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Education: *Is It an Essential Ingredient for Community-Based Water Management?*
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Keynote Address

Education – An Essential Ingredient for Successful Water Management

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The principle of using best management practices (BMPs) to conserve and improve natural resources is well established and time-honored in the resource field. It makes complete sense to take proven, exemplary approaches to land and water management and offer them as models for others. The BMP tradition helps millions of practitioners in agriculture, forestry, soil and water management and related fields to avoid "wheel reinvention." BMPs include outstanding methods, technologies and even rules of conduct. Importantly, they capture the state of the art and help the larger public understand how it too can contribute to water and natural resource management.

So can the BMP concept be extended to education by establishing a new set of "BEPs," best *education* practices for water? The quick answer is yes. If properly implemented, BEPs would likely become a significant and much-needed help in water resource management throughout the United States and elsewhere. That is because there is a growing body of evidence that education works in a practical sense and produces results both by itself, and as an added measure, in the larger natural resource and water management arenas. The signs are good that water management BEPs will become critically important.

For starters, we will need more of a focus on education because water management principles and practices are more complex today than they were 30 years ago and that complexity is rapidly increasing as scientists understand more about natural systems. Today's water management, for example, requires a grasp of watershed functions, geomorphology, nutrient transmission, seasonal flow regimes, surface and groundwater interfaces, patterns of polluted run-off, riparian resource and wetlands absorption, and more. Land managers may already have a significant grasp of many of these subjects but the future will require more public help to keep up. That is where BEPs come in.

Secondly, more complex and intense surface and ground water dynamics at the urban-rural interface place an additional burden on urban-dwelling people to more effectively share water resources with agricultural and natural resource managers, and vice versa. In many areas of the nation, balancing water consumption in the home, on the lawn and in business has never been so important. The reverse is true too. Rural land managers must better understand and mitigate their impact on urban water quality and quantity including potential pollution of drinking supplies, seasonal flow reductions, intensifying flood impacts and more.

Finally, nationwide population growth and redistribution will require more understanding of how truly finite our freshwater supplies are in America and throughout the world. To balance human needs with the needs of nature and establish more sustainable levels of water consumption will require greater per-capita knowledge of water resource basics and these can be well conveyed

through water BEPs. But, the very idea of BEPs introduces a threshold question. How much will water education actually work to improve management?

How Are We Doing On Environmental Knowledge and Literacy?

From 1996 through 2002, the National Environmental Education & Training Foundation (NEETF) and the international survey research firm of Roper examined the state of simple environmental knowledge or awareness among adult Americans. The surveys found that, while awareness of environmental subjects is high and most people express significant support for environmental protection, their actual knowledge of environmental subjects is relatively low (see the *Roper Report Card* at http://www.neetf.org/roper/ roper.html). Lack of environmental knowledge and literacy is most pronounced with regard to meaningful comprehension of the cause/effect relationships implied in watershed management, ecosystem conservation, wetlands management, water supply, drinking water systems and so on.

This means a major hurdle for BEPs is that few Americans grasp that rainwater picking up pollutants on and running off the land and into our water bodies is the leading form of water pollution today. There are two main reasons for this lack of knowledge. First, people of all ages have learned that industry is the leading pollution source. But, this is mostly old news held over from the decades of the 1960s and 1970s. Secondly, having an understanding of run-off also means knowing a modicum of information about the cause/effect relationships between rainfall, land management, water flow patterns and water quality. This raises the specter of whether those who work in the professional environmental field overestimate how much people actually know and, therefore, do not take enough time to review and educate them on fundamentals including drainage and spatial relationships, ecological sensitivities, and such simple facts as drinking and irrigation supplies can sometimes become polluted. Also, in rural areas, there can be a higher level of understanding of watershed, water supply, and water quality issues but the difference in knowledge and awareness between urban and rural residents is negligible.

Three Levels of Environmental Learning: Three Kinds of Impact

An examination of research on the efficacy of environmental information, education, and outreach indicates that there are at least three levels at which people come to grasp environmental subjects and there are three kinds of results from that knowledge. They are as follows:

1. The "Awareness Level"

Environmental "awareness" basically means a person has "heard of" an environmental topic, knows it is a public concern, but actually knows very little else of its details. Public knowledge and opinion research shows that many people (some 50% to 85%) have awareness of several main environmental subjects but it rests on weak foundations and lacks depth. The key reason so many people are aware of environmental subjects is the media's broad reach. A majority of Americans have, for example, heard of air and water pollution issues, loss of species and habitat, solid waste disposal problems, and more. Such awareness has little effect on behavior but is often a powerful aid to public understanding of simple topics. Simplified information can often foster misunderstanding of the more complicated subjects, however. The key public benefit from widespread environmental awareness is public support for the government and large companies to regulate or invest in environmental improvements.

2. The "Personal Steps Level"

This involves the kind of simple and practical environmental knowledge needed by an individual to take pro-environment steps in the home, the workplace or as a consumer. It comes partially through schools and the media, and also through government and company outreach programs. It can also come from consumer education (such as labeling or advertising). Information on personal environmental actions or steps encourages recycling, saving water, reducing waste, economizing on fuels, and purchasing more environmentally friendly products. Research shows that environmentally informed Americans *can* absorb and *will* take many personal steps to help maintain the quality of the environment at home, work and in their community. The same research indicates that a person who is thus informed is anywhere from 10% to 50% more likely to act more environmentally responsible. But, serious environmental educators are also quick to caution that such behavior change is fairly temporary, and while effective information and education programs can change many people's behavior it will not be all that durable. It is also important that the actions people are asked to perform are within ongoing activities such as using water, gasoline, electricity or shopping. This type of knowledge needs constant updating and reminders.

Common Ingredients for Personal Steps Education

- Small changes in ongoing behaviors
- Very little "dot connecting"
- A sense of "togetherness"

Even still, NEETF estimates that instructing more people on such simple personal steps, more frequently and on a broader scale, could quickly bring about a $75 billion annual environmental improvement in saved water, energy, and improved health.

3. The "Environmental Literacy Level"

In the past three decades, the environmental education field has defined environmental literacy as knowing underlying principles, and being able to analyze and apply them. The field distinguishes media or other information and outreach programs from true environmental education (EE).

- **Youth foundations** – Recent examinations of the state of environmental literacy find that a small percentage of the public is prepared for the complex environmental issues and decisions of the future. At least part of this shortfall is due to the status of environmental education in school. Simply put, EE has not achieved "core subject" status in most of our schools. Though EE is a popular elective and supplemental effort in more than half of our schools, there is too little of it that actually gets delivered and it is poorly sequenced so that environmental learning does not effectively accumulate. We need to offer students a sufficient amount of sequenced environmental education to let them absorb and retain the basic definitions and principles of environmental science and systems, and to learn how to actually apply those principles. It would be a major breakthrough if a majority of students could reach this level by the time they complete high school. For water BEPs this would mean providing a basic knowledge of watershed science, management, and related resource fundamentals.

- **Adult leadership literacy** – All people in the home, workplace, and community impact the environment including water resources. Research shows, however, that leaders in business, government, and civic affairs lack basic environmental literacy

and often either ignore environmental impacts and opportunities or address them solely through intuition.

Community leaders, in particular, need to be environmentally literate. They number in the tens of millions and are constantly making decisions on every aspect of community life from land development policy, to education, to waste removal. It is vitally important for adults in key positions and professions such as business, health, and education to make sound decisions about the environmental impacts of their decisions. We need mature and well-developed environmental literacy for a majority of those 30 million adults who comprise America's community and professional leaders – who our research partner Roper refers to as community "influentials."

By influentials, Roper means the one out of ten people living in American communities who get actively involved. They sit on planning boards and education boards, and participate in civic events. They are members of the PTA, the Lions club, and countless other civic organizations, and they are natural leaders in their towns and neighborhoods who are looked up to and respected by others. Importantly, many of these community influentials are highly curious and avid self-teachers, and learning about the environment is among their interests. In part that is because nearly one half of community influentials fall into what Roper classifies as the most environmentally disposed members of the public – the True Blue Greens. They are naturally civic-minded, educated, and willing to speak out for environmental management and stewardship in their communities. Further good news for achieving environmental literacy is the fact that the remaining group of influentials is also predisposed toward environmental management and protection.

Implications for BEP Program Design for Literacy

The above construct suggests a few basic "pointers" on how to create BEPs for water. We suggest that educators ask themselves a few simple questions about what and how they are teaching:

Can we achieve improved water management without stronger education?

Education will be a greater part of our water management future (not less) because of the growing need to address polluted run-off from its many sources, to handle intensifying competition between rural and urban water needs, and to lessen the impact of individual consumer activity on water quality and quantity. Moreover, as the American economy shifts toward smaller average enterprises a larger number of private sector companies are impacting water resources without the same level of knowledge, training, and expertise as larger counterpart companies.

Does the information to be imparted require simple awareness or deeper education?

Many environmental education programs err by assuming that the learner automatically understands underlying principles and definitions such as "watershed," "run-off," "non-point source pollution," "riparian zones," and "flow regimes." A well-developed program will spell out these basic concepts and display them in ways that the learner can understand and eventually apply. While it may seem obvious, those teaching BEPs for water resources must be keenly aware of the need to tailor their educational delivery and levels of detail to effectively accomplish the instructional task. It is critical that BEPs be appropriately adjusted to the complexity of the water subject being considered. Educators often overestimate what their students actually know by way

of background and basic principles. An example would be for a lesson plan covering watersheds to fail to adequately explain the definition of a watershed or to depict the relationship of rainfall to the overall catch basin. Another example might be to discuss the water quality opportunities presented by maintaining riparian strips while assuming (incorrectly) that students already understand the filtering effect of streamside vegetation on run-off.

Do the BEPs that are delivered adhere to other basic rules of pedagogy?

BEPs that follow basic pedagogical rules would include providing a sufficient amount of instruction time, providing sequenced delivery of basic principles so they build upon each other, and recognizing that knowledge accumulates over time.

BEPs will also require careful use of sound instructional materials including ample use of graphics and forms of visual presentations. Visuals are particularly helpful in setting out complex causal relationships. Another way to effectively teach causal connections is through stories. Storytelling as a general rule is a highly effective tool for education.

Does the instruction teach skills and application?

A significant aspect of environmental and natural resource education is its implied relationship with application in the real world. Many educational subjects are presented for their knowledge value alone. Many BEPs will contain specific education regarding skill development and application.

Will BEPs aim at community leaders or "influentials"?

For those skeptics who wonder if measurable results really ever come from environmental education programming, recent research offers some answers and tremendous hope. It shows, for example, that the environmentally informed person is anywhere from 5% to 90% more likely to engage in a set of pro-environment activities (water and energy saving, recycling, green consumerism) than a person who is not informed on the environment. A simple 5% reduction in the amount of water used in the average home would save Americans more than $14 billion on their water bills and make millions of acre feet of water available for other uses including fish and wildlife management.

In addition to seeking measurable impacts on a majority of the adult public, certain Roper-defined segments of the adult population may offer the brightest hope of all. Notable among these are what Roper calls the community "influentials." They are the one in ten adult Americans who are effective (usually volunteer) leaders in our communities. They are members of parent-teacher organizations, Lion's clubs, volunteer fire departments and civic associations. They sit on town councils and planning boards, and are active in their communities.

Roper finds that the environment matters to the community influentials. Some 78% of them, for example, think that businesses should also consider what is good for society and not just what is good for profit. Influentials have in fact been pushing government and business hardest to improve the environment. A majority (52%) believes that laws to protect the environment have not gone far enough and many of them seem ready to do more than recycle their trash. They say they would pay more for green products such as autos, gasoline and electricity.

Percentage of influentials who are *moderately* or *very* interested in a topic (Keller, 2004):

- News and Current Events 96%
- Environment 92%
- Fitness and Health 87%
- Nature and Animals 87%

Roper feels these influentials have untapped potential as change agents on many public issues including the environment. They are early-adopters of many environmentally considerate products and practices, and exhibit a true openness to learning about the environment. They are curious and deliberate seekers of information and, with a stronger base of environmental literacy, could have an exponential effect on the stewardship of our communities, ecosystems, air, and water. Some 74% attended a public meeting on town or school affairs (compared to 16% for the total public). Fully 50% served on a committee of a local organization (7% for the general public), 40% wrote a letter to the editor (6% for the general public), 35% were active members of groups trying to influence public policy (5% for the general public), and 31% made a speech (4% for the general public). Other research underscores that influentials are highly active in their communities by being among the core of people who volunteer. More than 60% of influentials engage in volunteer work in a typical month.

In addition to reaching the general public and school students, BEPs targeted toward community influentials would have a lasting effect on their ultimate success and implementation.

Reference

Keller, E., & Berry, J. (2004). *The influentials*. New York: The Free Press.

Featured Case Study Presentation

Making Our Nonpoint Source Pollution Education Programs Effective

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Abstract

In Wisconsin, nonpoint source pollution has been identified as the greatest cause of water quality degradation affecting over 75% of inland lakes, many of the harbors and coastal waters on the Great Lakes, and substantial groundwater resources. The majority of this problem is attributed to agricultural land use. Pervasive water quality problems are the symptoms – the primary cause being the failure to implement existing remedial technologies. Although education is often a major part of watershed protection programs, education strategies vary greatly from project to project and from educator to educator. Educational programming, often referred to as information and education (I&E) strategies, provides information to landowners in order to promote environmentally beneficial actions such as the installation of best management practices on farms. Prior research in Wisconsin's Priority Watershed Program has shown that I&E strategies, especially those that seek to reduce nonpoint source pollution from agriculture, generally rely on a combination of two approaches: 1. Diffuse communication campaign efforts; 2. One-on-one information transfer techniques such as on-farm visits, individual farm trials, and individual farmer consultation. To assess the effectiveness of these two approaches, this research compares the rate of adoption of nutrient management strategies by farmers in two different Wisconsin watersheds over the same five-year period of 1990 to 1995. This research supports an integration of a diverse set of educational approaches such as on-farm visits, small group demonstrations, and workshops. An over-reliance on diffuse information dissemination may come at the expense of interpersonal information transfer through direct farmer contact.[1]

[1] Editor's Note: This paper was published previously (Shepard, 1999) and not available for publication as part of the Symposium Proceedings.

