Computer Applications In Extension Water Quality Programs

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Cooperative Extension was established as an educational and problem-solving institution in 1914. Since that time, the tools of instructional technology have changed substantially. Cooperative Extension needs to use current and emerging technologies that will permit it to operate in an efficient and effective manner. The computer is a technological tool that offers many opportunities for improving the delivery of Extension programs.

The Department of Agricultural and Biological Engineering at Penn State is exploring several ways of using computers to enhance Extension programs in water quality. This article describes four applications of computer technology designed to address the information-age needs of Extension agents and clientele.

Introduction

Cooperative Extension was established in 1914 by the Smith- Lever Act as a partnership between the United States Department of Agriculture, land-grant universities established by the Morrill Acts of 1862 and 1890, and state and county governments. The Smith-Lever Act, as amended (United States Code, 1989), states:

Cooperative agricultural Extension work shall consist of the development of practical applications of research knowledge and *giving of instruction* and practical demonstrations of existing or improved practices or technologies in agriculture, home economics, and rural energy and subjects relating there to persons not attending or resident in said colleges in the several communities, and imparting information on said subjects through demonstrations, publications, and otherwise... (p. 221).

Although there is periodic debate about what subjects and to whom cooperative Extension should be "giving instruction," there is general agreement that cooperative Extension is, for the most part, an educational

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entity. Cooperative Extension functions as a nationwide educational network that provides adult and youth educational programs on a variety of topics to residents of the fifty states, Puerto Rico, the Virgin Islands, Guam, American Samoa, Micronesia, and the District of Columbia. Cooperative Extension also has a problem-solving role; it provides people with objective, factual information necessary to make informed decisions (USDA, 1986).

In cooperative Extension's educational sphere, the programs that it delivers can be considered instructional systems—arrangements of resources and procedures used to promote learning. The systematic process of planning instructional systems and implementing the plans is termed instructional technology (Gagne, Briggs, and Wager, 1988). Instructional technology can be viewed as a means of optimizing learning results (Blais, 1988). The means may encompass both tools and processes.

The technology that Extension used at its inception is still being used today. The first generation of Extension technology included home and farm visits, demonstrations, radio programs, and publications. These methods were the technology of the day and served the clientele well. In many situations, this technology still has merit. The major drawback is that the technology is very labor intensive. It is similar to the "craftsperson" approach commonly used in the U.S. formal education system (Heinich, 1984). This approach may be as firmly entrenched in Extension as it is in the school systems. Heinich argues that although the craftsperson approach to formal education is no longer universally applicable (because of cost factors), this approach remains because of institutional factors. In industry, market forces drive the adoption of technology; inefficient companies go out of business. This same pressure does not exist in the formal education setting and may not exist in Extension either. However, given the close scrutiny that Extension has received in recent years from the Office of Management and Budget and others, Extension may not have the luxury of ignoring its level of operating efficiency.

Newer technologies must be evaluated as to their appropriate place in supporting the information and educational program mission of Extension (Extension Committee on Organization and Policy, 1987). There is evidence that this is happening. With regard to the *tools* of technology, there have been major changes since Extension's founding. Videotape players and cameras, satellite television, videoconferences and teleconferences, and computers comprise the current generation of instructional technology. There are many examples of the use of these tools in Extension (King and Francis, 1988; Rockwell and King, 1990; Yates and Smith, 1988).

Although perhaps not as apparent, changes are also occurring in Extension's view of the *processes* of instructional technology. For example, Extension has identified several national initiatives on which to focus resources. The trend is away from programming that originates from academic disciplines and toward programming that is issues-oriented.

Cooperative Extension has always been an information-based system. Extension agents have conducted their educational programs using information generated primarily at the land-grant universities.

Today, most segments of society are heavily reliant on information. There has been a general shift in the economy from an industrial emphasis to an information emphasis. This move to an information-based economy requires the development and use of technologies to efficiently utilize the enormous amount of information that is available. The tool most capable of handling this task is the computer. A tool extends human capabilities (Belland, 1985). Applied to the educational and problem-solving needs of Extension, computers can extend the capabilities of Extension professionals.

