FEATURE ARTICLE
Innovations in Education

Environmental Health and Nursing

Piloting a Technology-Enhanced Distance Learning Module

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Abstract

The results of a pilot study evaluating a technology-enhanced distance learning module to impart environmental health core concepts to nurses are presented in this article. The internet-based module was developed for continuing professional education and imparts principles of adult education through interactive features including simulated clinical vignettes, an environmental justice case study, and hyperlinks to websites related to environmental protection and health regulation. Mean gains between pre- and post-tests; participant identification of adult learning principles as advanced by Knowles, Holton, and Swanson (1998); and satisfaction were measured among participating RNs ($N = 34$). A 6% mean gain in learning occurred between pre- and post-tests (95% CI .51 to 1.37, $p < .0001$). No significant differences in learning occurred for those who prefer face-to-face instruction and those who tend to procrastinate. Ninety-four percent of respondents indicated they were satisfied or very satisfied with the module. A strong association was found between recognition of adult learning principles as enhancing the assimilation of knowledge and competencies of environmental health and high satisfaction with the module. Distance learning via the Internet shows promise as a format to promote environmental health education for nurses.

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The environment is a primary determinant of health and, as such, its protection is an overarching public health priority. Individuals live in a specific environment, and, whether they are aware of it or not, are constantly modifying the environment to protect their lives and the lives of others. They are the beneficiaries of the "hidden" efforts of the environmental health team whose work makes their lives safer and more healthful. Environmental health, as defined by the World Health Organization, encompasses the study of "effects of various chemical, physical, and biological agents, as well as the effects on health of the broad physical and social environment, which includes housing, urban development, land-use and transportation, industry, and agriculture" (U.S. Department of Health and Human Services, 2000, p. 8-3).

In 1991, the Pew Health Professions Commission reported a need for health professionals to:

- Possess a comprehensive understanding of the determinants of health, including the environment.
- Collaborate with others in the community to promote, protect, and improve health.
- Be prepared to "assess, prevent and mitigate the impact of environmental hazards on the health of populations" (1991, p. 18).

Additionally, the American Association of Colleges of Nursing has determined a need for environmental and occupational health content to be included in professional programs so nurses can detect environmental problems and decrease the risk of environmentally induced disease (Bellack, Musham, Hainer, Graber, & Holmes, 1996).

However, nurses often are not prepared in their core educational curricula to address current environmental concerns. A 1995 report by the Institute of Medicine (IOM), *Nursing, Health & the Environment*, identified a critical lack of content in environmental health across undergraduate and graduate nursing programs in the United States (Pope, Snyder, & Mood, 1995). Nurses practice in the home, community, and workplace where environmental exposures occur. Without environmental health educa-

Institute of Medicine Recommendations for Nurses

Topics for study:

- Epidemiology.
- Risk communication.
- Environmental policy.
- Environmental justice.
- Effects of chemical, physical, and biologic agents on human exposure.
- Environmental regulatory agencies mandated to protect the environment.

Competencies include:

- Ability to provide environmental health advocacy.
- Use of environmental health referral resources.
- Ability to conduct an environmental exposure assessment on clients.
- Identification of basic environmental hazards, such as lead, asbestos, and radon.

From Pope, Snyder, & Mood (1995).

tion, nurses cannot identify or respond to exposures and thereby promote the health of the public they serve. Topics recommended in the IOM report for nurses to study are listed in the Sidebar, along with competencies.

DISTANCE LEARNING VIA THE INTERNET FOR CONTINUING PROFESSIONAL EDUCATION

Distance learning is instruction that occurs away from the location of instructors, and has been delivered through media such as mail correspondence, interactive television, satellite broadcasts, and computers. Continuing professional education (CPE) through distance learning technology that uses personal computers connected to the Internet is a primary format to provide environmental health education to practicing professionals.

Beatty (2001) administered a randomized survey to 20% of the population of rural health nurses in seven Pennsylvania counties (N = 622) to determine attitudes toward CPE. From 199 usable surveys, nurses reported they had to travel 30 to 60 miles to reach a college or university, and identified travel as a barrier to participation in CPE (p = .02). Using a correlation coefficient to test the relationship between the number of miles traveled and participation in CPE, participants living farther away from a higher education institution were less likely to participate in CPE (r = –.175, p = .025). Distance learning through the internet-based CPE has the potential to overcome obstacles of travel and inflexible scheduling because learning can be accessed from home at any time.

An increasing number of adults understand the benefit of engaging in distance learning activities. Random samples of 800 members of environmental and occupational health professional associations in the Midwest were surveyed to determine attitudes toward distance learning. With a response rate of 44% (350 of 800), 87% indicated a likeliness to participate in distance education via the Internet in the near future (Carlson & Olson, 2001).