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Shepard, R. (1999). Making our nonpoint source pollution education programs effective. *Journal of Extension*, *37*(5). Retrieved June 2004, from http://www.joe.org/joe/ 1999october/a2.html

Research Papers on Audience Specific BEPs

Livestock EMS Pilots: Lessons About Eduction Strategies

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Abstract

Globally, industries seek to meet the International Standard for Environmental Management Systems (ISO 14001). Increasingly, U.S. governmental agencies are promoting this standard to encourage firms to go beyond regulatory compliance. Are formal Environmental Management Systems (EMSs) useful to farmers and helpful to farm environmental protection? If so, this presentation aims to answer these questions for natural resource educators.

Partnerships for Livestock Environmental Management Systems (LEMS Project), have been exploring what educational strategies will most effectively assist farmers with implementation of continuous improvement environmental management systems. The Project has established a learning community of Extension educators led by Farm and Home Environmental Management Programs at University of Wisconsin-Madison and collaborators at the University of Nebraska and the University of Georgia. Objectives are to determine the following: 1. How can the EMS framework best fit diverse livestock producers' needs and constraints, and integrate with business management? The Project includes three state pilot projects each for dairy, beef and poultry producers, each led by an Extension professional. 2. What sort of educational interventions are most productive and amenable to livestock producers to induce EMS adoption? 3. What are the barriers to successful EMS implementation, and what incentives might be required? 4. What conditions do the EMSs need to meet to satisfy diverse stakeholder agendas?

Collaborators in each pilot include state agencies, commodity groups, stakeholder groups and other resource conservation professionals. The LEMS Project evaluation, conducted with an evaluation professional from the UW-Madison, Learning through Evaluation, Adaptation, and Dissemination Center (LEAD), compares the pilot states' approaches to assisting farmers with EMSs. The evaluation, which includes surveys and interviews with both participating producers and pilot states' project staff, will identify best education practices for engaging livestock producers in committing to and implementing continuous improvements in their environmental management systems. The intentions are to inform policy makers regarding appropriate uses of the EMS approach in agriculture and potential value for achieving environmental protection, and to inform educators about barriers and the most effective strategies to encourage and assist farmers with EMS implementation.

Applying Principles of Adult Education Theory to a Professional Development Program for Watershed Group Leaders

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Abstract

This paper addresses best education practices for building the leadership capacity of collaborative watershed management groups. We explore the results of applying principles of adult education theory to a distance education course for watershed group leaders. The Ohio Watershed Academy, in its fourth year, is designed to build the capacity of watershed group leaders to facilitate the development and implementation of community-based plans that address water quality impairments. Curriculum development and course design were based on four principles of adult education (Merriam & Caffarella, 1991):

- Life experience as a content/trigger to learning
- Self-direction and autonomy
- Self-reflection
- Expression of learning

The course design includes two major components: face-to-face workshops and web-based instructional modules. The workshops provide an opportunity for peer-teaching, based on student designed team learning projects. The web-based modules allow students to complete assignments from the office, but also require students to interact with stakeholders. Elements of adult education theory evident in the course design include:

- Entry interviews with students to assess and co-create learning objectives.
- Flexible scheduling and selection of assignments to match students' work experiences and learning objectives.
- Numerous opportunities for reflection on practice.
- Opportunities for peer teaching.

Data on student reactions and changes in knowledge, attitudes, and skills were collected through surveys and interviews over a three year period. We found gains in knowledge and skills were most evident in the area of stakeholder participation. Implications for course design include providing opportunities for peer interaction and student-designed learning activities.

Origins of the Ohio Watershed Academy

All across the United States, watershed collaboratives are forming to address water resource management issues. In Ohio, government agencies are encouraging the formation of watershed

collaboratives for the purposes of developing and implementing comprehensive watershed management plans. In 2000, the Ohio Environmental Protection Agency (OEPA) and Ohio Department of Natural Resources (ODNR) created a grant program whereby watershed collaboratives could hire full-time Watershed Coordinators to lead local stakeholders in developing watershed management plans. Recognizing the need to provide some basic training in collaborative planning for these new positions, administrators from OEPA and ODNR approached Ohio State University Extension about creating a professional development course in collaborative watershed planning for Watershed Coordinators and other interested watershed group leaders and participants. The Ohio Watershed Academy was thus created with funding from OEPA using federal dollars under the Clean Water Act, Section 319.

Course Design

The purpose of the Ohio Watershed Academy is to develop the capacity of students to facilitate collaborative watershed planning efforts by introducing them to some of the basic elements of collaborative watershed planning. The following topic areas are covered in the course curriculum:

- Overview of watershed planning
- Group facilitation
- Running effective meetings
- Understanding water quality criteria
- Developing problem statements
- Creating a watershed inventory
- Designing effective outreach programs

The majority of coursework is conducted at a distance, with students working through a series of instructional modules, submitting assignments electronically via the Internet. They use a Web interface developed by technicians in the Section of Communication and Technology in the College of Food, Agricultural, and Environmental Sciences at The Ohio State University. Instructional modules and corresponding assignments are posted on the Ohio Watershed Academy Web site and include learning objectives, an introduction to the topic, required and recommended readings, and a description of the assignment(s) to be completed by the student. Instructional modules can be viewed on the Web at the following URL: http://ohiowatersheds.osu.edu/owa/lessons/.

In addition to the standard assignments, students also complete two in-depth learning projects during the five-month course. Students are encouraged to work in pairs or small groups on a watershed-related topic of their choice. Students develop their own learning objectives, activities, and products. A summary of the in-depth learning projects is presented to the class and posted to the Academy Web site.

The third component of the course involves face-to-face meetings where students have an opportunity to get together for presentations from invited speakers and share the outcomes of their in-depth learning projects. These meetings also provide students with time to build social networks and share experiences with peers.

The Audience

The first class of thirty-nine students began in December of 2000. A total of four classes (60 students) have since graduated from the Ohio Watershed Academy. A majority of the Academy

students are full-time Watershed Coordinators who are required by their grant sponsors (OEPA and ODNR) to write a watershed action plan in collaboration with local stakeholders. Some students are not Watershed Coordinators, but are employed in teaching, soil and water conservation, planning, and other related professions. A few students are engaged in unrelated professions and became involved in watershed planning as volunteers. The age, years of resource management experience, and academic and professional background of the Watershed Coordinators vary widely. Some have retired from their first careers, while others are in their first professional position after college.

Curriculum Based on Principles of Adult Education

The curriculum and course design were developed by a team of staff at OSU Extension. An external multi-disciplinary and multi-stakeholder Advisory Committee provided feedback on course design and developed many of the instructional modules. Both the content and overall design of the course were created with the following four components of adult education in mind (Merriam & Caffarella, 1991):

- Life experience as a content/trigger to learning.
- Self-direction and autonomy.
- Self-reflection.
- Expression of learning.

Merriam and Caffarella (1991) proposed these four components based on a thorough review of adult learning theory in their book, *Learning in Adulthood*. Below, we provide a brief explanation of each principle and offer examples from the Ohio Watershed Academy.

Life Experience as a Content/Trigger to Learning

Adults bring a wealth of life experience to the learning environment. This can present both challenges and opportunities to the educator. On the one hand, adult students' experiences can enhance opportunities for peer teaching. On the other hand, students often come to the learning environment with widely varying levels of knowledge and skill. One of the challenges faced by the designers of the Ohio Watershed Academy was how to develop a curriculum that would be challenging for the more experienced students, without overwhelming the less experienced students. We also wanted to provide ample opportunities for peer-teaching to take advantage of the collective knowledge of the group.

Adults tend to seek learning experiences that increase their proficiency in their life roles (Knox, 1980). While some of the Academy participants were required to complete the course as a condition of the grants that funded their positions, we have never doubted that our students were motivated to be effective in their roles as leaders and facilitators of collaborative watershed planning efforts. We describe later in this paper how the Academy course was modified to allow students to personalize their own learning experience to match their work-related responsibilities.

Self-Direction and Autonomy

Knowles (1980) proposed that as learners mature, they become increasingly self-directed. According to Merriam and Caffarella (1991), the major motivators for engaging in self-directed learning are control, freedom, and flexibility. Adult learners prefer to set their own learning pace and experiment with alternative learning strategies. In designing the Ohio Watershed Academy we struggled to strike a balance between exposing students to a broad range of topic areas in a logical sequence on the one hand, and allowing students to select topic areas most relevant to

their life experiences when those topics were most salient. As we discuss in a later section, we modified the course design over time to allow students more control and flexibility.

Self-Reflection

Some scholars, most notably Mezirow (1981) and Freire (1970), have posed that adult learners, more so than children, are capable of transforming their perspectives and assumptions about the world around them as an outcome of the learning experience. These new perspectives can lead the learner to develop new and more effective approaches to solving problems. We attempted to incorporate opportunities for self-reflection throughout the Academy curriculum. Many of the assignments encouraged the students to reflect on how their watershed group functioned, how decisions were made, and who was involved in those decisions. The instructors challenged students to consider their own biases and assumptions.

Expression of Learning

Adults often seek out learning experiences in order to be more effective in their life roles. It is therefore natural that adult learners would be anxious to express their new knowledge and skills through action. This is especially true when the subject area is directly and immediately relevant to the educational needs of the learner. In developing the Academy curriculum, we attempted to design the instructional modules so that, in the process of completing assignments, students would be creating products (e.g., lists of potential stakeholders, problem statements, and data collection goals) that would have immediate application to their watershed planning effort. Evaluations indicate mixed results with respect to direct application of learning to watershed planning efforts. More recently, we allowed students more flexibility in choosing which assignments to complete and in what order, and incorporated in-depth learning assignments that allowed students to design their own learning experience to address a work-related issue. We discuss these adaptations in greater detail in a later section.

Early Experiences: Academy Classes I-III

Between the spring of 2000 and summer of 2003, an extensive formative evaluation process was conducted on the first three Ohio Watershed Academy courses. Evaluation questions were developed by OSU Extension staff with input from an advisory group made up of representatives of funding agencies (OEPA, ODNR), other stakeholder groups (e.g., watershed collaboratives), and non-formal educators. Several methods were used to collect evaluation data, including written and on-line surveys, and phone interviews (see Appendix for sample questions). A total of thirty-two written surveys (89% response rate) were completed by students from the first two courses. Phone interviews were conducted after each of the first three Academy courses. A total of twenty-seven interviews were conducted with participants who volunteered to be interviewed.

An evaluation framework, based on Bennett's Hierarchy, a widely used Extension program evaluation and planning model, was used to generate evaluation questions. We were interested in learning not only how participation in the Academy affected students' knowledge, attitudes, skills, and aspirations, but also how the structure, design, and delivery of the program enhanced or detracted from the learning experience. In other words, we wanted to know if we were offering a quality learning experience. The following discussion highlights the evaluation findings from the first three Academy classes in relation to the four components of adult learning introduced earlier.

What Worked?

Overall, Academy students reported having a positive learning experience. One of the most popular aspects of the course was the opportunity to meet and network with peers (other watershed coordinators and watershed group leaders) during face-to-face meetings. Collaborative watershed planning is a relatively new field; there are no universal manuals or blueprints for success. Under such circumstances, learning from the trials and errors of others is a key learning strategy for many Academy students. Students also appreciated the camaraderie provided by the Academy meetings, as indicated in the following quotes taken from student questionnaires:

"I enjoyed having the opportunity to discuss topics with other coordinators. It gave me insight into the operations of other groups."

"I really think the networking/moral support was beneficial, especially as some of us work by ourselves."

One of our primary objectives in designing the Ohio Watershed Academy curriculum was to support the students in fulfilling their work responsibilities. Feedback from students indicated that assignments did have direct application for some students. For example, one student indicated, "Some of the instructional modules came at very good times where our organization was dealing with a particular topic related to the modules."

Another student benefited from the instructional module on running effective meetings:

"A lot was helpful, particularly the meeting facilitation agenda form. The first Board meeting after the assignment, the members noticed an increase in organization immediately."

Other students indicated that portions or all of some assignments would be used directly in their watershed plans or other reports.

When asked if the Academy addressed the students' most pressing professional needs, the majority of respondents indicated that it had. Some of the areas in which students reported the Academy was helpful included:

- How to get input from the public.
- Instilling leadership.
- Emphasizing the need for broader stakeholder involvement.
- Making progress on developing a watershed plan.

Gaining New Perspectives

One of the most interesting evaluation findings was evidence that participants in the Ohio Watershed Academy gained new perspectives on watershed planning through self-reflection and instructor feedback. Several students reported having gained an appreciation for the importance of involving more stakeholders, as expressed in the following quote:

"In my watershed … I'm looking at expanding the Board to include more stakeholder groups (e.g., health departments, chamber of commerce). These ideas came from the readings – the idea of a more diverse Board and the idea of an array of stakeholders in planning."

In providing feedback on written assignments, the instructors encouraged students to consider alternative viewpoints and reflect on their biases and assumptions. This feedback apparently had the desired effect for some students, as indicated in the following quotes:

"The instructor feedback was an essential part of the class where different points of view were made that may not have been this obvious."

"Feedback was very helpful for me to see the entire picture of watersheds."

"The Academy made [me] stop to evaluate myself as to where I was with the development of the watershed group."

In summary, students who participated in the first three Ohio Watershed Academy courses reported having a positive learning experience. In relation to Merriam and Caffarella's (1991) principles of adult learning, the Academy allowed students to use their professional situations as a trigger and content to learning. The Academy also provided students with an opportunity to reflect on and alter their perspectives on watershed planning in general and stakeholder involvement in particular. The direct application of some assignments to job responsibilities, in some instances, allowed students to express their learning through their professional roles. One component of adult learning that did not emerge as a strength from the evaluation results was autonomy, or self-direction in learning. This was one of the areas we sought to improve in the fourth Academy class.

Room for Improvement

Evaluation results from the first three Academy classes also turned up areas where there was room for improvement. Of greatest concern to the instructors was the number of students who withdrew or simply did not complete all the assignments – a requirement for graduation. Among the third class of twenty registered students, only eleven completed the course. In October of 2003, phone interviews were conducted with five (of a total of nine) Academy participants who interrupted participation before graduation (see Appendix A for example interview questions). Respondents' primary reason for not completing the Academy was lack of time, both for completing assignments and attending face-to-face meetings, which were held in the Columbus area. While participants who did not complete the Academy generally had favorable opinions of the course and many expressed an interest in completing the course at a later date, one respondent felt that the course content was tailored too much toward watershed projects still in the planning phase, and not enough toward projects that had moved into the implementation phase.

