An Interdisciplinary Course In Holistic Problem Solving

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Abstract

Modern society is finding that the solution to many problems dictates a holistic approach that requires expertise from many disciplines. The university needs to provide educational experience in such a setting. A course being taught at the University of Nebraska entitled "Water Quality Strategy" was developed to provide such an experience. The objectives, class procedure, class outline, and crucial requirements for this course are presented. Although the vehicle for meeting the objectives of the course is the development of a water quality strategy by the students, the procedures described can be readily adapted for solving many other problems of an interdisciplinary nature.

Introduction

Universities have been advocating interdisciplinary research for several years. Evidence is now pointing to a need for more interdisciplinary problem solving experiences in classes. Viessman and Welty (1985) noted that the

> "solution of most of the nation's water problems will not be achieved without the recognition and taking on of all of the related elements - political, social, economic and technical". "There is a need for engineers, environmental scientists, planners, resource managers and others who can break the narrow confines of their disciplines and function as informed citizens and professionals in devising solutions to the many water problems being recognized worldwide".

In other words, a holistic (or systems) approach will be needed to solve these water problems and such an approach will require interdisciplinary teams.

The need for a holistic approach is recognized by public agencies as they form committees to develop these water quality protection strategies. When developing such strategies, public agencies must usually rely on professionally trained experts. However, most professionals have been taught in a discipline-centered program with little effort made to integrate other disciplines. Higher education needs to provide classroom experiences using holistic approaches to problem solving in an interdisciplinary setting.

The purpose of this paper is to present a course structure that provides such a setting. The learning vehicle is a class project in which an integrated water quality protection strategy is the outcome. The specific objective of the course is to enable the student to formulate problem solving strategies based on an analysis of the whole system (a holistic approach), rather than on just a few physical, institutional, or behavioral subsystems.

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Classroom Procedure

The class was conducted as if it were a committee charged with developing a water quality strategy within a few months. A conference style seating arrangement was used in the classroom. The instructor acted as the chair of the committee (class) which met weekly for three-hour sessions. The committee members (students) from diverse disciplines were expected to contribute their knowledge and expertise to the discussions. They were to be professional and act as part of a critical committee representing public agencies and private interests charged with developing a water quality protection strategy. The students were further expected to help gather information for, write portions of, and edit the strategy. This strategy was then printed, bound, and presented to a panel of state agency representatives for their critique. This panel consisted of volunteers from the Natural Resources Commission, the Department of Environmental Control, the Nebraska Department of Health, and the Natural Resources Districts. The students were graded on their contributions to the development (writing and editing) of the strategy and written synopses (minutes) of committee sessions.

The first year the course was taught (1989), there were 16 students representing the disciplines of Agronomy; Geology; Agricultural Economics; Engineering; Forestry, Fisheries and Wildlife; Geography; Regional and Community Planning; and Law. The objectives of the course were met by developing a water quality strategy entitled " A Strategy for Protecting Ground Water from Nonpoint Sources of Nitrate" and presenting it to a panel of state agency representatives. Student evaluations of the course indicated that they received a valuable learning experience in holistic problem solving.

The course is being taught for the second time (Spring, 1991) with 27 students representing the disciplines of Agronomy; Community and Regional Planning; Sociology: Economics; Law; Business Administration; English; Community and Human Resources; Political Science; Architecture; Civil Engineering; Agricultural Engineering; Forestry, Fisheries and Wildlife; Geology; and Geography.

A typical class session begins with a summary, by the instructor, of the students' synopses of the preceding session followed by discussion and the development of a consensus on a section of the strategy. The objectives of that day's session are then discussed by the committee followed by a presentation from a resource person. The resource person is a student, instructor, or guest lecturer. A discussion period guided to meet the day's objectives follows the presentation. The discussion session is an exchange of questions and ideas with the resource person. A draft of the next section of the strategy is then developed. The committee session closes with student assignments and each student submitting a written synopsis of the session.