Participant evaluations of distance learning for CPE via the Internet have been positive. The University of North Carolina at Chapel Hill produced an introductory no-cost continuing education course via the World Wide Web in the core topics of injury prevention for students and professionals. The evaluation method included pre- and post-surveys. Between 1998 and the end of 2000, 119 of the 323 users who took intake surveys (39%) completed follow-up surveys. A total of 83% reported they were satisfied or very satisfied with the course, with 87% stating they would recommend the course to others. At the start of this study, a pre- and post-test were included to measure knowledge. However, these tests were removed soon after implementation because they inhibited participants from accessing the course and thus completing the study post-surveys. However, two-thirds of respondents self-evaluated that they "learned a lot" from the course (Bernhardt, Runyan, Bou-Saada, & Felter, 2003).

A post-graduate interactive tutorial via the Internet on occupational health and workplace health promotion was produced and evaluated in a small pilot study (N = 13) by faculty at the University of Edinburgh in Scotland (Agius & Bagnall, 1998). Students were from varied professional backgrounds including health promotion, nursing, and environmental health. Twelve of 13 students completed the module and returned valid surveys (92%). Among those, 11 students rated the module as Very Good or Good on a 5-point Likert scale ranging from Excellent to Poor, and all students fulfilled the course objectives. In open-ended questions, students identified learning how to navigate and access resources on the Internet as a strength of this education format. The authors conclude, "the World-Wide-Web can contribute to a wide range of learning objectives in occupational and environmental health and medicine" (Agius & Bagnall, 1998, p. 41). A limitation of this study as a form of comparison for purely online modules is that students completed their final assignments in small groups, which occurred in person versus in a virtual environment.

Distance learning via the Internet in academic coursework has shown no significant differences in achievement outcomes compared to those attained by face-to-face classroom instruction (Leisure, Davis, & Thievon, 2000; Rose, Frisby, Hamlin, & Jones, 2000; Ryan, Carlton, & Ali, 1999; Schulman & Sims, 1999; Woo & Kimmick, 2000; Yucha & Princen, 2000). Satisfaction among students has varied from high (Rose et al., 2000) to no significant difference (Leisure et al., 2000; Woo & Kimmick, 2000), to less than traditional classroom education (Brown, Kirkpatrick, & Wrisley 2003; Yucha & Princen, 2000). Factors related to decreased satisfaction included a sense of isolation and a lack of technologic knowledge and accessibility.

In a search of Medline (www.ncbi.nlm.nih.gov/PubMed) and CINAHL (www.cinahl.com) databases, the authors found several journal articles reporting the results of distance learning via the Internet for academic courses that have included face-to-face interaction, with

fewer publications evaluating outcomes from solely online modules. Because face-to-face interaction may confound satisfaction and achievement variables in comparative evaluations of solely online learning, a need exists for more research to be conducted about exclusively online educational formats.

This article summarizes the results of a pilot study evaluating a technology-enhanced CPE distance learning module via the Internet delivered in an exclusively online format. The module imparts environmental health core concepts using principles of adult learning (PALs). PALs include these assumptions about adult learners (Knowles et al., 1998):

- Adults are self-directed.
- Adult learners need to know what will be learned and how they will benefit.
- Adults are motivated to learn by internal desires for self-development, which can be blocked by barriers such as lack of resources, time, and accessibility.
- Adults are experientially oriented, therefore learning is enhanced through modeling life-like scenarios using simulation, problem solving, discussion, and values clarification.

The module contains technology-enhanced, self-directed, interactive features consistent with PALs and include:

- Hyperlinks to government sites concerned with environmental protection and health regulation to promote knowledge of policy and environmental resources.
- An environmental justice case study that encourages clarification of values, problem solving, and the use of risk communication to facilitate development of skills in advocacy.
- An exposure assessment unit consisting of life-like simulated clinical vignettes through audio clips, along with drop-down database chart forms to provide instruction in how to conduct an exposure assessment.

The pilot study data were analyzed to ascertain:

- Participants' overall satisfaction.
- The comparison of participants' main learning styles.
- The identification of adult learning principles in module content.
- The occurrence of learning as measured through mean gains in pre- and post-test scores.

RECRUITMENT AND METHODS

Recruitment

The pilot study was conducted collaboratively with the following three universities between February 2003 and January 2004:

- The University of Wisconsin, Green Bay.
- Metropolitan State University, St. Paul, Minnesota.
- The University of North Dakota, Grand Forks.

