects involving university scientists, government agencies, schools, and local non-profits.

The purpose of this article is to: (1) briefly describe youth research programs implemented by the county educators and (2) document some of the issues that arise when county Extension educators engage youth in research.

4-H Environmental Inquiry

Using funds from the Cornell Research and Extension Integration grants program, we solicited proposals from NYS counties wanting to develop 4-H EI programs. Ten counties were awarded $500 "mini-grants," based on their plans for volunteers and CCE educators to work with at least 10 youths to conduct authentic research. A training workshop for educators and volunteers from the 10 counties was held in May 2001, during which participants were introduced to the National Science Education Standards and to a series of potential research projects that are appropriate for youth.

Methods

The focus of the program evaluation was to identify the aspects of project implementation in each county that reflected progress towards and challenges to achieving the goals of the 4-H EI program. Because we desired to gain an in-depth, detailed description of each county project, the evaluation methods were based on a naturalistic inquiry approach (Patton, 1990). Qualitative data were collected from the CCE county educators through open-ended surveys and semi-structured phone interviews. In addition, the evaluator conducted on-site observations of 4-H EI activities in several counties.

Educators completed a written survey at the beginning of the program, which focused on their background in research and education, goals for project implementation, and related concerns. They also completed a survey at the end of the program detailing the types of programs they conducted, number of youth participants, and partnerships formed.

The primary source of data was semi-structured, in-depth interviews with the 10 CCE county educators participating in the 4-H EI program. The interviews focused on four main areas: general experiences with and perceptions of the program, needs for project implementation, challenges faced, and benefits received as a result of participation. The complete, recorded interviews were transcribed, and by analyzing the content of the transcripts, emerging themes in each area were identified.

Observational data were collected through the evaluator's participation in a subset of the county projects, yielding an "insider" perspective on the process of engaging youth in research experiences. For example, by working alongside the CCE educator, local partners, and youth participants in the invasive species monitoring project, the evaluator experienced the general challenges and complexities of organizing and facilitating youth research activities. These observations aided in the analysis of the interview and questionnaire data by grounding the educators' responses in a practical context.

Considering the highly diverse set of county projects, we initially took an inductive approach to data analysis, which allowed issues related to project implementation to emerge rather than be constrained by pre-determined categories (Patton, 1990). Each educator's unique perspectives on the program were used to identify issues, which were coded into themes for further analysis.

We then took a deductive approach to developing a category of "key issues" based on the relevance of the issues to stated program goals. For example, the fundamental goal of 4-H EI was to engage youth in research experiences; hence, issues related to the educators' capacity to facilitate youth research projects were considered as key issues. This allowed us to examine more closely the alignment of program design with the way in which the program was implemented at the county level, resulting in an informed understanding of how the program works and where it can be improved for the future.

Results

County Programs

Each county implemented at least one program following the workshop. The educators utilized various models of implementation, including:

- Direct support of or collaboration with local partners to conduct research projects with youth (5 counties),
- Workshops to train local partners to lead youth in research projects (4 counties), and
- Working directly with youth and volunteers to conduct research activities (2 counties) (Table 1).

Table 1.
Overview of 4-H EI Projects in Each Participating County

Project Description	Project Model*	# of Youth	# of Partners
Amphibian population monitoring. Youth identified species using mating calls and submitted their data to a national amphibian monitoring database.	1	6	2 teachers
Eco-camp. Week-long day youth camp focusing on field research methods for wildlife and vegetation. Results of field sampling used to monitor a human-made wetland.	3	6	N/A
Effects of deer on forest regeneration. Youth measured vegetation regeneration inside and outside of deer exclosures.	1	8	2 teachers 2 volunteers
Biological control of invasive species. Using permanent plots, youth monitored the growth and spread of purple loosestrife before and after release of beetles used in biological control.	1	20	2 teachers 5 volunteers
Project Feeder Watch. Through participation in a citizen science program developed by the Cornell Laboratory of Ornithology, youth observed and identified bird species at feeders and submitted their data to a national database.	1	No data	1 teacher 1 4-H leader
Strawberry cultivation. After establishing a strawberry garden at their school, youth engaged in experiments to determine what factors contribute to different levels of strawberry sweetness.	1	~50	2 teachers 2 4-H leaders 2 volunteers
Water quality monitoring. Youth monitored the health of a stream adjacent to their school using water quality test kits and macro-invertebrates.	1, 2	12	1 teacher
Sugar maple sap sweetness. Youth measured sap sweetness and learned about the Sugar Maple Tree Improvement Program.	3	~30	2 teachers 2-3 syrup producers
Training workshops for local science teachers and students (3 counties). A series of workshops to introduce participants to youth research topics, raise awareness of CCE resources, and develop skills in inquiry-based instructional methods.	2	40	4 teachers

* Project Models

- Direct support of local partners to conduct scientific research projects with local youth (6 counties).
- Conduct workshops to train local partners to lead youth in research projects (3 counties).
- Work directly with volunteers and youth to conduct research activities (1 county).