Between weekly sessions, the chair (instructor) summarizes the student synopses for discussion at the beginning of the next session. Toward the end of the semester, the students will prepare and present preliminary drafts of sections of the strategy and after discussions with their colleagues, prepare the final drafts. The next-to-last session is spent evaluating an existing strategy and proof-reading the final draft before it goes to press. The published strategy is distributed to the panel of state agency representatives prior to the last session (during finals week). At this last session, an oral presentation is made to the panel by the instructor or a student. The session ends with the panel's critique of the strategy.

Course Outline

A complete outline of the course is presented in Appendix A. The course can be divided into two general phases (not indicated in the outline). Although the two phases have distinctly different objectives, the time at which they occur may overlap.

The first phase might be called a "get acquainted" phase. It is one in which the committee members get acquainted with each other, with some of the principles and jargon of the different disciplines, and with the general system to be considered for the holistic approach to problem solving. This initial phase is necessary for most interdisciplinary committees because people from different disciplines often have trouble communicating. For example, the social and political scientists are not familiar with agricultural terms such as surface irrigation, center pivot systems, legumes, rotations, recharge, etc. The agricultural and engineering scientists may not be familiar with such terms as norms, values, social stratification, profit margin, return-to- land, etc. It is essential that the committee members have enough of an understanding of each other's discipline so that they can participate in discussions on the impact of various strategy alternatives on the general system. To foster this understanding guest speakers from the different disciplines are invited to speak on topics related to the strategy.

The committee must also get acquainted with the general system structure so they can thoroughly examine the impact of the strategy alternatives on that system as well as the influence of the system on the success of the strategy, i.e., in order to use a holistic approach to problem solving. Any structure of the general system can be used if it completely describes the system. The general system structure used in this course is one modified from Cantanese and Snyder (1988) and is described in Appendix B.

The second phase of the course is the actual development of the strategy. This process begins with the presentation of the rational decision model (Cantanese and Snyder, 1988). The steps in this model are to (1) define the problem; (2) identify the objectives of the strategy; (3) specify performance measures of the objectives; (4) identify alternative strategies; (5) analyze the alternatives (their impacts on the system and the influence of the system on their success); (6) compare and select the best alternative strategies; (7) present the strategy; and (8) implement and evaluate the success of the strategy. The committee (class) sessions in the second phase are organized to complete, in turn, each step in the model.

Analyzing, comparing and selecting strategy alternatives, Steps 5 and 6, consume a large portion of the second phase. To accomplish these steps, a value (from 1-5) is assigned which represents the impact of the strategy alternative on each subsystem or property of the system presented in Appendix B. This value is assigned by the class and is based on four or five statements which describe the probable impact of the alternatives. These impact statements are developed by the students and refined during class. The assigned values can be positive or negative depending on whether the alternative is thought to have a positive or negative impact on that particular property of the system. A value of zero is assigned if the alternative is thought to have no impact on that particular property of the system. The sum of all the assigned values is the score for a given strategy alternative. This process completes Step 5. Step 6 is achieved by comparing the scores of the strategy alternatives and selecting the alternative with the greatest positive score.

If this process selects a strategy unacceptable to the majority of the committee (class), acceptable sections of several strategy alternatives can be combined and this compromise strategy evaluated as in Step 5 above. If its score is acceptable, it is adopted by the committee. This process is mentioned in Section IX of the course outline (Appendix A) as conflict resolution.

Step 7 is accomplished by presenting the strategy to the panel of state agency representatives. Due to time limitations, Step 8 cannot be completed for this strategy so it is simulated by examining a case history of a previous (real) strategy.

Crucial Requirements

The success or failure in achieving the objectives of the course depends greatly upon meeting several crucial requirements.

One requirement is that each discipline necessary for the system to operate be represented by a student. As a minimum for water quality, disciplines should include Agronomy; Agricultural Engineering; Civil Engineering; Forestry, Fisheries, Wildlife; Economics; Geology; Law; Political Science; and Sociology. Students from Community and Regional Planning and other disciplines can be a real asset to the class.