Review of the module content prior to initiation of the study was also conducted by public health training centers at Johns Hopkins University and the University of North Carolina, Chapel Hill. A total of 200 RNs enrolled in baccalaureate degree programs, and 25 students pursuing Master of Science in Nursing degrees were given the option to participate in a pilot study of the module. Participation was voluntary and in accordance with Institutional Review Board standards that exempted this study from full review. The module was also marketed through a posting on the University of Minnesota, School of Public Health, Centers for Public Education and Outreach website, a distribution of mailings and flyers at public health events, and a listing on the AskSphere Clearing House Website—a national source of public health training materials funded by the Health Resources and Services Administration.

In the pilot stage, nurses could choose either to take the module for free, or to take the module for 3.5 continuing education units at a nominal cost. The module was accessed from an announcement and link on the home page of the University of Minnesota Public Health Training Center, the Midwest Center for Life-Long-Learning in Public Health (MCLPH). After reading a consent form, those opting to participate as evaluators were led to a 16-question pre-survey, and a 15-question pre-test measuring knowledge of environmental health core concepts included in the module. Upon completion of the module, participants filled out a 23-question evaluator post-survey, followed by a 15-question post-test of environmental health core concepts that were identical to the pre-test. Surveys were constructed on a 5-point Likert scale and included questions about demographics, learning style preferences, experience with and access to the Internet, and distance from the University of Minnesota.

Methods

At the conclusion of the study, 706 individuals had accessed the website, with 178 participants completing the pre-test (25%) and 70 of these completing the post-test (40%). Those who completed both the pre- and post-tests were not significantly different from those who did not in gender, age, ethnicity, and distance from the University. More students completed both the pre- and post-tests (53%) than nurses (35%) or others (29%).

Descriptive statistics were used through measuring percents within answer categories. Inferential statistics tested associations between categories. A paired *t* test was conducted to ascertain differences in mean change in learning scores from pre-test to post-test among three employment categories consisting of nurses, students, and others. Analysis of variance (ANOVA) was used to test for associations between learning style and mean change in learning score from pre-test to post-test, and between satisfaction and mean change in learning scores from pre-test to post-test. Chi-square and Fisher's exact test were used to determine if an association existed between incorporation of PAL and satisfaction.

Questions that measured learning styles involved self-reported ratings in the importance of face-to-face interaction in learning, and in procrastination (see Table 1: Q10a and Q10b). Felder (1996) defined learning styles as "characteristic strengths and preferences in the ways they take in and process information." Satisfaction was evaluated by questions rating overall satisfaction with the module, and participant recommendation of the module to others (see Table 1: QP4 and QP6). PAL recognition

Table 1

Distribution of Responses to Questions Assessing Learning Styles, Recognition of Principles of Adult Learning, and Satisfaction ($N = 34$)

	Response	*Number*	*Percent*
Questions Related to Learning Style			
Q10a. Having face-to-face interaction with my instructors and other students is:	Not particularly important to me	6	18
	Somewhat important to me	9	26
	Very important to me	7	21
	Unknown	12	35
Q10b. I would classify myself as someone who:	Often gets things done ahead of time	9	26
	Puts things off until the last minute, but gets them done on time	12	35
	Puts things off until the last minute and often doesn't complete things	1	3
	Unknown	12	35
Questions Related to Principles of Adult Learning			
QP17. The module exposed me to resources I can access to gain professional knowledge or information in environmental health.	Strongly agree	26	76
	Somewhat agree	2	6
	Agree	5	15
	Unknown	1	3
QP19. The simulated clinical scenarios of listening to each client history and seeing pertinent information recorded on the database was helpful in learning how to conduct an exposure history.	Strongly agree	23	68
	Somewhat agree	5	15
	Agree	6	18
QP21. The South Bronx case study helped me to clarify my personal values as they relate to environmental justice.	Strongly agree	6	18
	Somewhat agree	12	35
	Agree	15	44
	Disagree	1	3
Questions Related to Satisfaction			
QP4. I would recommend this module to others.	Strongly agree	17	50
	Agree	14	41
	Disagree	3	9
QP6. Overall I have been:	Very satisfied	15	44
	Satisfied	17	50
	Dissatisfied	2	6

was measured by questions rating the module resources for developing professional knowledge in environmental health, the usefulness of clinical scenarios for learning how to conduct exposure histories, and the helpfulness of an environmental justice case study in clarifying values (see Table 1: QP17, QP19, and QP21). These questions were selected to test associations between categories because they most accurately depicted the concepts of learning styles, satisfaction, and PALs through the technology-enhanced features measured (see Table 1).