As mentioned in the introduction, students came to the Academy with widely varying backgrounds and levels of experience. Initially, students had very little flexibility in choosing which instructional modules (and corresponding assignments) to complete or the order in which they would be completed. As a result, some students found some of the modules to be too basic, while others found the same modules very challenging. Just as students enter the Academy at different stages of development as professionals, the watershed projects they are involved in are also in varying stages of development. By forcing students to complete the instructional modules sequentially, beginning with the basics of watershed planning, and ending with evaluation of project outcomes several months later, many students found that the assignments they were working on at any given time did not always coincide with their immediate work responsibilities. Referring to the instructional modules, one participant noted:

"The first half was great and relevant regardless of where a group was in the planning cycle. The second half was very dependent on where a group was in the cycle and was less directly useful if they did not correspond with where the group was."

Based on the feedback from students, several adjustments were made to the second and third Academy courses. In order to reduce the work load, the course was lengthened by a few weeks to allow the students more time to complete each assignment. To accommodate varying skill and knowledge levels, optional advanced assignments were added to some instructional modules. Evaluations from the third Academy class indicated that more radical changes were needed to address the issue of excessive time commitment and tailoring of the learning experience to meet professional demands. These changes were incorporated into the fourth Ohio Watershed Academy class and are described in the next section.

Academy IV: Moving Toward a More Learner-Centered Design

The fourth Academy course began in January of 2004 with a class of 27 students. Several months before the class began, OSU Extension staff reviewed the formative evaluation findings from the previous three classes. Two areas requiring significant adjustments were identified: 1) the workload was still too great for many students, and 2) participants were calling for more self-direction in choosing which assignments to complete and in what sequence to complete them. To address the first concern, the course was shortened from over six months to four. Also, students would no longer be required to complete all the assignments, but would choose ten of a total of nineteen assignments to complete, based on their personalized educational objectives. The objectives were co-created with the instructors during pre-course phone interviews. The pre-course phone interviews were adopted for the fourth class in an attempt to clarify expectations (e.g., time required, course content) on the part of both student and instructor before potential students committed to participating in the course.

Another innovation, developed to allow students more self-direction in creating their learning experience, was the in-depth learning project. The in-depth learning projects were designed by the students at the first orientation meeting and again at the second mid-term face-to-face meeting. The projects could be completed individually or in teams. Students worked with the instructors to identify learning objectives, activities, and outcomes (products in the form of presentations or materials that could be shared with the other students). Students presented the outcomes of their in-depth learning projects to their fellow students and invited guests at the mid-term and final face-to-face meetings. The purpose of the in-depth projects was not only to give students an opportunity to explore a topic of particular relevance to their current work responsibilities or interests, but also to give students an opportunity to express their learning through peer teaching. A brief description of the in-depth learning projects and the outcomes of those projects (e.g., slide presentations, summary findings) can be viewed on the Ohio Watershed Academy Web site at http://ohiowatersheds.osu.edu/owa/students/projects-2004.html

At the time this paper was written, the fourth Ohio Watershed Academy course was still one week from completion, but interim evaluation results indicate that students greatly appreciated the flexibility allowed in selecting assignments, both in terms of which assignments would be completed and the sequence in which assignments would be completed. Although students were required to select their assignments at the initial orientation meeting, several students made adjustments to that schedule throughout the course based on emerging issues in their work and in their watersheds. Interestingly, the percentage of students withdrawing from the fourth class remained relatively high (40%). Most of the students cited heavy workloads, busy lives, and job

changes as reasons for withdrawing. No one cited dissatisfaction with the course as a reason for withdrawing, though a few did not communicate any reasons for withdrawing.

Conclusions

Educational programs that target water resource management professionals can be designed with the needs and characteristics of adult learners in mind. In designing the Ohio Watershed Academy, we have strived to:

- respect the pre-existing knowledge and life experiences of our students,
- provide them with opportunities to critically reflect on their practices and express their learning, and
- create opportunities for building professional relationships.

Evaluations from the first three classes provided us with valuable information about the program's strengths and weaknesses. Based on student feedback, the strengths included:

- Relevance of course content to professional roles.
- Exposure to new perspectives on watershed planning, particularly related to stakeholder participation.
- Opportunities to network and socialize with other watershed professionals.

Evaluation results also indicated that we needed to give students more flexibility in choosing which instructional modules to complete and give them more freedom to explore specific areas of interest. As a result, we allowed students in the fourth Academy class (January-May, 2004) to choose which instructional modules they would complete and in the order that would best match the content of the modules with their job responsibilities. We also added a new component to the course design: in-depth learning projects. In-depth projects allow each student, individually or as part of a team, to identify and explore topic areas of special interest and relevance to their role in watershed planning. Students presented the results of their projects to their peers at two face-to-face meetings.

Recommendations

Developing educational programs is similar to watershed planning in the sense that effective educational programs must be appropriate to local context and adapted over time based on trial and error. Therefore, our strongest recommendation for developing non-formal watershed education programs for adults is to design a thorough structure for formative evaluation using multiple methods to gather feedback from students on their experiences. Methods we have found useful include on-line feedback forms accessible every time the students submit an assignment, written forms completed at face-to-face meetings, and phone interviews. Over time, in response to evaluation results and our own self-reflection, we have attempted to provide our students with greater autonomy in determining the content and timing of learning activities. We have challenged them to question their assumptions about watershed planning and we have created more opportunities for students to identify and address their own educational needs through in-depth learning projects. In summary, we have attempted to create an educational program that will lead our students through a process of self-discovery and leave them with a greater capacity to address their own professional needs in the future. We also acknowledge that, as educators, our own process of self-discovery and learning is ongoing.

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APPENDIX (Bonnell & Baird)

Example Evaluation Questions

Phone Interviews

(Students were interviewed two months after the Academy had ended.)

- Please describe your experience with the Ohio Watershed Academy.
- What questions did you have during your experience?
- What was helpful?
- Was anything a hindrance?
- Do you feel the Academy helped build confidence and/or interest in your role as a watershed coordinator?
- What educational needs are not being addressed in the Academy?
- If you could go back and change anything about your experience, what would you change?
- Can you think of three things you learned during the course that helped you in your role as a watershed coordinator?

For participants who did not complete the course:

- What was the primary reason you were not able to complete the Academy?

On-line survey

(Students were given the opportunity to respond to the following questions after completing each instructional module.)

- Were the assigned readings sufficient for completing the assignment in this module?
- Were the instructions presented clearly?
- Do you feel the assignments in this module are helpful to you as a watershed coordinator?
- Do you feel that by completing this module, you are better equipped to make progress toward your watershed plan?

Formative evaluation (Students were asked mid-way through the Academy to write reflections about their experiences.)

- What is working about your Academy experience?
- What is not working about your Academy experience?

Appendix (continued)

Written survey

- Please describe your overall experiences with the Academy.

To what extent…	**Not at all**						**Fully**	**Not Applicable**
... did your Academy experience address your main educational need?								
... did the Academy assignments help you address your job responsibilities relative to watershed planning?								
... were you exposed to new ideas during the Academy?								
... did you experience belonging to a community of learners during the Academy?								
... did you experience a sense of collegiality with your fellow Academy students?								
... did the Academy provide you an opportunity to network?								
... did the Academy provide you with useful examples from other watershed groups?								
... did the format of the Academy provide you with sufficient flexibility?								
... did the Academy provide you with specific tools you were looking for?								

Appendix (continued)

- Please mark an X in the box that best represents your experience with the Academy assignments.(Note: Other, similar questions using a semantic differential were included in the written survey to measure participants' perceptions of readings, in-depth learning projects, face-to-face meetings, interactions with peers, and instructors. For an explanation of semantic differential scales, see Hopkins (1998).

Overall, <u>assignments</u> were…

Disorganized								Organized
Not informative								Informative
Not Helpful								Helpful
Waste of time								Worth the time
Not useful for my job								Useful for my job
Theoretical								Practical
Difficult								Easy

- As a result of your participation in the Academy, to what extent has the following expanded?

To what extent has the following expanded?	**Not at all Expanded**						**Fully Expanded**
a. My professional network							
b. My sense of belonging to a professional community							
c. My knowledge of resources available from OSUE (The Ohio State University Extension)							
d. My knowledge of resources available from OEPA (Ohio Environmental Protection Agency)							
e. My knowledge of resources available from ODNR (Ohio Department of Natural Resources)							
f. My knowledge of resources available from other organizations (other than OSU, OEPA, ODNR)							

- What was the most significant experience you had during the Academy?

- If you have established a new relationship as a result of your participation in the Academy, please describe the nature of the new relationship.

- What new skills did you gain as a result of completing the Academy, that have been **most useful or beneficial** to you (your work and/or life experiences)?

Appendix (continued)

- How would your plan or planning process be different without your participation in the Academy?
- Has the Academy helped your watershed group sustain itself organizationally and/or financially?
- Please, give one example of how you have used the products from assignments and in-depth learning project.
- Please, give one example of how you have brought the lessons learned from the Academy modules to the community.

Shoreland Revegetation Workshops Promote Environmental Stewardship

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Abstract

The University of Minnesota Extension Service offers a Shoreland Education Program to promote Shoreland Best Management Practices (BMPs). As part of this program, the Shoreland Revegetation Workshop Series was developed to increase participants' ecological knowledge and sensitivity, their ability to analyze and investigate shoreland issues, their practical skill level in addressing these issues, and their motivation to take action in promoting shoreland BMPs at the local and regional levels. The Hungerford and Volk (1990) environmental education model, identifying major and minor variables in environmental education, was used as a basis for evaluation of the effectiveness of the Shoreland Revegetation Workshop Series in making long-term participant behavior changes that promote protection of the shoreland environment. A survey tool was developed to measure program effectiveness at meeting these goals. Participants indicated significant increases ($p<0.005$) in knowledge of ecological systems (85% increase), environmental sensitivity (85% increase), in-depth knowledge of issues (92–98% increase), issue analysis and investigation (87–98% increase), citizenship skills (61–77% increase), and locus of control (61–77% increase), as a result of attending the Shoreland Revegetation Workshop Series. They specifically noted an increase in knowledge of the functions of shoreland vegetation, skill and experience of designing and implementing shoreland revegetation projects, and interaction with local units of government and natural resource agencies in affecting shoreland policy changes. These and other participant responses are being utilized in guiding future development of the Shoreland Education Program.

Background and Theory

Behavior is considered environmentally responsible when individuals or groups are capable of making sound decisions and are empowered to advocate for a sustainable environment (Sivek & Hungerford, 1989/1990). Important prerequisites of environmentally responsible behavior are for learners to think critically, to understand the consequences of the choices they make, to know how they impact the environment, and to then use decision-making and the right course of action in environmental stewardship (Siemer, 2001). The ultimate goal of environmental education is not only to create citizens who are knowledgeable of the biophysical environment and the problems affecting it, but also to develop skills and motivation to solve these problems (Stapp, 1969).

Two opposing theories of environmental education are the positivist and constructivist theories. In the positivist theory, it is assumed that providing information alone will influence individuals to change their behaviors. However, research has proven that information alone is not adequate to change learner behavior. In contrast, the constructivist theory takes into account that learners

come to a learning task with different conceptions of the world, and that learning is a process of construing meaning and transforming understanding (Cranton, 1994).

Within the constructivist theory, several models of environmental education have been developed. In a more recently evolved model, Hungerford and Volk (1990) indicate three categories of variables contributing to environmentally responsible behavior: 1) entry-level variables, 2) ownership variables, and 3) empowerment variables (Figure 1).

Entry-level variables, according to Hungerford and Volk (1990) are good predictors of behaviors or ones that appear to be related to responsible citizenship behavior. A major entry-level variable is environmental sensitivity, knowledge about ecology, androgyny, and personal attitudes towards social and economic issues. Ownership variables are those that make environmental issues personal (i.e., the individual takes ownership of the issues). Ownership variables appear to be especially critical to responsible environmental behavior. Major ownership variables include in-depth knowledge and personal investment in issues.

Empowerment variables in this model are crucial in the training of environmentally responsible citizens. They bring a sense that individuals and groups can make a difference in helping to resolve environmental issues. Major empowerment variables include perceived skill in using environmental action strategies, knowledge of action strategies, locus of control, and the intention to act.

Hungerford and Volk (1990) ascertain that these variables flow in a linear progression from entry-level through empowerment, and that citizen behavior will more likely be pro-environment if all three levels are incorporated into environmental educational programs. They also believe that success will be greatest when done in a combination of formal and informal education learning environments.

Based upon their model, Hungerford and Volk (1990) identified six critical components that could maximize behavioral change when incorporated into the learning environment by educators:

1. Teach environmentally significant ecological concepts and the environmental interrelationships that exist within these concepts;

2. Provide carefully designed and in-depth opportunities for learners to achieve some level of environmental sensitivity that will promote a desire to behave in appropriate ways;

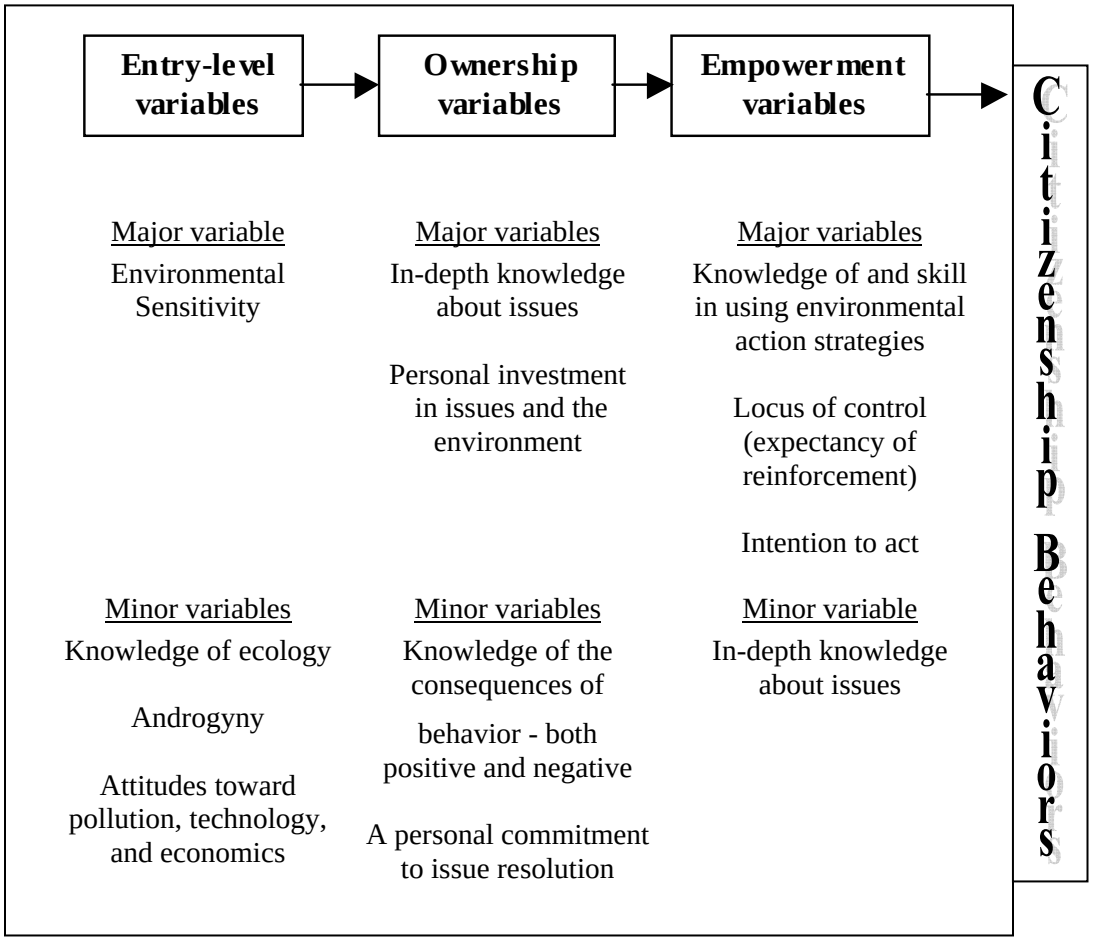
3. Provide a curriculum that will result in an in-depth knowledge of issues;

4. Provide a curriculum that will teach learners the skills of issue analysis and investigation as well as provide the time needed for the application of these skills;

5. Provide a curriculum that will teach learners the citizenship skills needed for issue remediation as well as the time needed for the application of these skills; and

6. Provide an instructional setting that increases learner's expectancy of reinforcement for acting in a responsible way; i.e., attempt to develop an internal locus of control in learners.

