PUBLIC INFORMATION IMPLICATIONS OF A TEACHER'S SUMMER COURSE ON RADIOACTIVE WASTE

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ABSTRACT

A week-long three credit graduate-level course was taught in June, 1991 for high school science and social science teachers. Instruction was at the layperson's level, and no prior knowledge was presumed. The objectives of the course were to present factual information about radioactive waste, to measure recipient's changes in perception about this topic, and to measure the effect of the course on others.

The students completed a questionnaire about a month before the course and again at the end of the course. They will respond to a third questionnaire in Spring, 1992. Items on the questionnaire were designed to gain information about both knowledge and personal opinions concerning radioactive waste. A composite of 176 knowledge-based responses showed a significant increase in knowledge between the first and second questionnaires. Correct responses increased from about 33% before the course to about 65% at the end of the course. Individual net increases in knowledge ranged from 23% to 46%.

Shifts in opinions were also measured. Before the course, attitudes of the participants varied from stridently pro-nuclear to cautiously guarded and concerned about nuclear issues. The intent of the faculty was not to persuade, but to provide information about radioactive waste issues. To the extent possible, all material in the course was presented as factually as possible. When an opinion was expressed, it was labeled as such. There was, however, a strong shift toward acceptance of radioactive waste as an environmental concern of magnitude no greater than many others. As an example, midway through the course the class members each ranked 30 different activities and technologies in order of risk. Nuclear power was ranked 12th by one individual (1st being most risky, 30th being least risky) and 22nd to 30th by the others. The composite ranking of the class for nuclear power was 29th out of 30.

INTRODUCTION

Since 1989, Oregon State University (OSU) and Oregon Department of Energy (ODOE) have worked cooperatively on a public information and involvement research program centered around radioactive waste transport issues (1,2). Specifically, the transport issue of concern involves transuranic waste shipments from the Hanford site through northeastern Oregon to the Waste Isolation Pilot Project site in New Mexico.

An important part of the public information and involvement program was a summer course (3) for Oregon high school science and social science teachers held in June, 1992. The eight students attending the course (five male and three female) had an average of over twenty years of teaching experience. They teach courses in Chemistry, Physics, Physical Sciences, Biology, Marine Science, Earth Science, Mathematics, Economics, and World Problems and Citizenship. The course enrollment was intentionally kept small for the first time offered to maximize the interaction between the course participants and the course faculty and among the participants themselves. This week-long graduate-level course will be repeated annually during the duration of the current research contract.

The objectives of the course were to (1) present factual information about radioactive waste, (2) to measure recipient's change in attitudes or perceptions about this topic, and (3) to measure the effect of the course on others (e.g., the recipient's students and acquaintances). Pre- and post-course questionnaires were used to accomplish the second objective; the Oregon Baseline Survey (4) conducted in 1990 and subsequent re-surveys plus feedback from the teachers will be used to assess the third objective.

Description of Course

An abbreviated course syllabus is shown in Table I. All material was presented at a layperson level with no prior background required. In addition to the three authors, five other individuals served as guest instructors. A panel discussion involved several other speakers.

Understanding Radioactive Waste by Raymond L. Murray was used as a textbook in the course. The students were also sent a set of articles to read about the technical and social aspects of radioactive waste.

The course was taught in a variety of formats: viewgraphs, 35 mm slides, videotapes, and open discussions. The students were provided with notebooks containing copies of the lecture notes and visual aids for their use during and after the course.

Technical Topics

The first 2 1/2 days of the course involved technical topics associated with radioactive waste. An outline of these topics follows.

