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A Capstone Problem Solving Course Revisited

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Abstract

Several years ago in an article in the NACTA Journal (Zimmerman, 1991), I wrote about a cap-stone problem solving course which I developed for students at a technical college (Ohio State University, Agricultural Technical Institute) and had offered for the first time. This course, *Problem Solving Using Systems Approaches*, has been offered annually for a total of seven times. This article is a reexamination of the problem solving course and a) reviews the literature to see if the course topics and content remain current and important, b) describes the major changes which have been made in the course during the past six years, and c) discusses student performance in and evaluation of the course.

Introduction

The rationale for and initial content of the course, *Problem Solving Using Systems Approaches*, were based on many studies conducted during the 1980's which addressed the improvement of college teaching, curriculum reform, and results of industry/graduate surveys. This body of research clearly documented the importance of incorporating concepts and skill development in such areas as problem solving, communications, creative and critical thinking, interpersonal relations, group processes and teamwork, leadership, personality and learning styles, and decision making into course work and the curriculum using an

interdisciplinary approach.

Does the current literature continue to support the importance of integrating these topics into courses and the curriculum? Even a review limited to articles published in the NACTA Journal since my article appeared in 1991 provides ample evidence that this question can be answered with a resounding "yes."

Authors of several articles discussed the results of industry surveys. Barkley (1991) surveyed employed graduates of the College of Agriculture at Kansas State University and reported that a large majority listed communication skills and people skills as the most important in their careers. Neal, et al. (1991) surveyed Ohio agricultural leaders and advisory committee members and found that communications and personnel management/leadership were two of five topics listed most often as important employment skills. Radhakrishma and Bruening (1994) surveyed agribusiness employees in Pennsylvania and reported that interpersonal and communication skills were included as very important for pursuing careers in agribusiness by the employee group. Bruening and Scanlon (1995) set up four agribusiness industry focus groups to help identify appropriate curricula modifications and revisions for courses offered by the Department of Agricultural and Extension Education at Penn State. Critical thinking, problem solving, decision making, team work, leadership, and communication skills were identified by this process as important topics to consider.

Several authors discussed important topics to

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include when reforming and updating curricula. Hawkins and Dymond (1991) stated that the characteristics most sought after in the agribusiness manager are interpersonal and communication skills and that major emphasis was placed on these in the revised curriculum at the Muresk Institute of Agriculture, Australia. Foster and Pikkert (1991) surveyed faculty in the College of Agricultural Science and Natural Resources at the University of Nebraska and found strong support for the need to integrate critical thinking skills in the curriculum. Christensen (1991) recommended communication skills, interpersonal relationships, and leadership be among the topics considered when designing new curricula. Brink (1994) included graduate competence in integrated problem solving and communications/leadership as two of four major general goals in developing new curricula. Jenkinson (1994) described a newly designed curriculum and courses for the B.Sc. (Agr) degree at the University of Guelph which emphasizes skill development in communications, problem solving, leadership, and cooperative group learning activities.

Three authors shared their experiences developing and teaching integrated, multi-discipline courses. Jimmerson (1991) discussed a broad-based leadership course taught in the College of Agriculture and Home Economics at Washington State University which includes topics and activities involving self-directed learning, projects and logs for improving communication and thinking skills, the Myers-Briggs Type Indicator (MBTI) and learning styles, team projects, group processes, solving problems within a broad context, peer teaching, and experiential learning. Powers (1991) described an interdisciplinary course in holistic problem solving taught at the University of Nebraska entitled Water Quality Strategy. The major objective of this course is to enable students to formulate problem-solving strategies for actual case studies based on analyses of whole systems. Wright (1992) wrote about an interdisciplinary capstone problem solving course in agricultural production taught at Massey University, New Zealand. The course is based on actual case studies and requires that students integrate knowledge in a multi-discipline approach as they develop problem solving, interpersonal, communication, and teamwork skills. Several other authors described specific teaching strategies and course activities which help students improve their critical and creative thinking, communications, and problem solving skills (Parker, 1993; Olien and Harper, 1994; Gleichsner, 1994; Wehner, 1995; Barkley, 1995).

Problem Solving Course

The basic organization, format, and content of the course *Problem Solving Using Systems Approaches* remains similar to what I described in a previous NACTA Journal article (Zimmerman, 1991) and readers are referred to that

article for background and detailed information. The following is a brief overview and update of the course.