Water quality is one of cooperative Extension's national initiatives (USDA, 1988). Penn State Cooperative Extension has a history of providing water quality programs. The Department of Agricultural and Biological Engineering has played an active role in designing, developing, and conducting these programs. During the past several years, the department has been making increasing use of computers as tools for more efficiently and effectively addressing educational and problem-solving needs related to water quality. The remainder of this paper will discuss these applications of technology.

Electronic References

PENpages, a computerized information retrieval system, was developed in January 1986. The information on this database can be accessed by Penn State Extension staff as well as personnel from other organizations and members of the public who have a computer, modem, and appropriate software. The only cost for residents of Pennsylvania to get information from the system is that of a call to the local Extension office. Access to the system is also available to residents of other states for the cost of phone service. (A complete description of the PENpages system can be found in Shaffer, 1989.)

A major portion of PENpages is devoted to housing Extension educational materials on a variety of topics. Subject matter experts provide information that is located by means of keywords. A recent search of the system (July 1991) revealed that 244 documents were listed under the keyword "water." Forty of these documents were provided by the Department of Agricultural and Biological Engineering. During a recent one-year period, July 1990 to July 1991, the water documents provided by the department were collectively accessed 482 times.

Much of the department's PENpages information on water consists of electronic versions of hard-copy publications. The key advantages of having electronic versions of the publications is that electronic versions can be rapidly located and retrieved and do not require the user to maintain an on-site filing system. If desired, the user can print these electronic versions for future reference. A disadvantage of the electronic versions is that illustrations that may be part of the hard-copy material cannot currently be reproduced over PENpages.

Information provided on PENpages has the advantage of being rapidly and easily updated. In fact, a portion of PENpages supports a news section which changes daily. Much of the information on water is relatively stable. For example, information provided today on proper well construction techniques will probably still be valid next year. Other water-related information is subject to change. This is especially true for drinking water contaminants (Robillard, 1989). For example, the levels of contamination considered acceptable change as regulatory agencies include additional research findings.

In the future it is likely that more use will be made of the ability of PENpages to handle water quality information that is changing rapidly. Information with a short life span can be developed solely for electronic dissemination. In this way Extension agents and the public will have access to the best current information that otherwise would not be available if the information needed to be relayed via a publication. A caution to this approach would be the necessity to clearly identify volatile information as such.

Hypermedia Databases

Contamination of rural drinking water supplies is a problem facing many communities and individuals. The immediate need for drinking water information and the lack of local expertise has placed a great demand on Extension agents, especially staff located in non-urban areas. Risk communication is often more effective if done by someone from the local community; therefore, the county agent has a potentially large role in communicating information concerning drinking water contamination. However, not all agents have the level of expertise required to disseminate pertinent drinking water information.

Media attention has heightened consumer concerns about potential contaminants and their effects on human health. Responding to the demand for water quality information, the USDA Extension Service sponsored a national focus-group study to determine the water quality training needs for Pennsylvania and other states (Bergsrud, Casey, and Krueger, 1989). Two recommendations, (1) Develop a Water Quality Information Management System and Train Staff in its Use, and (2) Develop and Implement Training in Risk Communication, are the precedent for developing a prototype hypermedia database for drinking water quality information. Hypermedia is a way of structuring information that involves the creation and representation of links between discrete pieces of data composed of text, visuals, and sound (Richards, St. Chignell, and Lacy, 1990).

Using the software HyperCard, the department is developing Drinking Water Solutions. This system is being developed for Extension staff who communicate information about potential drinking water contaminants of individual water supplies. Technical topics include water testing, treatment alternatives, health risks of individual parameters, and environmental fate of contaminants. Drinking water solutions will function as an electronic reference that is easy to use and will eliminate frustrating searches of various publications for desired information. Topics will be electronically linked to permit users to move easily among the various topic sections. The goal is to help agents communicate complex technical information that is clouded by uncertainty and is inherently difficult to understand. Agents who use this system will provide clients with a better understanding of the health risks associated with drinking contaminated water.

Expert Systems

Agricultural nonpoint-source pollution is a major water quality concern throughout the United States. The Rural Clean Water Program (RCWP) was established in 22 selected watersheds throughout the country to address this problem.