Figure 1. Major and minor variables in environmentally responsible behavior (Hungerford & Volk, 1990)



One should note that no one program will necessarily include all variables or critical components discussed here, but through reinforcement (experience of the concepts here mentioned, in different venues), learners will develop the skills needed for long-term behavior changes when facing critical environmental issues.

University of Minnesota Extension Service Shoreland Revegetation Workshop Series

Based on response to a needs assessment, the Shoreland Revegetation Workshop Series was initiated in 1999 to increase participant ecological knowledge and sensitivity, their ability to analyze and investigate shoreland issues, their practical skill level addressing these issues, and their motivation to take action in promoting Shoreland Best Management Practices (BMPs) at the local and regional levels. The workshop series evolved into a two-day classroom session followed by a one-day planting session that targets shoreland property owners, Master Gardeners, lake associations, local units of government, natural resource professionals, nursery and landscape industry professionals, realtors, and people interested in practicing or promoting shoreland stewardship.

Key teaching points include ecological aspects affecting water environments, rules and regulations, property owner needs, landscape design, erosion control, project planning, and project implementation. These concepts are presented through a variety of mediums including hands-on design and planting activities, small group problem solving and project development, instructor presentation and feedback, individual project development (take home assignment), guest expert and local resource presentations, participant presentations, and use of multi-media technology (videos, websites, shoreland CDs, databases, spreadsheets, PowerPoint etc). In addition workbooks, work sheets, fact sheets, contact list, native plant lists, local nursery lists, reference books and bioengineering samples are provided as resource materials.

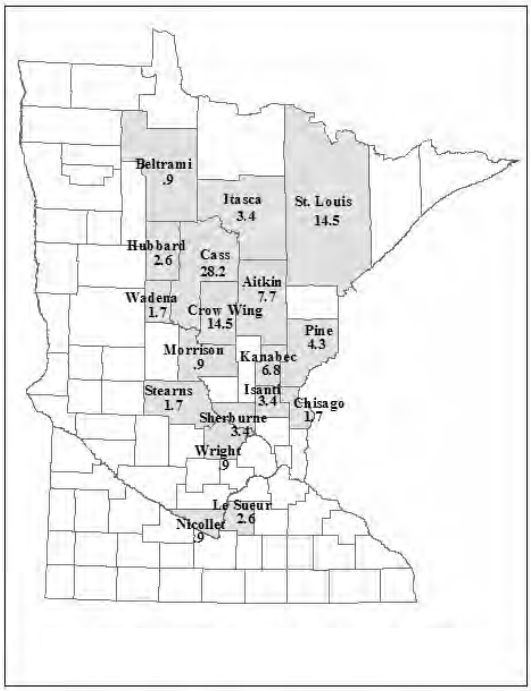
Program Evaluation

An evaluation of the effectiveness of the Shoreland Revegetation Workshop Series was used to determine the impacts on participant knowledge of ecological systems, environmental sensitivity, in-depth knowledge of issues, issue analysis and investigation, citizenship skills, and locus of control relating to shoreland issues, and to make recommendations for future workshops. The survey tool consisted of questions on demographic data, reflection on knowledge, and action and personal involvement before and after having taken the workshop series. It was sent to a random sample of 150 of 300 total participants who attended at least one session of the Shoreland Landscape Design Workshop Series, offered through the University of Minnesota Extension Service during 1999 – 2002. Sixty-three surveys were returned, resulting in a 42% response rate. Two of the returned surveys were not completed.

Demographic Data

Participants responding to this survey attended sessions of the workshop series in 19 counties. Figure 2 illustrates the workshop location in relation to percentages of respondents attending sessions.

Figure 2. Percent workshop attendance by county



Knowledge Gained, Actions Taken and Personal Involvement

A Likert scale was used for participants to rate the knowledge of ecological systems, environmental sensitivity, in-depth knowledge of issues, issue analysis and investigation, citizenship skills, and locus of control on a scale of 1 to 5, with 1 being low and 5 high. A summary of responses is shown in Table 1. Before and after data collected from these questions were analyzed using the Wilcoxon Signed Rank Test from the statistical analysis software SYSTAT 9.0.

Table 1. ***Reflective Survey Questions and Mean Change***

Question	Positive Change	No change	No response	M[1]
1. Why shoreland landscaping is important	85%	15%	0%	1.78*
2. How to design a shoreland-landscaping project	98%	2%	0%	2.11*
3. How to install a restoration project	92%	5%	2%	2.19*
4. Who to contact for help with a shoreland restoration project	93%	7%	0%	2.40*
5. How to acquire plants needed for a restoration project	90%	10%	0%	2.04*
6. Permits required for a project	87%	12%	1%	1.99*
7. Involvement with local shoreland policy or ordinances such as involvement in citizen groups or advisory committees	71%	29%	0%	1.13*
8. Interaction with agencies in community (i.e., DNR, SWCD, etc) on shoreland issues	61%	38%	1%	0.50*
9. Encourage others to use shoreland Best Management Practices	77%	23%	0%	1.63*
10. Assist others with projects (i.e., neighbors, friends, professional agencies, etc)	66%	34%	0%	1.00*
11. Use of shoreland Best Management Practices	71%	29%	0%	1.25*
12. Implement shoreland restoration projects	62%	37%	1%	0.88*

[1]*Calculations for* $M = (T_A - T_B)/n$
**Significant at* $p<0.0005$

Question 1 relates to environmental systems and sensitivity. Of respondents, 85% indicated a positive change with an average increase of 1.78 on a scale of 1–5. Questions 2 and 3 relate to in-depth knowledge of issues. Of respondents, 92–98% indicated a positive change with an average range of increase of 2.11–2.19 on a scale of 1–5. Questions 2 – 6 related to analysis skills. Of respondents, 87–98% indicated a positive change with an average range of increase of 1.99–2.4 on a scale of 1–5. Questions 7–10 relate to citizenship skills. Of respondents, 61–77% indicated a positive change with an average range of increase of 0.5–1.63 on a scale of 1–5. Questions 7–12 relate to internal locus of control. Of respondents, 61–77% indicated a positive change with an average range of increase of 0.5–1.63 on a scale of 1–5. The average increase for each of these questions is significant at $p<0.0005$.

Participant Recommendations

The survey also included two open-end questions asking participants which aspects of the workshop series they found most helpful and their recommendations to improve the workshop. Participant responses were favorable and varied greatly from specifics about the workshop series to comments overall about insights of environmental stewardship. Participant responses frequently noted the hands-on experience (offered both in the classroom and planting sessions) as being most helpful.

Examples of participant responses include:

> [Attending the entire workshop series] took me from a little knowledge to much more, the seminars were very good and the planting [session] finished the job.
>
> [I learned] that there is a compromise between still being able to use your shoreline yet designing a natural restoration that helps water quality.
>
> It opened a whole new aspect of landscape design for me. I don't ever look at a lakeshore property in the same way now. It helped me to see the potential for improvement in almost all populated lakeshore areas.
>
> More opportunity for one on one as each shoreline is different.

Other comments included:

- Offer an Internet option
- A small group workshop leader evaluating a site and designing a project
- Refresher course
- Offer continuing education credits

Discussion

This study supports Hungerford and Volk's (1990) model of major and minor variables in environmentally responsible behavior. The results of this study affirm that including a combination of entry-level, ownership, and empowerment variables in educational programming leads to environmentally responsible behavior. Respondents indicated positive change in behaviors representative of entry-level, ownership and empowerment variables and overall citizenship (See Appendix). Of respondents, 85% indicated an increase in knowledge of ecology and sensitivity (entry-level variables), 92 - 98% indicated an increase in in-depth knowledge of issues (ownership variables), and 61 – 98% indicated an increase in knowledge of and skill in using environmental action strategies and locus of control (empowerment variables). Finally, 61 – 77% of respondents indicated an increase in citizen involvement. The comparison in the appendix also illustrates parallels between Hungerford and Volk's (1990) model, components of the Shoreland Revegetation Workshop Series, and selected "Essential Best Education Practices" of the 2004 Best Education Practices for Water Outreach Professionals Symposium (Andrews, 2004).

Siemer (2001) stated that the most difficult challenge facing the stewardship educator is creating the basis for long-term behavior change and is essentially an exercise in character education. As predicted by Siemer, the results from this study found a greater percentage of participants indicating a positive change related to entry-level, ownership and empowerment variables than in

citizen involvement. One explanation for this difference may be that entry-level, ownership and empowerment activities involve participants in a passive way relative to the commitment and action required in citizen involvement. This recommendation is supported by Hungerford and Volk (1990) noting that educators must not assume that one course or one unit or one year of training will accomplish the task alone in creating environmentally responsible citizens.

In order to increase citizen involvement, the Shoreland Revegetation Workshop Series could incorporate additional strategies suggested by Siemer (2001) that directly address these objectives:

- Getting the learner to commit to doing some target behavior
- Getting the learner to select a personal or team goal related to a target behavior
- Engaging the learner in in-group competition related to a target behavior

In addition, participants could be encouraged to attend the Shoreland Volunteer training also offered through University of Minnesota Extension Service Shoreland Education Program. This training specifically develops skills to promote environmentally responsible behavior.

In summary, research shows that information alone does not change citizen behavior. In order to inspire environmentally responsible citizen behavior, curricula need to include ecological concepts, environmental sensitivity, in-depth knowledge of issues, issue analysis and investigation, locus of control, and citizenship skills. For long-term environmental citizenry, educational programs need to provide ongoing reinforcement through a variety of venues.

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APPENDIX (Burkett & Blickenderfer)

Comparison of Educational Components that Affect Behavioral Change

Citizen Behavior Change (Hungerford & Volk, 1990) [reference Figure 1]	**Critical Components to Maximize Behavioral Change** (Hungerford & Volk, 1990)	**Corresponding Components of *Essential Best Education Practices* for the Class or Group** (Andrews, 2004)	**Corresponding Components of the Shoreland Revegetation Workshop Series**	**Indicators of Success** (reference data analysis, Table 1)
Major and minor: *Entry-level variables*	Teach environmentally significant ecological concepts and the environmental interrelationships that exist within these concepts.	• Knowledge of environmental processes and systems • Systems and interdependence are characteristics of the biological and natural order.	• Plant ecology • Water cycle • Nutrient cycle • Disturbance ecology	Knowledge of environmental system: *85% of survey respondents indicated positive change.*
Major and minor: *Entry-level variables*	Provide carefully designed and in-depth opportunities for learners to achieve some level of environmental sensitivity that will promote a desire to behave in appropriate ways.	• Learner connections to immediate surroundings provide an immediate base for understanding larger systems, broader issues, causes and consequences.	• Real life examples of human activity and their ecological impacts	Environmental sensitivity: *85% of survey respondents indicated positive change.* Participant response: *It opened a whole new aspect of landscape design for me. I don't ever look at a lakeshore property in the same way now. It helped me to see the potential for improvement in almost all populated areas.*

Citizen Behavior Change (Hungerford & Volk, 1990) [reference Figure 1]	**Critical Components to Maximize Behavioral Change** (Hungerford & Volk, 1990)	**Corresponding Components of *Essential Best Education Practices* for the Class or Group** (Andrews, 2004)	**Corresponding Components of the Shoreland Revegetation Workshop Series**	**Indicators of Success** (reference data analysis, Table 1)
Major and minor: *Ownership and empowerment variables*	Provide a curriculum that will result in an in-depth knowledge of issues.	• Skills for understanding and addressing environmental issues • Natural sciences, social sciences, and humanities disciplines contribute to understanding of the environment and environmental issues.	• Ecological, political and social aspects of land and water use • Current research of land use and water quality	In-depth knowledge: *92-98% of survey respondents indicated positive change* Participant response: [I learned] *that there is a compromise between being able to use your shoreline yet designing a natural restoration that helps water quality.*
Major and minor: *Empowerment variables*	Provide a curriculum that will teach learners the skills of issue analysis and investigation as well as provide the time needed for the application of these skills.	• Questioning and analysis skills	• Site analysis, discussion of alternative solution and development of landscape design • Provide additional resource (professional contacts and materials/info lists).	Skill of issue analysis and investigation: *87-98% of survey respondents indicated positive change.*