Student Population

The problem-solving course continues to be a graduation requirement for all students in the engineering technology programs and as a capstone course is only open to students who are graduating or are within a quarter or two of graduation. More than 150 students have enrolled during the seven times that the course has been offered. Class size is typically about 20-25 students but has ranged from 12 students the first time the course was offered to 36 students.

Organization and Format

Problem Solving Using Systems Approaches is a three credit hour course (quarter basis) and therefore meets for three hours of class sessions per week for ten weeks. In order to allow time for extended discussions and activities the course is scheduled once a week for three hours. In recent years it has been offered during Spring Quarter on Monday afternoons from 2-5. Due to a Monday holiday only nine class sessions are held, students are directed to use the tenth session time allotment working independently on their final project. The course is concluded with an individual session held in my office during which the student's graded journal is returned and discussed and the student is given a brief oral final.

All sessions are held in a classroom with moveable desks which allow for flexible seating arrangements. Students are randomly assigned to groups of three or four at the start of each class, form their desks in clusters, and work as teams during the entire class session. The classroom environment is informal, flexible, student-directed, experiential, and discussion-oriented.

The information and activities for each session are based on handouts developed by me and provided during the class period. Overheads are used where appropriate. I function primarily as a coordinator and facilitator and do very limited teaching of content. Typically, students are asked to read the handouts or complete the exercises/activities within their groups and then the class as a whole engages in follow-up discussion.

The current grading system for the course is: four projects/reports (25%), class participation (15%), case study project/report (20%), journal (30%), and individual oral final (10%). The grading system does not include written quizzes or tests.

Changes in Content and Learning Activities

I developed the matrix shown in Figure 1 to help me better visualize and structure a variety of learning activities

to meet educational objectives regarding the major topics and content of the course. The matrix is also useful when I explain to students the purpose of the various learning activities assigned in the course. Another benefit is that the matrix has helped me better integrate learning activities related to the course topics in individual class sessions and throughout the course. Based on the matrix, information in the literature, my experience with the course, and student feedback, I have added, dropped, or modified learning activities as appropriate. Major changes that I have made in the course are discussed below. A current list of the topics and activities for the nine class sessions is included as Appendix I.

Student facilitator teams have been incorporated as an integral part of the course. Students are randomly assigned to one of eight facilitator teams at the first class meeting. Each team is then assigned an upcoming class session. Student facilitator team members are required to meet with me prior to the class session for which they are responsible in order to discuss the session outline, study the

handouts, and help plan class activities. The team members then meet on their own to plan "their" class session in more detail and to decide on each person's responsibilities. Team members serve as facilitators during the class session; I am present to provide assistance and additional input as needed. Performance as a member of the facilitator team is factored into the student participation portion of the course grade. The teams further empower students, strengthen the self-directed learning nature of the course, enable students to gain valuable experience as peer teachers, and help them develop skills in several course topic areas.

More emphasis has been placed on the use of the journal for both in-class and out-of-class free writing. Writing in the journal is an activity which can be used to enhance student learning in all the topic areas covered in the course and provides students with an excellent opportunity to actively engage in self-directed analysis and learning. The interaction between instructor and students due to the journal is one of the most important and rewarding parts of the course. For more specific information about the use of

TOPIC/CONTENT	LEARNING ACTIVITIES *									
	CA	J	SF	MBTI	P/R1	P/R2	P/R3	P/R4	CSP/R5	OF
Problem Solving	X	X	X	X	X	X	X	X	X	X
Written Communications	X	X			X	X	X	X	X	
Oral Communications	X		X			X			X	X
Interpersonal Relations	X	X	X	X			X		X	X
Critical & Creative Thinking	X	X	X		X			X	X	X
Learning Styles/Personality Types	X	X	X	X			X		X	X
Teamwork and Group Processes	X	X	X	X					X	X
Decision Making	X	X	X	X	X			X	X	X
Leadership	X	X	X	X			X		X	X
Management as Problem Solving (Planning, Personnel, Conflict Resolution, etc.)	X	X		X		X	X		X	X

- * CA = Classroom Activities
- J = Journal
- SF = Student Facilitators
- MBTI = Myers Briggs Type Indicator
- P/R1 = Project/Report 1; Application of Technology - Example
- P/R2 = Project/Report 2; Industry Personnel Interview - Problem Solving
- P/R3 = Project/Report 3; Personality Types/Learning Styles - Applications
- P/R4 = Project/Report 4; Scientific Method - Seed Experiment
- CSP/R5 = Case Study Project/Report 5; Soft Systems (Conflict Resolution) Case Study
- OF = Oral Final

Figure 1. Course Topic/Content and Learning Activities Matrix

journals and free writing in course work readers are referred to Zimmerman(1991).