Benefits, Challenges, and Needs

Opportunities for networking with other Extension educators and local partners was the most important benefit of participation, although ties to campus, curricula, funding, and professional development opportunities also were cited by educators (Table 2). As one educator suggested, networking and seeing how other programs work could be a key factor in breaking down barriers to implementing a new program such as 4-H EI (Table 3).

Table 2.
Themes and Corresponding Issues Related to Program Participation and Implementation Identified from Interview Data

Theme	Issue
Benefits of participation	Opportunities for networking with other CCE educators and local partners*
	Increased support from university or CCE administration
	Professional development
	Funding
	New curricular materials or resources
	New teaching methods/ improved pedagogy
	Increased ability to facilitate scientific research
	Stronger/ new connections to university or other organizations
Challenges to implementation	Lack of confidence or ability to implement research project*
	Lack of previous research experience*
	Presence of school system-related constraints *
	Lack of community awareness of CCE programs and resources*
	Constrained time availability of CCE educators or local partners
	Lack of support from community or administration

	Difficulty in development of project plan
	Alignment with required job duties of educator
Needs related to project implementation	Program better aligned with local needs*
	Improved collaboration with partners in formal education setting
	Improved program curricula or materials
	More training for either the educator or local program partners
	Improved collaboration with Cornell faculty and researchers
	Increased funding
* Indicates key issue for program implementation	

Table 3.
Key Issues and Selected Quotes from Interviews with CCE Educators

Key Issue	Example Quotes
Networking with other educators and university faculty (benefit)	• *When one school or group of kids is able to do something like EI,* it gives the other kids and other schools the confidence necessary to try it themselves. This in effect breaks down barriers.* • *I liked the workshop at the Arnot because I got some perspectives from other teachers, and other researchers about how they have adapted their research projects to a different venue.* • *I am also very interested in how people structure their own programs. Also to meet with other educators to find out what is working for them and what their needs are, so that can apply that info to my own programs.*
Presence of school system-related constraints (challenge)	• *Curriculum in the BOCES and AP science course is less structured than a regents class, so there would be additional challenges to getting the EI* program into those classrooms and meeting the standards, but if you are working with 4-H, that will not matter.* • *I am constantly trying to build my base of teachers in the county, but they are so restricted by the standards by the curricula by the demands of the school district that they have trouble being able to commit to a project even if they are interested.*
Lack of community awareness/ support of local Extension programs (challenge)	• *There would have to be enough awareness amongst the people we work with, so that they would demand that we prioritize this in our job description for it to work.* • *A lot of times if they do programs, they (teachers) don't even come through Cooperative Extension on a local level -- they go straight to Cornell.*

Better alignment of program design with local needs (needs)	• *When we make connection between the researchers on campus and youth out in the field, you really have to make sure that it is something that they really want to get engaged in.* • *I think that most important thing with this type of program is to say "who are the people who you want to use it," then find out from them what they think of different models of projects in terms of the youth that would be involved.* • *I would hate to see a lot of time and energy devoted to developing, or continue to develop programs without knowing the people who I am trying to market them to, or help with.*
*EI = Environmental Inquiry	

The biggest challenges related to working with program partners (Tables 2 and 3). Most of the county projects involved schoolteachers as local partners and encountered constraints associated with fitting new material into an already full school curriculum. General community awareness and support of CCE educational programs also presented a challenge. Several county 4-H educators noted that other local educators were not aware of the county's ability to provide science experiences, and in fact, some teachers go straight to Cornell University for training and support needs, bypassing the county office.

Several educators felt that programs developed on campus, including this youth research program, were a mismatch for the intended audiences (Tables 2 and 3). One educator referred to the "marketability" of some Extension programs over others and to her obligation to provide programs that her county residents are calling for.

More traditional 4-H activities, such as those associated with animal husbandry and textiles, may overshadow newer science education programs. According to one educator, there is resistance to change 4-H club-based to school-based programs, and the Extension educators feel an obligation to remain loyal to the well-established programs in their community. Furthermore, the 4-H EI program was designed for middle and high school youth, whereas the county 4-H programs generally focus on elementary age youth.

Previous Research Experience and Program Implementation

The level of prior experience conducting scientific research was identified as having important implications for the educators' ability to facilitate youth research projects. In response to the pre-workshop survey item, "List three things you think it is important for youth to understand about environmental sciences research or science research in general," educators with prior research experience mentioned youth understanding of the process of scientific research, while those without research experience placed more priority on learning outcomes associated with, but not integral to, conducting research (e.g., career explorations) (Table 4).