Citizen Behavior Change (Hungerford & Volk, 1990) [reference Figure 1]	**Critical Components to Maximize Behavioral Change** (Hungerford & Volk, 1990)	**Corresponding Components of *Essential Best Education Practices* for the Class or Group** (Andrews, 2004)	**Corresponding Components of the Shoreland Revegetation Workshop Series**	**Indicators of Success** (reference data analysis, Table 1)
Major and minor: *Ownership and empowerment variables*	Provide a curriculum that will teach learners the citizenship skills needed for issue remediation as well as the time needed for the application of these skills.	• Personal and civic responsibility	• Identify environmental and social issues, and potential avenues for action. • Group problem solving and role playing with presentation experience	Citizenship skills result in citizenship involvement: *61-77% of survey respondents indicated positive change.*
Major and minor: *Ownership and empowerment variables*	Provide an instructional setting that increases learner's expectancy of reinforcement for acting in a responsible way; i.e., attempt to develop an internal locus of control in learners.	• The learning experience is learner-centered. • Promotes active engagement in real world problem solving. • Enables learner to link new knowledge to existing knowledge. • Provides *nurturing context* for learning. • Provides opportunities for extended effort and practices.	• Small group, jargon, challenge and problem solving • Large group reinforcement through presentations • Small group and large group discussions of issues, impacts and solutions using real life, local examples • Empowerment through hands-on design and planting experience	Positive experience translates into future action (locus of control): *61-77% of survey respondents indicated positive change.*

Education and Changes in Residential Nonpoint Source Pollution

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Abstract

Urban areas contribute pollutants such as excess nitrogen and bacteria to receiving water bodies. Branford River and Long Island Sound have experienced excess nutrient loading, low dissolved oxygen levels, and high bacteria levels, due partly to urban runoff. The objective of this project was to determine whether stormwater quality could be improved by educating homeowners and implementing best management practices (BMPs) in a suburban neighborhood. The paired watershed design was used, where a control and treatment watershed are monitored during a calibration and treatment period. Treatment consisted of education of homeowners and structural changes designed to minimize nonpoint pollution. Some changes in measured behavior were reported. According to the treatment period survey, 11% of respondents in the treatment watershed began fertilizing their lawn based on the results of a soil test, whereas none had done so before. In addition, 82% of respondents in the treatment watershed stated that they left clippings on the lawn compared to 62% from the initial survey. Twelve of 34 lots (35%) adopted some BMP following education efforts, indicating a significant ($p=0.0001$) increase in BMP use overall. However, a χ^2 analysis of survey data indicated no significant changes in measured behavior in regards to specific questions. ANCOVA[1] results indicated that a 75% reduction in nitrate+nitrite-N (change in intercept, $p=0.0001$) and a 127% reduction in fecal coliform bacteria (change in slope, $p=0.05$) concentrations occurred (Table 1). However, the treatment period regression was non-significant for bacteria. Total nitrogen, total phosphorus, and ammonia-N concentrations did not change significantly. Intensive education efforts produced BMP implementation and measurable water quality improvements. A complete manuscript will be appearing in an upcoming issue of Environmental Management. An earlier version was published in the December 2002 issue of the *Journal of Extension* (Dietz, Clausen, Warner, & Filchak, 2002).

[1] Editor's Note: ANCOVA refers to analyses of variance and covariance statistical methods. For one source of information, see G. David Garson, North Caroline State University course notes, http://www2.chass.ncsu.edu/garson/pa765/ancova.htm

Table 1. *Summary of Means and Percent Change for Bacteria and Nutrient Concentrations for the Control and Treatment Watersheds During the Calibration and Treatment Periods in Branford, CT*

	Calibration Period (n=60)[1]		Treatment Period (n=44)[2]			
					Treatment	
	Control	Treatment	Control	Observed	Predicted	% Change
	---------- (FCU/100 mL) ----------					
Fecal Coliform Bacteria	**1,382**	**2,341**	**898**	**731**	**1,660**	**-127***
	---------- (mg/L) ----------					
NO_3-N	**1.6**	**1.3**	**1.9**	**0.8**	**1.4**	**-75*****
NH_3-N	**0.09**	**0.18**	**0.21**	**0.35**	**0.23**	**34**
TKN	**0.6**	**1.1**	**1.3**	**2**	**1.9**	**5**
TN	**2.7**	**3.1**	**3.9**	**3.3**	**4**	**-21**
TP	**0.073**	**0.117**	**0.124**	**0.226**	**0.164**	**27**

[1]Number of nutrient samples. Numbers of samples for stormflow and bacteria were 32 and 13, respectively.

[2]Number of nutrient samples. Numbers of samples for stormflow and bacteria were 27 and 13, respectively.

*** P value=0.05**

***** P value=0.001**

Reference

Dietz, M. E., Clausen, J. C., Warner, G. S., & Filchak, K. K. (2002, December). Impacts of Extension education on improving residential stormwater quality: Monitoring results. *Journal of Extension*, *40*(6). Retrieved June 2004, from http://www.joe.org/joe/2002december/rb5.shtml

Improving Aquatic Insect Identifications Made by Students and Volunteers

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Abstract

Educators and volunteer groups are increasingly using aquatic macroinvertebrate biomonitoring, not only as a way to engage the community in environmental stewardship, but also as a strategy for generating valuable water quality data. While the efforts of these groups have certainly increased understanding and concern for the health of our streams and rivers, the quality of the data collected through these programs is being called into question. To be useful in both the research and policy arenas, biomonitoring data must be accurate and conducted at a level of precision that will determine water quality within an appropriate level of certainty. Research, recently conducted at several Portland, Oregon high schools and a university, shows that student-collected data is not of sufficient quality. This paper reviews the literature on student and volunteer collected biomonitoring data, and presents results from a study on two strategies for improving students' field identifications of aquatic insects. Results from this research show that two interventions: *describing and showing Key Identification features, and using live reference specimens*, drastically improve the accuracy of aquatic insect identifications made by students.

Introduction

Education-Based Aquatic Insect Biomonitoring

The simplicity and natural wonder of aquatic insect studies is well suited to the educational setting, and teachers at all levels are increasingly using biomonitoring as a way to engage their students in scientific inquiry and research. More importantly, local volunteer and watershed management groups across the nation are using aquatic insect data to monitor and track the quality of streams and rivers. For many science teachers, there is strong incentive to partner their students' biomonitoring research with the data needs of community stakeholders and policy makers. In fact there are hundreds of organizations that promote education-biomonitoring partnerships (U.S. Geological Survey, 1995), and many of them use student-derived data in official documents and studies including 305(b) reports to congress (U.S. Environmental Protection Agency [EPA], 1998; Nerbonne & Vondracek, 2003). However, there is justifiable concern for the quality of student-collected biomonitoring data (Penrose & Call, 1995). As more biomonitoring education/research partnerships are established and promoted, it is critical that the accuracy and taxonomy of such work is considered and that biomonitoring training and field methods reflect best practices for ensuring the accuracy of volunteer/student identifications.

Accurate identification is the cornerstone of high quality biomonitoring. Thus, incorrect identification invalidates the results of a biomonitoring study. Unfortunately, there is scant research on instructions or field conditions which may lead to highly accurate insect identification. A literature review uncovered relatively few publications specifically focused on the accuracy of aquatic insect identifications made by students or volunteers. One study published in 2001 found that Volunteer data was comparable to professionals (Fore, Paulsen, & O'Laughlin,

2001). Another study by Nerbonne and Vondracek (2003) found that the volunteer success rate in identifying families of aquatic insects was only 29.6%. Rather than *identification accuracy*, most of the published research on volunteer based biomonitoring is focused on the ability of volunteers or students to accurately determine the ecological condition of streams using multimetric indexes as evidence for correct insect identification (Ely, 2000; Engel & Voshell, 2002; Fore et al., 2001).

The purpose of this paper is to examine procedural factors and conditions that influence the accuracy of college students' insect identifications and to make recommendations for strategies that will likely improve identification accuracy. Because professional biomonitoring data require at least family level taxonomy, this study focuses on the accuracy of identifications made at the family level.

Methods

Overview

This study examined the accuracy of insect identifications by students enrolled in an upper division science course called "Water in the Environment." Participating students ranged in age and backgrounds, and few, if any of them had experience collecting or identifying aquatic insects. Three separate experiments (Exp 1: guide only. Exp 2: key ID, and Exp 3: reference tray) were conducted over the course of a 10-week term to determine the affect of a guide (Exp 1), and the effect of two interventions (Exp 1 & 2), on the accuracy of students' aquatic insect identifications. Between studies, students did not receive any additional training in insect identification nor did they learn whether their identifications were correct. Due to absences and other logistical challenges, only about 70% of the students participated in all three experiments, the remaining 30% missed at least one of the experiments. The data from one group in Exp. 3 was eliminated for incorrect procedures.

To quantify identification accuracy in each experiment, students were given a white sorting tray with 50-100 live aquatic insect specimens (including debris). The students searched through the samples selecting out as many aquatic insects as they could find and placing each specimen into an ice cube tray, then sorting them into families. In all three experiments, students used one of three regional insect guides as a reference for identification. Any specimens that were too small to identify were labeled as such and not used in the calculations. Specimens categorized as unknown were counted as an incorrect identification. Once the students were done sorting through the sample, they placed each family of insects into a separate jar and labeled each jar with the family name. The samples were then verified for correct identification and analyzed for identification accuracy. For all three experiments, the same data collection and verification procedures were followed.

Baseline Study

Experiment 1: Guide Only

This study, conducted in April of 2004, determined the accuracy of insect identifications made by inexperienced students using only field guides. In this case, students were not given any prior identification training or practice. The purpose of this experiment is twofold: First, is to determine the effect of a field guide on identification accuracy; second, is to provide a baseline data set for comparison with the two interventions - Experiments 1 and 2.

Interventions

Experiment 2: Key ID Characteristics
In this intervention, conducted in April of 2004, students viewed photographic slides of 15 aquatic insect families and learned to recognize the key identifying features of each family. For example, several slides of *Ephemeroptera heptageniidae* (flathead mayfly) were shown with the following list of Key ID features:

- "One set" of wingpads
- Large head that is wider than body
- Large oval-shaped gills
- Light brown to dark brown in coloration

The students were then given the same set of aquatic insect guides and a handout summarizing the previous lecture on key identification features. Live insects from a local river were provided in the classroom for identification.

Experiment 3: Reference Tray:
This final intervention took place in May of 2004 using insects students collected from three different streams on the west slope of the Cascades Range in Oregon. In addition to the same guides and the *Key ID* handout, students were also given a reference ice cube tray containing live examples of all insect families collected. Using all three resources, including the reference set of live insects, students followed the same procedures to sort and identify insects.

Determining Identification Accuracy

The accuracy of students' data was recorded by: 1) determining if the insect family was correctly identified, and 2) if each specimen identified by the students was actually present in the jar. So for example, if jar #1 contained 6 specimens and was identified as five *Baetidae*, but it actually had four *Baetidae* and one *Heptageniidae*, the data were recorded as follows (Table 1):

Table 1 *Illustration of How Student Data Were Organized and Recorded*

Jar #	Students ID's	Instructor Verification	Correct?
1	**6 *Baetidae***	**4 *Baetidae*, 1 *Heptageniidae***	**Yes**
2	5 *Ephemerillidae*	1 *Ephemerillidae*, 4 *Baetidae*	No
3	75 *Heptageniidae*	70 *Heptageniidae*, 4 *Baetidae*	Yes

The data from all jars per group were combined and each groups' data were summarized and analyzed (Table 2). To fully characterize the accuracy of students' identifications, two calculation methods, Percent Correct and Percent Taxonomical Difference, were used:

- *Percent Correct* is calculated by determining the percent of total families correctly identified by the students. This method of calculating accuracy is limited in that it does not accurately distinguish between families that are partially identified correctly. For example, students may have only correctly identified a portion of individual specimens within a particular family. If they identified more than 75% correctly, it was considered a correct identification (Table 1).

- *Percent Taxonomical Difference* (PTD) represents the percent difference between the students' identifications and the verified sample. The PTD is calculated using the following formula where $comp_{pos}$ is the total number of correctly identified insects and N is the total number of insects in the larger of the two counts (Stribling, Moulton, & Lester, 2003):

$$PTD = [1- (comp_{pos} / N] \ X\ 100$$

A low PTD value indicates agreement between the students' data and the verified data. Thus, the lower the PTD the higher is the accuracy of the students' data. An article published in the *Journal of the North American Benthological Society* (Stribling et al., 2003) suggested a maximum PTD value of 15% as a benchmark for identification accuracy. The PTD is limited in samples where one or two families are represented by a high number of individuals. For example, in the results presented in table 1, the *Heptageniidae* family represents the majority of specimens from all three jars but only one of four families found. In this example, the Percent Correct for Group A = .66, but the PTD = .13.

The results of both analyses (% Correct and PTD) were summarized for each group, averaged, and statistically analyzed using an ANOVA analysis.

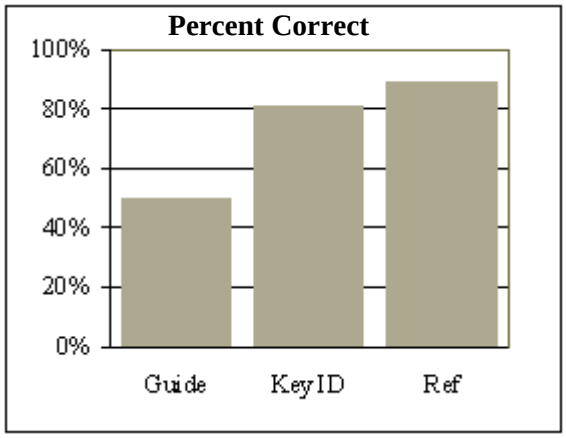
Results

The results show that both the Key ID and Reference Tray interventions drastically improve the accuracy of students' identifications. Simply describing and showing students Key ID features to look for when identifying insects improved their identifications from a baseline of 50% correct to 81% correct and the PTD from 40% to 18% (see Table 2). With live insects as a visual reference, students further improved their accuracy rates from 81% Correct to 89% Correct and 11.1% PTD to 4.3% PTD (see Graphs 1 and 2). More importantly, both interventions result in data that meet and exceed the standards proposed by Stribling et al (2003).