- Nuclear physics concepts

  Atomic structure, isotopes, radionuclides, types of radiation particles, radiation interaction with matter, radiation shielding (with demonstration), radioactivity, half life (with simulation experiment), and types of radioactive decay
- Radiation effects and control and biological effects of radiation

TABLE I

Course Outline

Monday	Tuesday	Wednesday	Thursday	Friday
Continental breakfast Registration Introduction of instructors and students Course overview Radiation Center orientation Basic nuclear physics	Basic radiation effects and radiation protection Nuclear fuel cycle Waste management principles	Basic concepts of radioactive material transport TRUPACT-II shipping cask videotape and discussion Transport of radioactive material and associated risks Shipping cask test videotapes and discussion	Actual vs. perceived risks Comparison of risks; discussion of class risk rankings Discussion of selected segments of Hanford NOVA videotape	Public participation in decision making Results of Oregon Baseline Survey
Radiation Center tour Basic radiation effects and radiation protection	Hanford wastes (historical look) Hanford environmental surveillance Panel discussion on Hanford environmental remediation	Participation session (Rokeach values evaluation) Personal attitudes and values Results of Oregon Baseline Survey Participation session (Class ranking of different risks)	Relation of risk to attitudes and values Risk communication Tragedy of the commons	Course evaluation; student questionnaire Summary and conclusions Final examination

Radiation levels and units, naturally occurring radiation, manmade radiation, short and long term biological effects of radiation, standards for protection from radiation, control of radiation hazards, radioactive material contamination and control, restricted areas, sources of information about biological effects, stages of biological damage, cellular effects, nonstochastic and stochastic effects, and hereditary effects

- Nuclear fuel cycle

  Classification and characteristics of radioactive waste, quantities of waste, sources and current locations of wastes, basic types of nuclear fuel cycles, steps in the fuel cycle, waste produced at each step of the cycle, principles and responsibility of radioactive waste management, high level waste (HLW) disposal options and congressional acts, characteristics of a good geologic repository, hazards of deep geologic disposal, HLW activity in other countries, low level waste (LLW) disposal options and congressional acts, hazards of LLW disposal, LLW activity in other countries, and transuranic (TRU) waste disposal

- Hanford waste issues

  Historical survey of Hanford activities as related to waste, current Hanford environmental surveillance activities, panel discussion focused on the role of states and local citizens in a major federal cleanup project, proper interaction and balance between the technical issues surrounding waste cleanup and social and ethical issues

- Transport of radioactive waste

  Form of transported waste, packaging classifications, labeling, placarding, transport index, radioactive material transport shipment and accident statistics, types of radioactive material routinely transported, transport vehicles and casks, Oregon and federal regulations, transport radiation limits, videotapes of nuclear waste shipping cask crash tests

Social Topics

The second half of the course involved social issues concerning radioactive waste. These topics included:

- Discussion of values and attitudes

Ranking of a set of personal values, role of values and attitudes from an historical and a pragmatic viewpoint, details of the OSU Values Survey (5)

- Risk

  Ranking a set of thirty risk-related items (taken from Slovic (6)), comparison of responses with each other and with the other respondents in Slovic's paper, actual versus perceived risks, different types of risk comparisons, class critique of statements from the 1990 NOVA program on Hanford entitled "Hanford: The Bomb's Lethal Legacy"

- Relation of risks to attitudes and values

  Risk communication, tragedy of the commons (7) (with NIMBY discussion)

- Public participation in decision-making

  Role playing session, Oregon Baseline Survey (4) results.

Other Course Features

The students were taken on a tour of the OSU Radiation Center facilities, including research laboratories, the nuclear reactor, and the ^{60}Co irradiator. At the start and end of each day a question and answer review session was held. These sessions allowed discussion of other topics of interest to the students and clarification of the material which had been presented.

A continental breakfast, morning and afternoon refreshment breaks, a buffet dinner at a local pizza restaurant, and a barbecue were designed to make the students feel as comfortable as possible with the course, each other, and the faculty.

The students were given a final examination at the end of the course. In addition, their course grade was based on a post-course requirement of two lesson plans in which they incorporated the pertinent material from the course into a class that they taught.

Student Evaluation of Course

The students completed an extensive six-page course evaluation at the end of the course. The responses were overwhelmingly very supportive of the course. Highlights included the tour of the OSU Radiation Center; the interesting material; the enthusiasm, openness, and preparation of the faculty; the blending of technical and social topics; and the exchange of ideas and interaction between the faculty and the students.