After nearly ten years of implementing control practices and monitoring water quality, these RCWP watersheds represent the longest, most extensive experience with the application of nonpoint-source practices to control contaminants in surface and groundwater systems. This knowledge base is now being incorporated into an expert system called RCWP EXPERT.

Expert systems are computer applications that simulate the decision-making process that subject-matter experts use to make recommendations. Utilizing an expert system shell created at Penn State, RCWP EXPERT is derived from a C-language, frame-based, object-oriented expert system with extensive help and explanation (logic trace) facilities. RCWP EXPERT draws upon the extensive experience and successes of RCWP. Expert knowledge in engineering design, monitoring, and practice implementation generated from these unique watersheds is being compiled and utilized in RCWP EXPERT. The five basic modules under development are contaminants, monitoring, transport, control practices, and case studies. The system is designed to provide engineers and water quality monitoring personnel with support information and calculation methods to aid in the design and selection of nonpoint-source pollution control practices.

Computer-Assisted Instruction (CAI)

Alternative approaches to conventional in-service delivery must be evaluated as to their appropriate place in supporting the information and educational program mission of Extension (Extension Committee on Organization and Policy, 1987). Computer-assisted instruction (CAI) is one such alternative technology. CAI is the application of computer technology to solve an instructional problem (Hannafin and Peck, 1988). Kamouri (1984) stated that the potential capabilities of the computer in meeting various organizational training needs have been acknowledged. They include accommodating individual learning differences and time schedules, simulating work experiences, giving immediate feedback, making training supervisors more available, and incorporating interaction and multisensory communication with the user.

Developing CAI for in-service water quality training could eliminate several problems that exist with the conventional classroom method of delivering training. With CAI, agents can go through training when they have a need for it. Agents do not have to wait for the training to be offered at a particular time and place. This is especially important for newly hired agents or those with a newly acquired responsibility in the water quality area. These agents need immediate training. For all agents, CAI eliminates the need for travel and the scheduling conflicts that often arise with traditional in-service training. In-service training delivered via CAI is available at the agents' convenience.

Agents come to in-service training with a wide range of prerequisite knowledge. CAI has the capability of adapting the instruction to fit the needs of the individual learner. When these individual differences are accounted for, compared to traditional means of instruction, CAI can produce more learning in a given period of time. Similarly, CAI can produce a given amount of learning in a shorter period of time (Hannafin and Peck, 1988).

Using HyperCard, the Department of Agricultural Biological Engineering is currently developing

BacStack—a CAI in-service training unit on bacterial contamination of individual water supplies. Bacterial contamination was chosen as the pilot topic because it is a common problem with relatively simple remedies. Agents will learn the steps homeowners should take to correct a bacterial contamination problem of their well. When complete, BacStack will contain several modules. Modules which have been developed and undergone some formative evaluation include modules on chlorinators, ultraviolet light disinfection units, and proper well location and construction. Field tests reveal that the modules provide effective instruction and that agents have a generally favorable view of the courseware.

Conclusions

The Penn State Department of Agricultural and Biological Engineering is exploring the use of computers to increase the efficiency and effectiveness of its Extension water quality programs. Both the education and problem-solving functions of Extension are being addressed through different applications. The courseware BacStack is predominantly educational in nature, RCWP EXPERT falls under the problem-solving heading, while PENpages and Drinking Water Solutions contribute to both the education and problem-solving functions of Extension.

In adapting computer technology to Extension water quality programs in Pennsylvania, several institutional factors may either facilitate or inhibit the use of this technology.

Facilitating factors include:

- Standardization of computers, (all Macintosh).
- Agents that are generally computer-literate.
- Existence of a Computer Sevices Unit for technical support.

Some potentially inhibiting factors:

- Availability of personnel experienced in instructional design and CAI.
- Availability of support personnel for computer graphics and programming.
- Sufficient hardware and sofware for development personnel.

Finally, for any of these technologies to attain their desired results of improving the effectiveness and efficiency of Extension water quality programs, they must be accepted by county agents. Agents must view these technologies as a better way to do things. For this reason it is important to involve agents in the development of these technologies as well as to provide them with training and readily available user support.

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