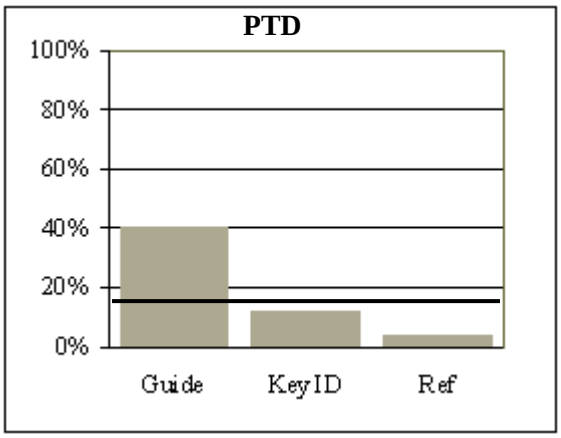
Table 2. *All Interventions: Guides (baseline), Key ID Characteristics, and Reference Tray*

	# of student Groups	# of Specimens per group (max/min)	# of insect Families	Too small to ID	% Avg Correct	% Correct Range (max/min)	Avg PTD	PTD Range (max/min)
Exp1: Guides (baseline)	11	8-52	9	14	50%	0 -100%	40%	7%-100%
Exp 2: Key ID Characteristics	5	6 -13	10	9	81%	66%-100%	11.1%	0%-22%
Exp 3: Reference Tray	4	41-75	17	1	89%	77%-100%	4.3%	0%-11%

Results from baseline study and interventions for both **PTD (p< .25)** and **% Correct (p< .0025)**
"Too small to ID" and "# of insect families" are total amounts for each experiment, not total per group.



Graph 1: **Percent Correct** for all interventions and guide (baseline). p<.0025



Graph 2: **Percent Taxonomical Difference** for all interventions and guide (baseline). A low PTD value indicates higher accuracy. Line represents suggested max PTD. p<.25

Discussion

This study demonstrates that under certain field conditions and with appropriate instruction, students and volunteers can identify aquatic insects relatively accurately. The increase in identifications accuracy is likely attributed to two factors:

1. Learning to recognize key features to look for when identifying insects provides students with the same skills and knowledge that professional taxonomists rely on to distinguish different families of insects.
2. Students easily match their specimen to the reference insect when they have a live insect for reference.

In fact, highly accurate insect identifications may be achieved with very little instruction by simply pre-collecting reference insects to be used by volunteers and students during their biomonitoring study. This approach will not only result in higher quality biomonitoring data, but also smooth the rather complicated process of collecting and identifying insects.

While the results of this study seem to support the claim that students and volunteers can identify insects at a level accurate for use by professional scientists, there are several limitations worth considering.

The data used for this research is derived from non-randomized samples that get smaller as the study proceeds. This is due to the fact that Experiment 1 took place in the field with small groups, Experiment 2 was conducted in the classroom with larger groups, and Experiment 3 took place on an optional field trip. This suggests the results could be due to group size or self-selection for the field trip. In all experiments, however, there were students that missed an earlier experiment and thus had very little familiarity with insect identification, thereby partially mitigating the effect of experience on identification accuracy. Also, this study focuses only on identification accuracy, not how accurately students can conduct biomonitoring research, which is heavily dependent on randomization of site selection and subsampling procedures.

Another important consideration is the fact that Experiments 2 and 3 do not reflect best practices for teaching how to identify insects. It is well known that trial and error is an effective strategy for teaching and learning. Because this project simply gives students the information needed to identify insects, it does not provide a framework for students to build identification skills through trial and error. So for example, it would not be a good idea to use the strategies presented here to train teachers or volunteer coordinators to identify insects. However, if the goal is to ensure accurate field identifications in a limited educational setting, then both interventions (Key ID characteristics and reference insects) are an effective practice for facilitating a volunteer or education based biomonitoring study.

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From Dewey to Doing: How Experiential Education Theory Can Be Effectively Used as a Best Education Practice

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Abstract

This manuscript documents how the promise of best educational theory fares in the real world crucible of community-based education programs. For almost a hundred years, the work of John Dewey has inspired educators who adhere to an idea proposed by Aristotle that "what one learns to do, one learns by doing." We will argue that the need for experiences, distributed over time, and with time built in for individual and group reflections on action provide the best opportunity for learning.

The paper builds upon program and assessment examples, and the outcome data gleaned from hard-won lessons to describe how Dewey's principles of interaction and continuity are brought into play day after day in 4-H. The presentation makes visible the impacts of interaction and continuity in the context of a strong and ongoing experiential, youth program, *Ridges to Rivers: Watershed Explorations*. We will also discuss what makes an "experience" valuable to learners and how these principles can help educators understand the participant's learning experience.

The authors assert that although the principles of interaction and continuity are vague and often overlooked, they are important underpinnings of Dewey's philosophy of experiential education. Furthermore, a good understanding of the principles can help a practitioner in the field of experiential education refine and strengthen the effectiveness of their work.

Introduction: Theory into Practice

This paper documents how the promise of best education theory into practice fares in the real world crucible of community-based education programs. As our research tool, we use an inquiry process (Karplus, et al., 1980; National Research Council, 2000) to ask what, why, where, who and how to answer our questions, and to generate others, as we go. The authors build upon program experiences and products, assessment examples, and outcome data gleaned from "hard-won" lessons, to compare how Dewey's principles of interaction and continuity (Dewey, 1938) come into play in 4-H watershed, restoration and monitoring, education programs.

In the educational context, we attempt to make visible the impact of interaction and continuity in a strong ongoing experiential education program entitled, *Ridges to Rivers: Watershed Exploration* (Enfield, DePeri, Harback, & Neuhauser, 1994*)*. We proceed from an understanding that there are two key goals of this program, first, to support learners to value both the experience of inquiry based education, and second, to help learners to value the program content. To assess

our program we asked, “What makes an ‘experience’ valuable to learners?” This is explored utilizing Dewey’s principles of continuity and interaction to understand, design, and implement educational experiences to maximize the participant’s learning.

For almost a century, the work of John Dewey has inspired educators who adhere to a set of principles and practices that embody this basic idea – what one learns to do, one learns by doing (Dewey, 1938). We assert that the need for experiences, distributed over time, with time built in for reflection-on-action as past experience will maximize the opportunity for learning. This model is theoretically sound and has proven to be practical in developing an effective and community-based operational water education program for youth. Additionally, this program focuses on two educational goals:

1. To increase the science literacy of its participants.
2. To incorporate academic service learning for individuals, mostly adolescents, who deliver the primary educational experiences to young children in the program.

Why Water Stewardship, Why Science Literacy?

Water stewardship and water issues provide a most viable content for investigation. Water is ubiquitous, universal in our human experience, relatively cheap to get and to use, and available to children and adults in a variety of states and situations, and all of the time. If we observe children and adults we come to realize that, for the most part, water itself is tantalizing and engaging.

Water features prominently in studies of geology, physics, chemistry, biology and ecology. Water is a natural and ordinary component of most thematic science studies. The study of water and water issues is appropriate for all grade levels in schools and all age levels in community-based education groups such as 4-H, Boys and Girls Clubs. Also, it is an appropriate topic for Adopt a Watershed, community agencies such as municipal water districts, community environmental groups such as The Nature Conservancy and Volunteers in Neighborhood Ecology, and for study in after school child-care settings.

As we enter the new millennium, the needs for integrated water awareness and stewardship programs create unique opportunities to capitalize on three trends in educational settings. The first is a growing national and international awareness that though water is ubiquitous, covering three-fourths of the Earth’s surface, that clean, safe water is a scarce and valuable resource. A question for our inquiry on water issues is that having safe drinking water for humans is a non-issue, however, how do we accomplish this? A second trend is that increasing national awareness that the processes and products of scientific investigation are driving the global economy and are increasingly part of daily life in the 21st Century (Reich, 1983). A third trend is a growing awareness that place-based, authentic learning that is the kind of teaching that situates problem finding and problem framing along with problem solving, develops a skill set that is highly valued in the workplace. This third trend of problem solving expertise is articulated by economists such as Robert Reich as a “flexible-system production” model (1983, pp. 13 & 214-215) that relies on students to work collaboratively to solve real-world novel problems – the essence of flexible-system production in the corporate world. This type of situated problem-solving education not only teaches learners skills that translate to the workforce skills and economic capital, it also develops a second form of capital called, “social capital.” Social capital is that accumulation of capacity or “human capital” which accrues to learners as individuals who possess both the technological skills and capacities to be productive in organizations but also the social skills to be effective participants in those organizations and society (Dika & Singh, 2002; Field, 2003).

Best Education Practices in Service of Water Education

Best education practices during the past two decades have included an integration of one or more groups of educational stakeholders, students, teachers, volunteers, community groups, and businesses, into education alliances. Often these alliances come about for a broad educational purpose called "service learning." In his description of service learning James Kielsmeier (2000) states that "at every level of schooling, youth participation in service is at an all-time high," and that, the "service-learning movement demands nothing less than reconceptualizing the role of young people in modern democratic societies, particularly in the context of schooling" (p. 652). This view of citizen development and community development vis-à-vis "service learning" develops both social and economic capital within our society. In addition, the notion of "academic" service learning focuses on the additional benefits to participants by bringing academic content into the fore.

Academic service learning is distinguished from typical service learning by the role of scientific inquiry and reflection in relation to essential academic content understanding. The goal is to make "academic learning" more authentic and visible. In terms of our focus on best education practices related to water, we assert that taking the best service learning practices described above and providing more depth through the application of John Dewey's principles of interaction and continuity, makes the learning more relevant and rigorous. Academic service learning programs tied to community-based water education issues offer a rewarding educational opportunity for water agency personnel, teachers, volunteers, students and parents to make an authentic difference in their community.

Who Should Get Involved?

Getting people of all ages involved in water stewardship and safe water issues is important. Dialogue among groups that need water: farmers, municipalities, recreation agencies, sport and commercial fishers, land owners and the public, is important for generating water stewardship that will allow these same people to survive and prosper. Earlier we introduced social capital in relation to workforce preparedness and the requirements of modern, flexible-system production economy. However, the development of social capital, itself, has become a focus of educators during the past decade (Dika & Singh, 2002; Field, 2003; Putnam, 2000). One general concept of social capital is that benefits accrue to individuals or families by virtue of their ties with others. Recent assessments of the impact of cross-age teaching document that older youth, supervised by an adult volunteer or coach, can work effectively with young children to find, frame, and solve community environmental issues in a project-based context (Ponzio & Fisher, 1998; Ponzio, Junge, Smith, Manglallan, & Peterson, 2000).

Development of Situated Water Education Programs

An important connection between education in the processes of scientific investigation and effective water education programs is beginning the process with a situational analysis. In other words,

- What is the condition of the water in this context?
- What are the "stakeholder" needs…all of the stakeholders, plants, animals, people and systems that depend on the water?
- What are the interactions you can observe, measure and document?
- What are the needs that are not being met?

- How can we find and use information sources that will help us determine if there is a problem?
- Is there a problem? If so, how can we describe it?
- How are we framing the problem so that we can solve it (or parts of it)?
- Is it a problem worth investigating and working on?
- How will we know if we have a solution?
- How will we know if today's solution can become tomorrow's problem?

The Learning Cycle Model: How and Why Does it Work?

These questions, along with others, are amenable to an instructional model labeled as "the learning cycle" by Robert Karplus, et al. (1980). Although Karplus et al. identified three phases of the learning cycle, some more recent proponents of this model have identified additional sub-phases (Carlson & Maxa, 1998; Horton & Hutchison, 1997; McArthur, Shields, & Zurcher, 1987; Ponzio & Stanley, 1997). The learning cycle has proven to be an effective way to structure the instructional situation for inquiry in situated settings (Karplus, et al., 1980; Marek & Cavallo, 1997; National Research Council, 2000). The learning cycle model provides for the independent inquiry in the first phase of the activity, and for interdependent inquiry in both the concept development (second, phase) and the concept application (third phase). The concept development and concept application phases are critical to academic service learning programs as they provide learners with the contextual dialogue and shared work among colleagues. The three phases of the learning cycle match up with:

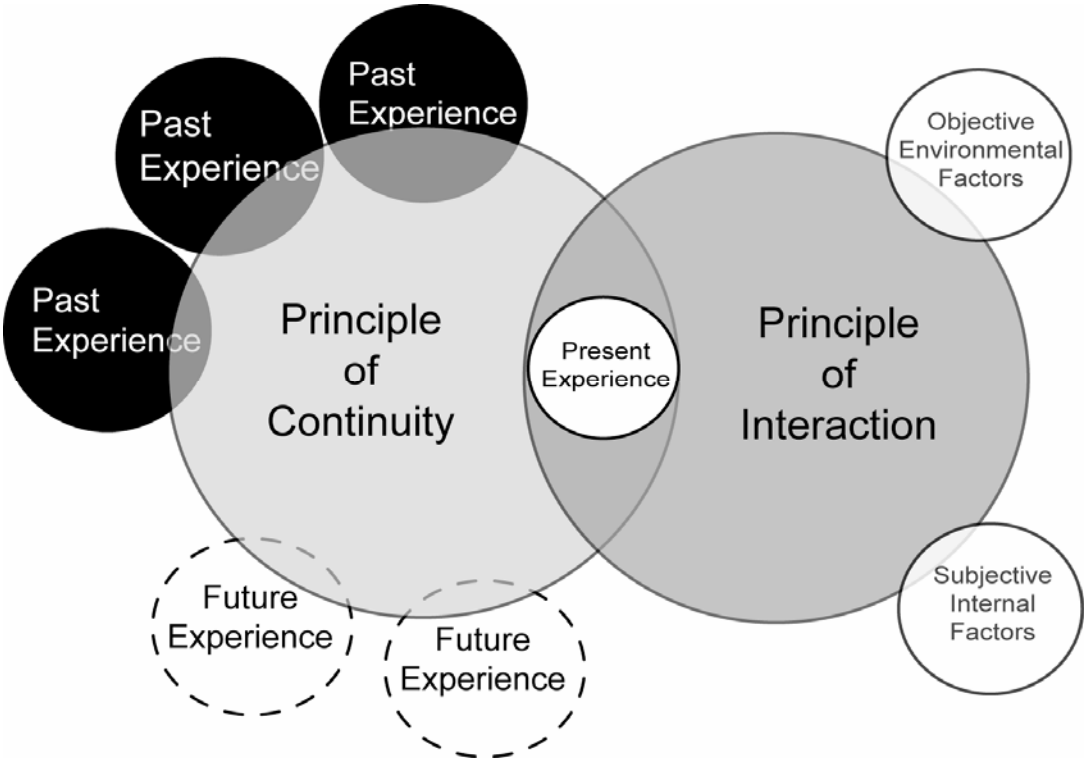
1. The exploration phase (situational analysis or problem finding)
2. The concept development phase (problem framing or investigative)
3. The concept application phase (generating solution scenarios, testing, evaluation, implementing and assessing the solution outcomes)

The learning cycle can be integrated as a core feature of an effective project-based water education program as described in the next section.