Of the 70 valid pre–post-surveys and tests completed at the end of the pilot, self-identified employment categories consisted of 49% nurses ($n = 34$), 40% students ($n = 28$), and 11% other ($n = 8$). This analysis focuses exclusively on the results of participating nurses.

It was hypothesized that learning would occur, as measured by mean gains in scores between pre- and post-tests, and that a positive association would occur between recognition of PALs as beneficial in facilitating learning and overall satisfaction.

RESULTS

Pre-Surveys

Of those nurses responding ($n = 34$), 88% were White, and 11% Black; 100% were women; 68% were between ages 40 and 59; and 68% lived more than 50 miles from the University of Minnesota. Primary professional practice areas included:

- Public health nursing (21%).
- Advanced practice nursing (12%).

Table 2

Associations Between Recognition of Principles of Adult Learning (PALs) and Satisfaction ($N = 34$)

Questions Testing PALs	*Percent who Strongly Agree to PAL question & who Strongly Agree they would "recommend this module to others"*	*Percent who do not Strongly Agree to PAL question & who Strongly Agree they would "recommend this module to others"*	p *value*
QP17. The module exposed me to resources I can access to gain professional knowledge or information in environmental health.	62	13	.04
QP19. The simulated clinical scenarios of listening to each client history and seeing pertinent information recorded on the database was helpful in learning how to conduct an exposure history.	65	18	.01
QP21. The South Bronx case study helped me to clarify my personal values as they relate to environmental justice.	100	39	.02

- Pediatric nursing (9%).
- Occupational health nursing (6%).
- Nurse educator (6%).
- Other nursing (47%).

Sixty-two percent reported a high need to take the module. Additionally, 91% had used the Internet, 85% had Internet access at their workplace, 100% had home access to the Internet, and 82% were comfortable conducting Internet searches.

Pre–Post-Tests

The mean pre-test score was 12 of 15 questions, or 80%. The mean post-test score was 13 of 15 questions or 86%. The mean difference in pre- and post-test scores was .94 (95% CI = .5 to 1.4). This difference was significant at the 95% confidence level with a p value $< .0001$.

Satisfaction

Ninety-one percent of participants agreed or strongly agreed they would recommend the module to others, and 94% said they were satisfied or very satisfied with the module.

Principals of Adult Learning

Ninety-one percent agreed or strongly agreed that the module exposed them to resources they can access to gain professional knowledge and information in environmental health; 86% agreed or strongly agreed that the simulated, interactive clinical scenarios were helpful in learning how to conduct an exposure history; and 62% agreed or strongly agreed that the module case study helped them to clarify personal values related to environmental justice. Strong agreement existed that the module was flexible to take within the context of personal schedules (88%), and that the format was convenient because it did not involve travel (82%). In addition, 82% reported feeling comfortable or very comfortable with searching for information on the Internet in the pre-survey, which increased significantly to 97% after completing the module ($p = .02$).

Statistical Associations

No significant associations were noted between differences in pre- and post-test learning scores and reported recognition of adult PALs, overall satisfaction, and preferred learning styles.

Strong evidence exists at the 95% confidence interval that recognizing PALs (QP17, QP19, and QP21) is associated with agreeing strongly about recommending the module to others. Of those participants who agreed strongly that the module exposed them to helpful resources, 62% said they would recommend the module to others, as compared to 13% of nurses who did not Strongly Agree ($p = .04$). Similarly, 65% of those who strongly agreed that the clinical scenarios were helpful agreed strongly that they would recommend the module to others, compared with 18% of those who did not Strongly Agree ($p = .03$). All those who agreed strongly that the South Bronx case helped them clarify their personal values would recommend the module to others compared to 39% of those who did not Strongly Agree ($p = .02$) (see Table 2).

Major premises of PALs are based on assertions that adults are self-directed, need schedule flexibility in learning, and want value-applied learning.

DISCUSSION

Several lessons were learned through this pilot study. First, 4 months into the pilot, an analysis revealed that of 565 individuals who accessed the module, only 51 (9%) chose to participate in the pilot by doing the pre-test, and 16 (31%) of these completed the post-test. In response, the module was modified so it was available at no cost to those who agreed to participate as evaluators. In addition, instructions were added to encourage completion. These instructions enabled participants to take the module in more than one sitting and bypass the pre-test upon re-entry. After the changes were made, 90% of those who accessed the website completed the pre-test, and 43% completed the post-test.

Third, demographic survey categories were classified as nurses, students, and others. Because the student category did not specify RN-to-baccalaureate programs, and the module was available to the public, nursing students who may have identified themselves in the student category could not be counted in this pilot, because it could not be determined if students were nurses as opposed to other students. A future, larger-scale study will include an RN-to-baccalaureate sub-category for students.