Budgetary Matters

This course was partially subsidized for the students by the research project. The net cost to the student was $200. Student costs for room and board, other supplied food, textbooks, reading materials, travel to and from home, and partial tuition were covered by the research project. The net cost of the course to the research project was approximately $4600.

PUBLIC INFORMATION RESULTS OF COURSE

A 31-item questionnaire was administered to the course participants about a month before they enrolled in the class and before they had received any of the course reading material. The same questionnaire was repeated at the end of the course. The questionnaire will be given a third time in the spring of 1992. The questionnaire responses served as a measurement tool for changes in knowledge *and in attitude about* radioactive waste issues.

About two-thirds of the questionnaire items were designed to measure knowledge. Many of the initial responses to the knowledge items on the questionnaire were "Don't know". A decided increase in knowledge was demonstrated by each of the participants at the conclusion of the course, as evidenced by the number of correct responses. Very few "Don't know" answers appeared on the second questionnaire.

A composite of the 176 knowledge-based responses showed a significant increase in knowledge between the first and second questionnaires, as seen in Table II. Correct responses to the knowledge items increased from about 33% before the course to about 65% at the end of the course. Items that had multiple answers were scored either all right or all wrong. With partial scoring, the percentages correct would have increased somewhat both before and after the course. The mean change of all respondents was 0.32 ± 0.10 per item, i.e., the class on the average showed a net increase in knowledge on 32% of the items (determined by scoring the four sets of before and after responses in Table II as -1, 0, 0, and +1, respectively). Individual net increases in knowledge ranged from 23% to 46%.

TABLE II

Response to Knowledge-Based Items

First Questionnaire	Second Questionnaire	Percent of Responses
Correct	Don't know or wrong	1.1
Don't know or wrong	Don't know or wrong	33.5
Correct	Correct	31.8
Don't know or wrong	Correct	33.5

TABLE III

Ranking of Health and Safety Risk Items

Risk Item	Mean of Individual Changes
Home accidents	-1.86 ± 2.17
Motor vehicle accidents	1.00 ± 2.20
Chemical pesticides	1.57 ± 2.82
Airplane travel	0.00 ± 1.85
Toxic chemical and explosive transport	1.14 ± 1.12
Prescription drugs	-0.71 ± 2.05
Medical x-rays	1.29 ± 2.43
Radioactive waste transport	-3.29 ± 2.60

A positive value indicates a change toward more perceived risk.

Two of the items involved ranking risks and trust. Health and safety risk items were ranked on a scale of 1 (not at all serious) to 10 (very serious). Mean results for the respondents, expressed as the change from the first to the second questionnaire, are shown in Table III. A positive value indicates a change toward more perceived risk. Although in nearly every case the standard deviation listed is greater than the mean value, half of the risk items were perceived as more serious after the course, even though these items weren't discussed *per se* in the course. The mean shift of all items taken together was -0.11 ± 1.62, a negligible change. In the case of the radioactive waste transport item, which was discussed in the course, the perceived risk by the class as a whole shifted by about 3 out of a range of 10 toward less serious. Each of the respondents indicated a change of equal or less seriousness for this item. Changes ranged from 0 (from 1 to 1 by two people) to 8 (from 9 down to 1 by one person). At the end of the course, radioactive waste transport risk was ranked as 1 by five people, as 2 by two people, and as 5 by one person. Hence there was a significant decrease in perceived seriousness of radioactive waste transport after the course.

The class's risk rankings on the questionnaire were also compared with the student's ordinate ranking of Slovic's 30 risks (6) (performed midway through the course). There was a reasonably strong correlation of these two rankings (r^2 = 0.650). It was assumed here that radioactive waste transport on the questionnaire and nuclear power on Slovic's list were similar risks. Of the 30 risks, the class as a whole ranked nuclear power 29th out of 30, with only food coloring being less risky. Individual rankings of nuclear power varied from 12th (medium risk) to 30th (least risk). The person who ranked nuclear power 12th mentioned that before the course it would have been ranked considerably higher.