Educative Experiences as a Best Education Practice in *From Ridges to Rivers: Watershed Explorations*

In *Experience and Education* (1938), Dewey discusses his ideas of an educative experience; he presents two principles, interaction and continuity, which he states are critical to the success of an experience. The principle of continuity "means that every experience both takes up something from those which have gone before and modifies in some way the quality of those which come after" (Dewey, 1938, p. 27). The principle of interaction states that an individual's experience results from the interaction between self and the environment. Dewey states that there are two factors in experience, objective experience and subjective internal conditions; and "any normal experience is an interplay of these two sets of conditions" (1938, p. 39), which Dewey called a "situation." A graphic portrayal of the principles of continuity and interaction can be seen in Figure 1.

Figure 1. Dewey's continuity and interaction in 4-H



For Dewey, the principles of interaction and continuity, when taken together, provide a tool for measuring the value of an experience. In a sense, this was Dewey's contribution to an early version of what constitutes Best Education Practices. The authors have reviewed numerous instances of student involvement in the 4-H SERIES: *From Ridges to Rivers: Watershed Explorations* curriculum (Enfield, DiPeri, Harback, & Neuhauser, 1994), and have selected two members' stories and experiences – two snapshots in time – to show the two principles in action.

Two Stories

Describing the evolution of a 4-H presentation or public talk can show an example of Dewey's principles of continuity and interaction playing out in the life of a 4-H member. An example from the San Luis Obispo County 4-H Program in California can illustrate the connection. A 12-year-old 4-H member had been involved in a science and technology project exploring the effect of phytoplankton on a local estuary. She had worked, under the guidance of an adult project leader, on the project for several years, interacting with the watershed, estuary and bay in numerous different ways (PAST EXPERIENCE). She first learned about a watershed using the hands-on 4-H curriculum, *From Ridges to Rivers: Watershed Explorations* (PAST EXPERIENCE) through a program called 4-H SLO Scientists (Enfield, 2000). She had searched for insects in streams that help tell a story about the health of a stream; she had helped to build a 12' x 12' scale-model of the watershed being studied; and she has helped others in the project do water sampling over a period of months from a U. S. Coast Guard ship (PAST EXPERIENCES). She used all her knowledge gained from her interactive experiences with the estuary environment to prepare a 10 minute 4-H presentation for delivery at the countywide 4-H Presentation Day (CURRENT EXPERIENCE). Her "supersleuth" presentation on the effects of phytoplankton on the bay was

well received by the audience and judges, but the judges felt that the 4-H member was a little unsure of herself when she was describing some of the aspects of the impacts of phytoplankton and in answering follow-up questions from the audience and judges.

After receiving constructive written input from the judges, the member had to decide whether to take her presentation to the next (i.e., regional) level. After considering the judge's comments, the time frame (OBJECTIVE ENVIRONMENTAL FACTORS), her feelings, interest and knowledge (SUBJECTIVE INTERNAL FACTORS), she decided to rework her presentation and offer her revised presentation at the regional event (FUTURE EXPERIENCE). Based on her work on her presentation, she also decided to prepare and present other talks for interested groups in her community and school (FUTURE EXPERIENCES). It should be easy to see that the principles of continuity and interaction were in play during the entire evolutionary process of this 4-H member's presentation. This learner was totally engaged with the local estuary and interacted with other interested parties leading to her ability to exhibit a high degree of thought, awareness and self-motivation throughout the entire experience.

The second example of these principles of experiential education in action can be told through the story of a young man who also became active in the *From Ridges to Rivers: Watershed Explorations* project while in junior high school (PAST EXPERIENCE). Bryan, a member of the Valley of the Bears 4-H Club, was active in the 4-H Watershed Environment Project; in the project, he first learned about watersheds in general, and then he explored and studied the watershed in his geographic location (PAST EXPERIENCE). One level of his involvement with the project was participation in teen leader trainings, preparing teens to work with younger 4-H members on hands-on watershed activities (PAST EXPERIENCE), such as ground water models, aquifer in a cup, scale watershed models, and making soil. Partly as a result of his experience as a 4-H member since the age of nine, as well as his religious affiliation, Bryan was aware of the meaning and importance of community involvement and service projects (PAST EXPERIENCE & SUBJECTIVE INTERNAL FACTORS). Bryan was also an active member of the Boy Scouts, and he was interested in utilizing his involvement in the 4-H watershed project as a dual project in the Boy Scouts (SUBJECTIVE INTERNAL FACTOR).

As a result of his activities, he became familiar with the increased rate of sedimentation in the local estuary near his home. As a result of some reports in the popular media, it was becoming apparent to some that lived in the Morro Bay area of the Central Coast of California (OBJECTIVE ENVIRONMENTAL FACTORS) that disturbance to the Morro Bay watershed by the impacts of agriculture, residential development, transportation, and military activities, were greatly increasing the sedimentation rate of the sea-level estuary. Bryan was interested in helping to educate a wider audience about the estuary (SUBJECTIVE INTERNAL FACTOR).

Based on his past experiences, objective environmental factors, and subjective internal factors, Bryan decided to organize a community awareness event on watersheds in general and the Morro Bay Watershed and Estuary in particular. Based on his involvement in the 4H Program, he became aware of grant opportunities for science-related activities being offered to 4-H members through the Hewlett Packard Foundation. With the assistance of his father and the Watershed Environment Project Coordinator, Bryan applied for and received a grant for $850 to plan and conduct a "Watershed Awareness Day." He recruited community organizations to participate, and 17 agencies and organizations took part in the event to educate the public about different attributes of watershed health. Over 200 people attended this very successful event.

After the event, an article appeared in the San Luis Obispo County paper extolling the success of the event and the virtues of the Bryan's work. Flamion (1994) wrote:

> Bryan...has made a difference. He has done something about the filling of the estuary at Morro Bay. He has provided an information day to educate the public. The room was filled with people wanting to learn and become involved. Now, it is up to the citizens in their own yards to make a difference. (p. B8)

We believe that by examining the two examples above, the reader can easily see that many components of what is commonly referred to as experiential education are apparent when viewed through the Dewey lens of interaction and continuity. Certainly, in both examples, there is evidence of carefully chosen experiences, development of skills, numerous opportunities and instances of reflection, significant scrutiny, construction of meaning, assumption of responsibility and decision making, as well as other components of experiential education.

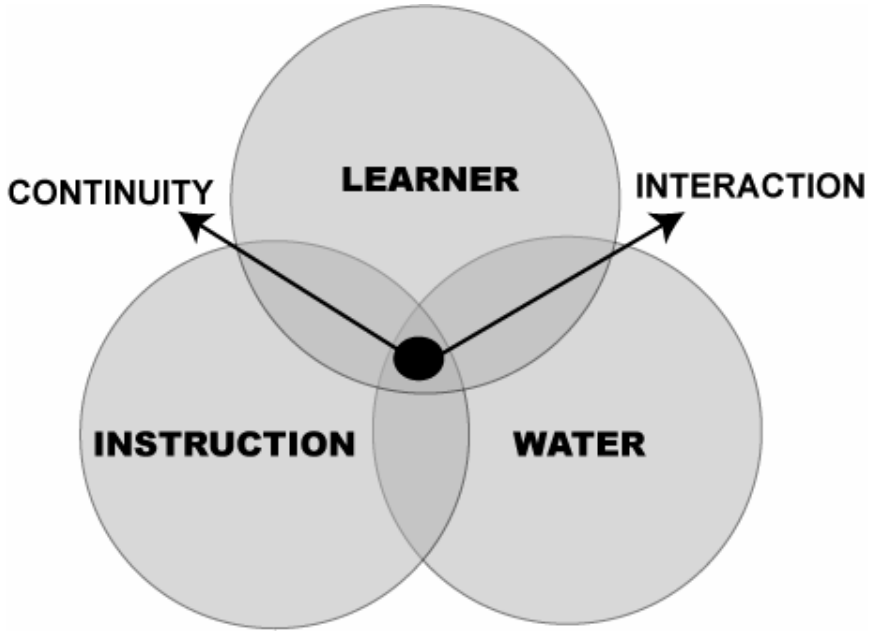
Design Characteristics/Considerations for Effective Water Education Programs

We feel that all educators should consider Dewey's important principles of interaction and continuity when developing, instituting, or evaluating curricula or programs. If this is done, program participants will experience the best that experiential education programs have to offer. In order to ensure that these two principals are taken into account when designing curricula or programs, there are three critical components to consider. The development, implementation and evaluation of effective programs revolve around three major themes: 1) The Learner, 2) Instruction and Experiences, and 3) Content (knowledge, information, skills and behavior are four common to most education programs).

> **1. The learner** is probably the most important design consideration…what fits your intended learner? Does your (model) learner exist or only in your imagination? What information do you have about your learner, and the skill set they bring to the learning activities you intend? This learner information can be related to interests, abilities, age, language proficiency, dexterity, preferred learning modality…the list can go on and on, but it is most important to know who your learners are.
>
> **2. Instruction** is something you can control and do a lot with. Are you interested in using simulations, direct, hands-on instruction experiences, audio tapes, field trips, film, demonstrations, overhead projectors, chalk…you get the idea here, too we're sure…the list is pretty long. You can also control (to varying degrees) or allow the learners to choose, what task/activity they do, how long they will have to do it, with whom they work, the role they play, how they will know they're done. You can also tell them, or allow them to decide, how the activity/task/experience will be evaluated.
>
> **3. Content** is also something you can control. What information, knowledge, skills, experiences are you intending? Again, what fits best with the learner, time considerations, and where the learning will take place are all considerations.

A graphic portrayal of the three design considerations presented above, and their relationship to continuity and interaction, can be seen in Figure 2.

Figure 2: Design considerations of effective programs



Overall, you may be an expert in one or more of these areas, but if you are unsure, (or want to put together a **very** good educational experience) put together a planning team…composed of 'experts.' The team can be composed of teachers of the age groups you want to reach, experts in the areas of the water-related content, parents, children, community agency personnel. We have found that such teams can work wonders in designing a curriculum that meets the criteria for helping to bring about meaningful educative experiences for learners.

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The Long and Short of Groundwater Education for Michigan Farmers

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Abstract

The Michigan Groundwater Stewardship Program (MGSP) has pursued a variety of educational strategies to educate farmers about groundwater risks associated with pesticide and fertilizer use. MGSP collaborates with local, state, and federal agencies to provide confidential information, assessment tools, and technical assistance to farmers. The Farm*A*Syst program is based on environmental education and adult learning theories. This article describes four different evaluation studies investigating program effectiveness. The evaluations focused on the MGSP program objectives and behavioral change theories, and utilized mail surveys. The results suggest that Farm*A*Syst has been a successful intervention for promoting farm environmental management practices. Yet, despite the apparent changes in some farm management practices, little impact on groundwater literacy has been achieved. We suspect adoption of these practices may be driven by financial incentives rather than an improved understanding of the need to assess and evaluate risks to their local groundwater supplies.

Introduction

We all hope that Extension education programs empower learners to make lasting changes that improve their lives. Empowerment is especially desirable when addressing issues that directly affect an individual's quality of life with respect to health and safety concerns. One prime example relates to efforts to educate the public about steps they can take to protect their drinking water.

Agriculture poses particular risks to groundwater because of the widespread use of pesticides and liquid fertilizer in concentrated quantities (Moody, 1990). In agricultural states, farmers play an especially key role in land use to protect groundwater supplies that often provide drinking water to many communities.

Though most Americans express a strong concern for water quality, they are not well informed about water quality issues, sources of pollution, and ways to prevent it (National Environmental Education and Training Foundation, 1999; Marketing Horizons, Inc., 1997). Jones and Jackson

(1990) determined in their study of Wisconsin farmers that they "lacked the means to evaluate their farms' potential pollution sources, including management activities and to draw conclusions on the possible effects and options to reduce risks" (p. 236). Some of the risky practices they discovered included the improper storage and handling of fertilizers and pesticides. The need to educate and promote behavior changes in farm management and to promote safer groundwater practices among farmers was apparent.

Theories of Behavior Change

Research has overturned the long-standing and naive assumption that there is a direct and linear relationship between providing information to individuals and changing the behaviors of those clients (Hungerford & Volk, 1990; Newhouse, 1990). Knowledge of groundwater and of its sources of contamination may be only one factor among many antecedents that influence farmer behavior. Other important psychological variables include attitudes toward the behavior(s), perceived self-efficacy, social norms, and knowledge of and perceived competencies with behavior strategies (Azjen & Fishbein, 1980; Hungerford & Volk, 1990).

Other educational principles to consider when working with adult learners, which are based on Knowles' theory of andragogy (1984), are: a) adult learners need to be involved in the planning and evaluation of their instruction, b) adult learners' past experiences provide the basis for learning, c) adult learners want to learn information that has immediate relevance to their lives or jobs, and d) adult learning is problem-based.

Risk perception is another important criterion that is likely to have an impact on decision-making (Slovic, 1987). Raedeke, Nilon, and Rikoon (2001) found that farmers' who believed their land uses had impacts on the local watershed were more interested in participating in conservation programs. Yet it has been shown that even farmers who express higher levels of environmental concern are just as likely to perceive high risks of adopting new technologies aimed at addressing soil and water conservation problems (Napier, Camboni, & Thraen, 1986).

In order to accomplish lasting impacts, educational strategies need to emphasize skills that empower learners in order to increase the likelihood that knowledge gains will lead to permanent adoption of new practices or ways of living. Dwyer, Leeming, Cobern, Jackson, and Porter (1993) termed the behavior change strategies alluded to here as "antecedent strategies" because they attempt to bring about changes in the attitudinal determinants of behavior. They also described "consequence" strategies that focus on rewards and punishments as a to way influence behavior. Economic incentives for taking (or not taking) some action are an example of a consequence strategy.

Program Background

Since 1995, the Michigan Groundwater Stewardship Program (MGSP) has pursued a variety of educational strategies to educate pesticide and fertilizer users about risks to groundwater, and suggests ways to minimize those risks. This article describes results of several years of research and program evaluation done to track the effectiveness of the MGSP.