To assure the proper class composition, the course should be cross-listed in appropriate departments of the university. When the class is taught for the first time, the instructor might need to visit the several departments on "recruiting" trips. Announcements of the class might also need to be posted on the bulletin boards in these departments.

A second crucial requirement is that the class schedule must be followed closely and class assignments be turned in on time because the success of the educational experience depends on the completion of the strategy and its presentation to the panel of state agency representatives. At the beginning of the semester the students are informed that the success of the class depends upon the completion of their assignments before or by the date indicated in the class schedule. Unexcused absences result in a reduced grade, except under the most exceptional circumstances.

Another requirement is that the class must also be of the "right" size for meaningful and organized discussions (between 10 and 20). One way to insure proper class size is to recruit students, but set enrollment limits from each cross-listed department.

A final requirement is that the committee (class) sessions must be long enough to allow for a thorough discussion of a topic without a prolonged interruption. To insure enough time, the class sessions should not be less than two hours long. Three hour sessions (with appropriate breaks) seem to be of optimum length.

Acknowledgements

The author wishes to express his fondest appreciation to his colleagues at the University of Nebraska, in particular Dr. Robert Sorensen, for their support during the development of this course and the preparation of this manuscript.

References

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Appendix A

Water Quality Strategy Course Outline

(Session)

I. Introduction
   A. Purpose and requirements of the course
II. General system theory (See Appendix B)
   A. System structure
      1. Component subsystems or properties
      2. Interrelationships and feedback (1)
   B. The general system
      1. The agriculture *production* component
         a. Physical subsystems or properties (Appendix B)
            (1) The Hydrologic Cycle
            (2) The Nitrogen Cycle
            (3) Ecological subsystems (Resource person- Agronomy Prof.)
         b. Institutional properties (Appendix B)
            (1) Technology
            (2) Economics
            (3) Politics
         c. Behavioral properties (Appendix B)
            (1) Sociology
            (2) Ideology (Resource Person - Sociology Prof.) (2)
      2. The *allocation* component (Appendix B)
         a. Physical properties
         b. Institutional properties
         c. Behavioral properties
      3. The *control* component (Appendix B)
         a. Physical properties
         b. Institutional properties
         c. Behavioral properties
      4. The *staffing* component (Appendix B)
         a. Physical properties
         b. Institutional properties
         c. Behavioral properties
      5. Summary of the agriculture component from a producers perspective. (Resource person - Irrigation Farmer)
III. The rational decision model
   A. Define problem
   B. Identify objectives
   C. Specify performance measures of objectives
   D. Identify alternatives
   E. Analyze alternatives
   F. Compare impacts and select the best alternatives
   G. Present results and conclusions
   H. Implement and evaluate success of alternatives (3)
IV. Defining the problem (Student Report)
   A. The water quality situation
      1. The national situation
      2. The state and regional situation
   B. Stating the problem
   C. Defining the scope of the strategy
V. Identifying the objectives
   A. Good water quality
   B. Optimum production (agricultural)
   C. Sustainable agriculture (Resource person - Agronomy Professor)
VI. Specifying performance measures of objectives
   A. Problem review
   B. Water quality standards
   C. Optimum yields (4)
VII. Identifying alternatives
   A. Current or pending legislation (Resource Person - Law Professor)
   B. Identify alternative strategies. (Class discussions) (5)
VIII. Analyzing the alternatives
   A. Finalizing the strategy alternatives
   B. Developing impact statements (Class Assignments) (6)
   C. Understanding the impact of strategy alternatives on agribusiness. (Resource Person - Agrichemical Industry Representative)
   D. Understanding the impact of strategy alternatives on staffing component (public health & risk assessment). (Resource person - Environmental Engineer) (7)
   E. Determining the impact of strategy alternatives (student assignments, class discussions, and scoring of student impact statements) (8,9, & 10)