Eight organizations or groups of people were ranked by the class as to level of trust on a scale of 1 (no trust) to 10 (complete trust). Mean changes (before and at the end of the course) are shown in Table IV. Plus or minus values are 1σ values. A positive mean change indicates more trust. Generally there was an increase in trust for most entities, in particular for radioactive waste truck drivers (gain in trust of 2.43 out of 10). The mean change for all items was 0.75 ± 0.74, an insignificant change. The most trusted by the class were nuclear engineering professors (9.13 at the end of class) and radioactive waste truck drivers (8.38). Least trusted at the end of class were federal government officials (4.75).

These values are somewhat similar to trust ratings of Oregonians as a whole (4), although some sharp contrasts, as seen in Table IV, also exist, notably for industries that produce nuclear waste and radioactive waste truck drivers (more trusted by the high school teachers than by the general public). Environmental activists were the only group somewhat less trusted.

Five other items on the questionnaire involved only a perception element, i.e., there was no "correct" answer for these items. These free response entries were rated as being generally negative, neutral, or positive. Initial image of radioactive waste changed from 75% negative, 25% neutral before the course to 50% negative, 50% neutral after the course. Concerns about the transport of radioactive material were initially 75% negative, 25% positive. After the course, the breakdown was 38% negative, 25% neutral, and 38% positive. The phrase "radiation is bad" was perceived as being true by 25%, neutral by 25%, and either false or misleading (the speaker needed more information) by 50% of the class before the course. After the course, 25% viewed this as true and 75% correctly indicated that the statement lacked a context in order to evaluate the effect of radiation. There was a significant change toward believing that radioactive material is currently being transported safely. Initial responses of "don't know", "strongly disagree", and "agree" changed to either "agree" or "strongly agree" after the course. No one moved in the direction of less agreement with this statement.

CONCLUSIONS

It appears that this summer course for high school teachers played a significant role in (1) informing them about an issue (radioactive waste) which was of significant interest and/or concern to them, (2) increasing their knowledge about

TABLE IV

Ranking of Trust Items

Trust Item	Baseline Survey(4)	Before Course	After Course	Mean of Individual Changes
Federal government officials	4.68	4.86	4.75	-0.43 ± 3.06
State and local government officials	5.49	5.00	6.13	0.86 ± 1.25
Nuclear regulatory agencies	5.31	5.86	6.50	0.57 ± 2.32
U.S. Department of Energy	5.09	5.86	6.63	0.71 ± 2.12
Industries that produce nuclear waste	3.79	5.57	6.13	1.43 ± 2.13
Radioactive waste truck drivers	5.51	6.14	8.38	2.43 ± 0.90
Environmental activist groups	6.30	4.86	5.25	0.57 ± 2.38
Nuclear engineering professors	Not included	7.14	9.13	0.83 ± 1.07

A positive mean change indicates more trust.

this issue, (3) easing some of their fears about radioactive waste, based upon the factual information they received and were able to discuss, and (4) giving them resources to pass on to their high school students.

As part of their course requirement, the high school teachers developed two lesson plans dealing with radioactive waste that could be used in their classes. A followup questionnaire will be administered to the high school teachers near the end of the 1991-92 school year. By this time, they will have had opportunity to cover the topic of radioactive waste in their science or social science courses. These third questionnaire responses will be correlated with the pre- and post-course responses as a measurement of (1) how much of the technical informational details are retained in particular (actual values, etc.) and also generally (order of magnitude awareness), (2) how attitudes and values have changed over time, and (3) how the material presented by the high school teachers impacted the high school students.

Discussions about radioactive waste issues with high school teachers, especially of an extended nature such as a week-long course, are an effective tool since high school teachers are a critical link to reaching the next generation. Armed with facts presented in open, non-confrontational format, these teachers tend to become more understanding and accepting of radioactive waste issues.

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