In an effort to be proactive in preventing pollution, the Michigan legislature created a special funding mechanism—a tax on pesticide and fertilizers users—earmarked for education about the wise use of these products. This initiative led to the creation of the Michigan Groundwater Stewardship Program, housed in and administered by the Michigan Department of Agriculture (MDA) in cooperation with Michigan State University Extension (MSUE), Michigan

Conservation Districts (CDs) and the USDA Natural Resource Conservation Service (NRCS). Since its inception, the focus of MGSP has been to provide voluntary, confidential risk assessments, education and demonstration projects, technical assistance, and cost-share money to promote the adoption of farm management practices that minimize risks to groundwater.

The implementation of these groundwater education and outreach efforts is conducted by a network of trained groundwater technicians who are employed by local grantee organizations (usually Conservation Districts) but whose activities are directed through partnerships with regional Extension offices. The keystone in MGSP's approach to education and outreach with farmers has been the deployment of the Farmstead Assessment System (Farm*A*Syst or FAS), a nationally developed risk assessment tool.[1]

Groundwater Education Approach

Since 1995, groundwater technicians have conducted Farm*A*Syst assessments on over 10,000 Michigan farms (Michigan Groundwater Stewardship Program, 1999). Through these voluntary and confidential assessments, technicians provide farmers with workbooks that contain worksheets for calculating various risks to groundwater and an Improvement Action Plan. It is the goal of Extension that the FAS workbook serves to expand farmer knowledge regarding groundwater and the risks presented by common farming practices involving the storage and use of pesticides and fertilizers. These individualized educational interventions are designed for the technician to train the farmers in use of the FAS workbook and to empower farmers to assess their own groundwater risk factors now and in the future. The Action Plan includes a timeline for addressing high risks on the farm, in addition to the technical assistance or financial assistance needed to help make the change. Both the farmer and technician sign the Action Plan.

The on-site visit also provides technicians with opportunities to share additional information with farmers regarding cost-share options available through MDA grants, local stewardship activities, or other additional programs that provide technical assistance or services that encourage groundwater stewardship behaviors. In addition, all program participants are eligible to apply for cost-share through the MGSP. The types of practices eligible vary based on funding availability and local priorities.

Evaluation Methods

In order to assess the effectiveness of the program, we drew upon the results of four separate studies. First, we employed a statewide baseline mail survey in 1996 that was sent to a randomly selected sample of 400 Michigan farmers drawn from the Michigan Agricultural Statistics Service's database. The mail survey measured groundwater knowledge, risk perceptions posed by various materials and land uses to groundwater contamination, and awareness related to groundwater education and technical assistance programs.

In 2000, the baseline survey was repeated with another sample of 400 Michigan farmers drawn from the same source to assess changes in knowledge and attitudes. The same survey instrument was used, with an additional set of seven questions added, targeting groundwater stewardship farm practices. Response rates for the survey in 1996 and 2000 were 53% and 51%, respectively.

[1] Editor's Note: The Farm*A*Syst (Farm Assessment System) and Home*A*Syst (Home Assessment System) programs pioneered the development of a voluntary, confidential environmental risk assessment for farmers, ranchers, homeowners. Information is available from the Farm*A*Syst Web site, http://www.uwex.edu/farmasyst/ (accessed June 2004).

The second study was the annual survey of farmers who participated in the FAS program. The evaluation survey tracked the self-reported behavior changes and program satisfaction levels of FAS participants. This program participant data was collected each year from 1998-2003. Though the methodology for this annual survey has varied over the course of this article, the results obtained have been consistent for the past 3 years. In the past three years, mail surveys were sent to FAS participants three to six months after they had assessments conducted on their farms. The mail surveys followed Dillman's Total Design Method (1978) and the response rates ranged from 53-58%.

A third study was a follow-up survey with 2001 FAS participants who had high risks to groundwater on their farm; however, they had not made changes to the high risks (Farrell, 2001, 2002). Again, the Dillman survey method was followed and a 44.7% response rate was obtained.

A fourth study was conducted in 2002 with Michigan Certified Pesticide Applicators (Farrell, 2003b). A stratified random sample was created by MDA based on the seven MDA regions. The survey instrument comprised of two pages and included a question on whether or not an applicator had participated in a FAS, farm demographic questions, and farm environmental stewardship management practices. The response rate was 62.4%.

Results of the FAS Evaluation

Results of annual evaluations by program participants indicate strong levels of satisfaction with the program and with the technical assistance provided by technicians. In addition, the evaluations have revealed numerous behavior changes following completion of an on-site FAS. Highlights of the most recent findings include the following:

- Nearly four out of five (78.9%) respondents made at least one management change to protect groundwater.
- The majority of respondents changed more than one farm management practice as a result of program participation.
- Most respondents (78%) applied for program cost-share dollars in order to make changes (Holsman, Heyboer, Geisler, & Campo, 2000).
- The most frequently reported stewardship practices included emergency farm planning (56.1%), closing abandoned wells (79.8%), enacting safeguards in pesticide storage and handling (37.6%), testing well water (52.2%), and creating drift management plans (52.7%) (Farrell, 2003a).

Meanwhile, the longitudinal study of Michigan farmers' knowledge, attitudes, and groundwater behaviors indicates that groundwater literacy scores are low and remained unchanged on all 12 groundwater knowledge items over the 4-year period (see Table 1). On average, farmers scored 55% correct on the knowledge section in 2000. There was not a significant difference in the overall score between 1996 and 2000.

Table 1. *Frequency of Farmer Responses to Groundwater Knowledge Questions on the Longitudinal Statewide Survey, 1996-2000*

Groundwater Knowledge Items	**Year**	**% Agree**	**% Disagree**	**% Don't Know**
It is more cost effective to prevent pollution of groundwater than to pay for the cleanup. (True)	1996 2000	95.4 94.5	2.3 4.6	2.3 1.0
Irrigation and lawn watering can affect the amount of water leaching into the ground. (True)	1996 2000	88.4 90.7	7.4 7.9	4.1 1.4
Groundwater in Michigan provides water to lakes and streams. (True)	1996 2000	81.5 79.6	13.4 13.5	5.1 6.9
Groundwater in Michigan can best be described as an interconnected series of rivers, streams, and caverns. (False)	1996 2000	72.1 65.1	13.5 19.5	14.4 15.3
Groundwater in Michigan can best be described as a wet sponge where water fills the spaces between soil particles. (True)	1996 2000	68.8 64.5	14.1 16.4	17.2 19.2
Approximately 50% of Michigan's population relies on groundwater for drinking purposes. (True)	1996 2000	61.2 54.4	10.7 13.4	28.1 32.3
An average American uses 50 gallons of water each day. (False)	1996 2000	56.7 59.1	17.7 11.2	25.6 29.8
Groundwater generally follows the contours of the land surface. (True)	1996 2000	56.6 55.8	35.2 37.7	8.3 6.5
Less than 1% of the earth's water is available for drinking. (True)	1996 2000	45.1 48.8	11.2 7.0	43.7 44.2
Just like surface water, groundwater flows downhill. (True)	1996 2000	43.7 42.5	39.9 37.4	16.4 20.1
Once it reaches the water table, groundwater does not move, unless pumped. (False)	1996 2000	6.6 9.7	84.3 82.5	9.3 7.8
Water that looks clear and tastes good is safe to drink. (False)	1996 2000	3.7 6.9	85.6 84.3	10.6 8.8

(No significant changes were found on any item.)

The results indicate that most farmers/respondents knew that:

- Groundwater provides water to lakes and streams.
- It is more cost effective to prevent pollution than to pay for cleanup.
- Irrigation and lawn watering can affect the amount of water leaching into the ground.
- Water that looks clear and tastes good is not necessarily safe to drink.

Conversely, less than a majority of farmers understand what groundwater is by definition. The fact that most respondents agreed with both definitions provided (the correct and the incorrect one) indicates confusion over the concept. Farmers also do not fully understand the relative

scarcity of groundwater as a global resource or have any idea how much American's use in a day (Holsman et al., 2000).

On the statewide survey in 2000, farmers also were asked if they had ever participated in a Farm*A*Syst. One-quarter of the respondents indicated that they had gone through the program (n=47). Knowledge scores of these farmers were compared with farmers who had not participated in the program. No significant differences were observed on any of these items.

In 2001, six months after the annual FAS evaluation, a follow-up study was conducted with farmers who had high risks on their farms but who had not made changes to those high risks. According to responses on the FAS annual evaluation, approximately 42 percent had made changes to all of the high risks on their farms. The study found that 57 percent of the farmers made changes, including:

- 75.9% closed abandoned well(s)
- 68.0% created emergency plans
- 62.1% changed pesticide storage and handling practices
- 46.2% changed fertilizer storage and handling practices

The findings from the follow-up study introduced changes to how the FAS process occurred between the groundwater technician and farmer. In addition, a farm improvement action plan was made part of the FAS. Together, the technician and farmer create a plan on how the high risks on the farm would be addressed, including timeline and implementation strategies.

The findings provided MGSP with reasons why participants had not made changes to their high risks:

- 29.4% waiting for cost-share funding
- 28.8% encountered financial constraints
- 22.9% did not know how to complete changes

Lastly, in 2002 a study was conducted with Certified Pesticide Applicators within Michigan. Approximately 24% of the respondents had had a FAS conducted on their operation. The findings indicate that MGSP and FAS are having an impact on farmers' environmental stewardship management practices (see Table 2).

Discussion

The results of the studies taken together suggest that Farm*A*Syst is a successful intervention for promoting certain farm management practices in Michigan. Yet, despite the apparent shift in several types of farm management practices indicated by the FAS evaluation survey and the differences in frequency of adoption rates between participants and non-participants, the program appears to be having little impact on groundwater literacy.

At the beginning of this article we acknowledged that knowledge change alone is not an effective predictor of behavior change. At first glance, these results suggest that knowledge change may not even be necessary in order to shift behaviors. In 2004, a new FAS was created for technicians to use that included an Action Improvement Plan. The plan includes high risks, timeline, and what is needed for the high risk to be lowered. This plan requires the technician to follow-up with the FAS participant regarding the Improvement Plan. In addition, technician grants are now

focused on deliverables, including number of high risks lowered and if a FAS participant proceeds to farmstead system verification (For more information see the Michigan Agriculture Environmental Assurance Program Web site: http://www.maeap.org). But, will these program changes have impact on environmental stewardship ownership or empowerment? Future evaluation studies will be critical to learning if behavioral changes are occurring because of participation in the FAS program.

In conclusion, we suspect that adoption of groundwater stewardship practices may be driven by short-term financial incentives, rather than by an improved understanding by farmers of the need to assess and evaluate risks to their local groundwater supplies. Some may argue that the question is moot as long as farmers are taking positive actions.

Table 2. *Stewardship Practices Between FAS and non-FAS Participants*

Stewardship Practice	**% *Yes*— F*A*S Participants**	**% *Yes*— Non-F*A*S Participants**
Pesticide containers are triple- or power-rinsed, and recycled.	85.1	85.9
Air-gap or anti-backflow device(s) is installed on well(s).	64.6	51.3
All unused wells are “properly” closed.	83.3	68.6
Drinking water is tested annually.	50.0*	28.2
Farm fuel tanks are being monitored for leaks.	91.7	80.0
Pesticides are stored in a fenced or locked separate facility away from all other farm equipment.	68.8**	48.7
Pesticides are mixed on a mixing and loading pad.	21.3	26.4
Pesticides are mixed in different locations in the field each time.	56.3	42.8
Used oil is recycled.	79.2	80.1
A written emergency response plan has been developed.	57.4*	20.6
Home septic system has been pumped out within the last five years.	66.7	66.4
A spill kit and fire extinguisher is available at the pesticide storage area.	72.9	55.8
Extremely hazardous pesticides and fertilizers have been reported to the local emergency planning committee.	41.7*	15.4
A written drift management plan has been developed.	43.8*	16.1
All liquid fertilizer is stored within secondary containment.	20.8	10.9
Pesticide treated seed bags are returned to dealer.	16.7	13.5

* Stewardship Practice found to be significant at < .01
** Stewardship Practice found to be significant at < .05

It is often difficult to reach adult audiences with educational messages, especially when those messages pose threats to their current habits or practices. Farmers can be an especially challenging audience because of their skepticism toward government agencies. While cost-share incentives can provide a great way to market programming by providing a "hook" to get farmers to participate, there are notable drawbacks to the approach. Other researchers have found that conservation behaviors adopted through financial incentives are often discontinued by individuals once those incentives are discontinued (Thörgeson, 1996; Dwyer et al., 1993).

In the case of the MGSP and FAS, changes like well closures provide the farmers and local communities with lasting benefits, but many other groundwater practices (e.g., pesticide application, water testing, etc.) represent annual, if not daily choices on the part of the farmer. Further research is needed to investigate the long-term impact of program participation on farmers' management decisions regarding groundwater stewardship practices. There is also a need to identify the importance of groundwater knowledge as a mediating variable on the farmers' awareness of risk and willingness to take action. Increased knowledge may be one important factor in a farmer's willingness to seek information (Raedeke et al., 2001).

In the meantime, we caution educators to specify precise cognitive, affective, and behavioral objectives with programs. Long-term behavior change, whether for groundwater stewardship or other health and safety issues, is likely a complex process that requires interventions designed to affect multiple determinants of an individual's decision-making process.

Educators need specific strategies and messages to affect all determinants of behavior. Just as it is often possible to fail to detect the long-term changes of learners who have received an intervention of short duration, it may also be possible to mistake "education" for manipulation of behavior via rewards.

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Evaluation of the Chesapeake Bay Foundation's Conservation Education Programs

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Abstract

We conducted an evaluation of the Chesapeake Bay Foundation's conservation education programs to determine to what extent they promote participants' environmentally responsible behavior and reduce teachers' perceived barriers to teaching about the bay. We assessed outcomes of five youth- and two teacher-education programs through pre-, post-, and retention tests and mail questionnaires from samples of current and past participants. Based on improvements in characteristics that promote environmentally responsible behavior, such as perceived knowledge of issues and actions, environmental sensitivity, and–particularly–intention to act, we concluded that the education programs increased some youths' and many teachers' environmentally responsible behavior. We also concluded that the teacher-education programs facilitated teaching about the bay by reducing teachers' constraints. As a result of our evaluation, the Chesapeake Bay Foundation implemented several changes that administrators of other similar conservation education programs may also want to consider. These changes include focusing programs to target specific, suitable goals; coordinating programs to provide experiences that build on one another; and conducting periodic evaluations.[1]

Reference

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[1] Editor's Note: This paper was published previously (Zint, Kraemer, Northway, & Lim, 2002) and not available for publication as part of the Symposium Proceedings.