Although there was a strong significant gain in mean learning from pre-tests to post-tests ($p < .0001$), the difference of one point, or 6% may not be meaningful. One possible reason for the small change may be that the mean pre-test score was 80%; therefore, participants may have begun the module with a relatively high degree of knowledge about the subject. A second possible reason may be that the test questions did not accurately measure the content learned in the module. Of 15 questions, 7 questions had been used for several years as a valid measure of learning in a graduate course, and 3 questions were used with permission from a case study in environmental health, "Taking an Exposure History" (Agency for Toxic Substances and Diseases Registry, 2000). These 10 questions were appropriate measures of learning because content from both sources were included in the module. However, 5 of the questions were newly developed. Future validity and reliability testing of the new questions through item analysis, and review by a panel of environmental health nursing experts to assess content validity, may more accurately measure mean learning changes for future research.

A limitation of the pre–post-test design is that post-test results can be biased because of participant exposure to the identical questions in the pre-test (Polit & Beck, 2004). Because participants were not given the correct answers to questions after the pre-test, this effect may have been minimized. To evaluate for this potential bias, a future, larger-scale study could include two randomized groups, one that receives a pre- and post-test, and a second that receives a post-test only.

That there were no differences in mean gains from pre- to post-tests among participants with different learning styles may mean that learning in this online module is not limited to any one type of learning style, because participants who said face-to-face instruction is very important learned as much as those who said it was only somewhat or not important. Additionally, participants who identified themselves as procrastinators learned as much as those who said they tended to complete work in advance (Q10a and 10b).

High satisfaction with the module (QP4 and QP6), and high agreement that PALs were helpful in facilitating learning (QP17, QP19, and QP21) may explain the lack of significant association between mean gains in learning and satisfaction and mean gains in learning and recognition of PALs as helpful, due to less statistical variation.

The association between strong agreement that PALs was helpful in promoting learning, and strong satisfaction with the module supports the theory and benefits of using PALs in adult education. Major premises of PALs are based on assertions that adults are self-directed, need schedule flexibility in learning, and want value-applied learning. Technology-enhanced learning via the Internet is a medium that lends itself to the successful use of PALs because students direct their own learning in their own time and place, and the use of technology can simulate relevant life-like situations. Therefore, the strong association of high satisfaction with high agreement is plausible. In addition, high satisfaction reported by participants is consistent with results from participants who completed a solely online module via the Internet in injury prevention (Bernhardt et al., 2003). Because the need for face-to-face interaction may be stronger in semester-long academic courses than in shorter CPE online modules, satisfaction may have been less effected by this factor.

Increases in comfort with Internet searches between pre-surveys (82%) and post-surveys (97%) is consistent with results from studies on academic online courses that indicate improvement among participants in computer skills and familiarity with the Web (Cragg, 1994; Yucha & Princen, 2000). A benefit of learning in this format is that it facilitates the ability to access a wide variety of updated information that can be used in multidisciplinary collaboration—a critical expectation for nurses in the "information age" (Thiele, Allen, & Stucky, 1999).

Distance learning modules for CPE via the Internet that do not have a face-to-face requirement have the advantage of potentially greater outreach to rural areas because they eliminate the obligation to travel. Several valuable insights were gained through the pilot study that can be used in future, larger-scale research on the efficacy of this online module and similar trainings. Distance learning via the Internet shows promise for

nurses to increase knowledge and competencies in environmental health and enhance nurses' roles as contributing members of the environmental health team.

The educational module evaluated in this article is publicly available at www.sph.umn.edu/mclph/courses/Environmental_Health_and_Nursing.html from the University of Minnesota School of Public Health and the Midwest Center for Life-Long-Learning in Public Health, a Public Health Training Center Program supported in part by a grant from the Health Resources and Services Administration (DHHS, HRSA grant number 6D20-HP00021-02-01) and an Interagency Agreement with the Agency for Toxic Substances Disease Registry as part of a Federal initiative to promote education for nurses as members of the environmental health team.

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IN SUMMARY

Environmental Health and Nursing

Piloting a Technology-Enhanced Distance Learning Module

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1. Distance learning via the Internet shows promise as a format to promote environmental health education for nurses.
2. The use of principles of adult learning in the development of technology-enhanced distance learning modules can enhance the assimilation of knowledge and satisfaction with the learning experience.
3. No differences in mean gain in knowledge among participants with different learning styles may be interpreted that learning online is not limited to any one type of learner.

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