Table 4.
Responses to Pre-Workshop Survey item: "List three things you think it is important for youth to understand about environmental sciences research or science research in general."

Respondents with research experience	• *Things go wrong! Sometimes you don't answer the question, but end up with more questions. Science is active--not just memorizing facts.* • *It is long term, use all your senses to observe, follow procedures, but always try to improve them.* • *Knowledge is key--must be informed to design a functional research program. You need to be patient; not everything is going to happen at once. Knowledge how data collected is going to be analyzed before starting data collection.*
Respondents without research experience	• *I think the most important aspect is that youth get an opportunity to have a critical thinking learning experience. I think it offers career opportunities not originally thought of. Environment research provided the problem solving skills.* • *The hand-on activities are effective learning*

	opportunities and can encourage students to network with researchers and service providers, to develop and strengthen students' communication, written and technical skills, and to introduce students to careers in science and health fields. • *It can be fun! Scientific inquiry, question and wonder, how to find answers.*

Prior research experience also appeared to have a strong influence on implementation of research projects. An educator with research experience commented,

> It is a long-term project, so I did not expect to get any results immediately, but wanted the younger people to understand that ecology and environmental cycles are long-term and it is just as important to think about those issues.

In contrast, an educator lacking research experience indicated some of the challenges her group faced:

> We had the training day at the Arnot, which was very helpful, but we just kind of skimmed the surface of each topic, and did not get too far into it. For someone like me for whom this is not their background, it took some extra work before I felt like I could teach this.

Another educator recognized that program partners who lack science backgrounds were less confident to engage in research activities, and because of this tailored her training workshops to directly address this issue.

> (As a result of these workshops) several people came up to me and said "this is really good, it makes me less intimidated by the whole process, because there are not wrong questions, or wrong answers--it's really, it's promoting curiosity. And that's really what we need to do with kids."

Prior research experience by the local program partner was also a key factor in the implementation of a 4-H EI project in one county. The youth in this county set up research plots to monitor the invasive plant, purple loosestrife. One of the local partners, a high school teacher, had previous research experience, which enabled him to show the youth how to obtain a random sample and to articulate the importance of random sampling.

Discussion

Was the 4-H EI program successful in reaching its goal of building the capacity of Extension educators to play a role in science education reform in their communities, through providing opportunities for youth to engage in open-ended research? Some counties, particularly those where Extension educators had research experience, were able to engage youth in research, drawing on the curriculum resources, financial support, and opportunities for networking with university scientists and like-minded educators provided through the program.

In other counties, the program was seen as not meeting local needs and presented significant challenges. In these counties, engaging youth in research activities may have been used to meet other county 4-H priorities, such as providing career opportunities and hands-on learning.

The National Science Education Standards recommend that teachers be provided with inquiry-based experiences, which are considered necessary for a teacher to be effective at facilitating inquiry-based learning (NRC, 1996). In hindsight, it might have been more effective for the 4-H EI educator workshop to have engaged the participants in a "mini-research" project from start to finish, thus providing them with at least minimal experience with the research process and also modeling how we wanted the educators to guide youth in research.

Instead, the training included a series of hour-long presentations to introduce the educators to the variety of potential youth research projects (e.g., sugar maple sap sweetness, herpetology monitoring) but did not provide time for the educators to experience the research process. Whether or not a short workshop could provide sufficient research experience to prepare educators to implement youth research projects is not known, although a similar short-term research experience had some positive effects on high school teacher and student understanding of the research process (Krasny, unpublished data).

Thus, designing and evaluating creative ways to engage county 4-H educators in either short-term research at workshops or longer-term projects in collaboration with university scientists would be an important next step in trying to meet our original goal. In addition to providing research experience for Extension educators, consideration must be given to providing such experiences for teachers and other local educators and volunteers.

Once a more appropriate workshop format is in place, a program such as 4-H EI can draw on the support educators offer each other to help overcome additional barriers to program

implementation. Similar to the results from this program, networking among Extension educators, Cornell faculty, and local partners was a major benefit for participants in a program that focused on engaging CCE educators and volunteers in research and education programs focusing on invasive species (Krasny & Lee, 2001).

However, there likely will still be challenges related to different priorities of university faculty and county educators. In NYS, university faculty engaged in 4-H and other types of outreach often are influenced by their university research colleagues and by funding opportunities from the National Science Foundation and other agencies that require attention to the National Science Education Standards. In contrast, county Extension programs often reflect the priorities of farm families and volunteers working with elementary-aged and younger youth.

Conclusion

The 4-H EI program demonstrated county Extension educators with research experience are able to engage youth in research and uncovered some factors that might be considered in developing workshops for educators without research experience. It is important to recognize that some of the issues the counties faced are more difficult to address through trainings, such as discrepancies between county educator and faculty priorities, school-related constraints, and local awareness of the types of programs 4-H might offer.

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