Use of the MBTI has been more thoroughly integrated into the course. The MBTI is administered to all incoming students on my campus and is used in a number of applications in addition to the problem solving course (Johnson, et al., 1993). I have adapted various MBTI materials and activities specifically for the course to help students understand concepts and improve skills in several topic areas. Composite MBTI results for engineering technology students enrolled in the problem solving course are tabulated on a continuing basis, are compared with campus and other populations (Zimmerman, et al., 1994), and are presented to the students for discussion purposes. This provides another excellent opportunity for students to engage in self-directed analysis and learning.

The concepts and topics for two of the four projects/reports (see Figure 1) required during the first half of the course have been modified. The second project/report now requires that students select and interview an individual from industry and write a follow-up formal report based on the title "Use, Need, and Importance of Problem Solving Skills and Abilities in Industry." Most of the industry personnel interviewed invariably respond with a version of the concept that "basically the essence of my job is solving problems" and are very supportive of a capstone course in problem solving. I have found this learning activity to be very effective in helping to validate the course and content to the students and in increasing their interest and participation. The third report is now titled "Practical Applications of Personality Types/Learning Styles in Employment Situations." During classroom discussions leading up to this assignment, I emphasize that all individuals will work with people and be teachers and learners throughout their lives as supervisors and managers, parents, members and officers of civic, religious, and volunteer organizations, etc. I have found this learning activity to be effective as a follow-up to help students relate the topics of personality types and learning styles to themselves, their work experiences, and their future careers in supervisory and management positions.

I have also further developed and strengthened the soft systems and case study portions of the course. These activities address several topics in which technology oriented students typically need more skill development. Students are given more detailed instructions about their responsibilities involving the case study and role playing activity conducted during one class session. More time is allotted and guidance provided for the actual role playing exercise and follow-up discussion. I have also found that the basic concepts of soft systems problem solving and conflict resolution are new and often alien to most students.

Therefore, more class time and assistance is devoted to helping students work on their soft system case study project/report.

Student Performance in and Evaluation of the Course

The unique subject matter and format of the problem solving course poses a challenge to the instructor because initial student reaction will vary depending on the learning styles, personality types, and viewpoints of the individual students. Therefore, it is important to develop and schedule a variety of learning activities which encourage and reinforce student interest and participation in the course. Relating the material to the "real world" of business and industry is essential for establishing the credibility of this type of course.

I have high expectations for students and maintain the work load, standards and rigor of the problem solving course accordingly. I have been pleased with the way that students have responded to the uniqueness and challenge of the course. Most students participate actively and overall performance has been good with class GPA's typically averaging in the B- range. However, I have learned to expect and accept that a few students may adopt a negative attitude about the course and perform accordingly.

Two years ago Ohio State adopted a new survey instrument for student evaluation of instruction (SEI) to replace a previous one used for many years. Results of student evaluations using this instrument for the last two course offerings are shown in Figure 2. The results show that student ratings are typically above college/campus averages. This is consistent with the student evaluation results for previous offerings of the course.

Teaching a unique course such as problem solving does involve some risk, and as mentioned above, I have encountered a few students during the past seven years who object to the unique format and content of the course. Typically, these students do not actively participate in classroom discussions and projects and do minimal, low-quality work on written assignments. In spite of my efforts, these students adopt and retain a negative attitude about the course. Given their small number and low profile, the negative students do not adversely effect the other students or the course as a whole. However, these students can be expected to give low rating on course evaluations. Three such students were enrolled in the SP/96 class (versus none in Sp/95), and their negative opinions are probably the reason for the lower SEI results for all question categories for SP/96 versus SP/95 as shown in Figure 2. This is one of many reasons why student evaluation of instruction results must be interpreted in the proper context and should only be one of a multitude of methods for evaluating the effectiveness of

QUARTER/YEAR	SP/95		SP/96	
CLASS SIZE/NUMBER OF RESPONDENTS	19/19		20/19	
QUESTION:	I *	C *	I *	C *
1. Instructor well organized	4.8	4.3	4.5	4.1
2. Intellectually stimulating	4.8	4.0	4.5	3.9
3. Instructor interested in teaching	4.9	4.4	4.6	4.3
4. Encouraged independent thinking	5.0	4.4	4.7	4.2
5. Instructor well prepared	4.9	4.3	4.6	4.1
6. Interested in helping students	4.9	4.4	4.7	4.2
7. Learned greatly from instructor	4.8	4.1	4.3	3.9
8. Created learning atmosphere	4.9	4.2	4.4	4.0
9. Communicated subject matter clearly	4.8	4.1	4.1	3.9
10. Overall rating	4.7	4.2	4.4	4.1
* I = Instructor Mean C = College/Campus Mean Scale: 0 - 5				

Figure 2. Student Evaluation of Instruction (SEI) Results.

a course and the quality of instruction.

In addition to the SEI, students are given the opportunity to provide anonymous written comments about the course. Many take the time and make the effort to do so. Typically responses include: *interesting, fun and challenging; enjoyable and well-organized; taught aspects of life, the real world and people; helps people open their minds; and allows us to look at things from different perspectives.* Overall, the written comments are very positive and supportive of this required course.

Conclusion

The literature clearly supports the importance of including the topics and content of the problem solving course in the college curriculum. Based on information from the literature, my experience in teaching problem solving several times, and student feedback, I have been able to improve the course by making several appropriate changes. This process will continue each time the course is offered. Overall, student performance in and evaluation of the course has been very positive.

Curriculum review and reform is an ongoing process on most college campuses. I strongly recommend that the major topics presented in the problem solving course be included in the curricula for all majors and required for all students. If a required capstone problem solving course is not feasible, then it is important that the topics and content of the course be incorporated into other required courses. Students, faculty, employers and society will all benefit as a result.

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Appendix I. List of Topics and Activities for the Nine Course Sessions

- Week 1. "Restaurants" Problem
 Course Introduction & Syllabus
 Student Facilitator Teams
 Journal Handout and Discussion
 Journal Examples
 Journal Entry - A Recent Problem and How I Solved It
 Football Puzzle
 Problem Solving/Physics
 Problem Solving Strategies List
 Problem Solving Strategies and Exercises 1
 Four Problem Solving Approaches and Hierarchy
 Design and Methodical Approach Problem Solving Steps
 Application of Technology Problem Solving Steps

Assignment - Application of Technology Project/Report

- Week 2. Inspector Problem
 Review of Four Problem Solving Approaches and Hierarchy
 Review of Application of Technology Method Flow Chart (Humorous)
 Collect/Discuss Application of Technology Reports
 Journal Entry - Concepts I Have Learned in Class to Date
Assignment - Industry Personnel Interview Project/Report "Use, Need, and Importance of Problem Solving Skills and Abilities in Industry"
 Equation Analysis Puzzle
 Scientific Method
 Scientific Method - Seed Experiment Assignment
Assignment - Start Seed Experiment
 Wacky Words
 Collect One Journal Entry

- Week 3. Morbid Inquiry Tasks
 Collect/Discuss Industry Personnel Interview Reports
 BEST Personality Types
 Difficult Personality Types
 Personality Types & Applications
 Journal Entry - Personal Analysis of My Personality
 Choice of Wacky Wordies or Equation Analysis
 Paradigm Picture
 Student Learning Styles
 Learning Styles Applications
 Journal Entry - Personal Analysis of My Learning Style
Assignment - Project/Report "Practical Applications of Personality Types and Learning Styles in Employment Situations"
 Update - Status of Seed Project
 "Sinking Boat" Problem
 Collect One Journal Entry

- Week 4. Word Puzzle
 Collect/Discuss Practical Applications Reports
 Employee Internship Form
 Employee Appraisal Form
 Right/Left Sides of the Brain
 Right/Left Shift Exercise
 R-Shift Exercise
 Journal Entry - Right Or Left Side of the Brain