

AN EXPLORATION OF THE OUTCOMES OF UTILIZING ILL-STRUCTURED PROBLEMS IN PRE-SERVICE TEACHER PREPARATION

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Abstract

The researchers of this collective case study sought to explore and understand the population of a cohort group of 22 pre-service teachers in agricultural education at the University of Illinois at Urbana-Champaign. The purpose of this study was to determine the outcomes of using problem-based learning cases by pre-service teachers to learn how to manage difficult student problems related to FFA supervision. Pre-service teachers faced difficulties in making decisions regarding ill-structured problems. They expressed challenges related to thinking of creative alternatives, considering the interests of others, and pursuing legal action if necessary in reaching solutions that were fair, relevant, appropriate, and effective. Ill-structured problems engaged pre-service teachers to be creative and reflective problem-solvers in making decisions. The pre-service teachers learned how to creatively generate alternatives, determine potential consequences for each alternative, consider possible implications of the consequences, and make decisions in a more reasonable period of time. Finally, pre-service teachers indicated that the ill-structured problems related to FFA supervision prepared them to solve similar problems that they may face as future agriculture teachers and exposed them to a variety of situations that they did not consider before the problem-based learning experience.

Introduction and Theoretical Framework

Beginning teachers face many ill-structured, complex problems. Among their many needs, novice teachers of agriculture have problems managing and advising FFA activities (Edwards & Briers, 1999; Garton & Chung, 1996; Layfield & Dobbins, 2000; Mundt, 1991; Mundt & Connors, 1999; Talbert, Camp, & Heath-Camp, 1994) and disciplining students (Joerger & Boettcher, 2000; Mundt; Mundt & Connors; Nesbitt & Mundt, 1993; Talbert et al.). Because teacher educators play an important role in developing teachers (American Council on Education, 1999; McGhee & Cheek, 1990) and shaping the future of agricultural education (Anderson, 1977), preparing pre-service teachers through problem-based learning may help them become more reflective practitioners more capable of solving the complex,

ill-structured problems they may face in their initial years of teaching.

Conceptually, teacher thinking and problem-solving are not new to agricultural education. Problem-solving approaches to teaching have been a standard method in agricultural education programs (Brown, 1998), and have changed very little from the early days of agricultural education (Straquadine & Egelund, 1992). One of the basic tenets of traditional problem-solving methods is the existence of a clearly defined problem (Hedges, 1996; Newcomb, McCracken, & Warmbrod, 1993; Stewart, 1950; Sutherland, 1948). Yet, researchers and practitioners alike would agree that the profession of teaching requires educators to make decisions about and act upon problems that are often complex and ill-structured. Schön (1983) noted that teaching as a profession requires the skill of inquiring into and reflecting upon complex problems, often in very ill-structured, demanding contexts.

Research comparing novices to experts in their cognitive processing abilities (Sweller, 1988) reveals that experts have more well-developed schemas or mechanisms for structuring and recognizing problems. Novices, as such, must refer to more rudimentary and generic mechanisms for approaching problem situations. Furthermore, research on the practice of expert versus novice teachers indicates that expert teachers have more efficient mechanisms for thinking about and solving the problems of practice, with student development as the central outcome (Fuller, 1970). While advanced cognitive processing abilities such as critical and creative thinking, analytical thinking, higher-order thinking, and metacognition have been espoused as the aims of an educational system, research regarding the widening gap between theory and practice in professional education indicates that few pre-service teachers leave higher education with the ability to think, process, and solve the ill-structured problems of practice.

The theoretical framework for the study was derived from Jonassen's (2000) meta-theory of problem-solving. One of the basic tenets of this theory (Jonassen) is that there are critical differences between well-structured and ill-structured problems, and that ability to solve well-structured problems does not translate to ability to solve complex, ill-structured problems. As opposed to well-structured problems, ill-structured problems are authentic or emergent, have unpredictable solutions, appear ill-structured because one or more of the elements are unknown, possess multiple solutions or solution paths, possess multiple criteria for evaluating solutions, and require learners to make judgments or are dependent upon learners' epistemological beliefs (Jonassen, 2000).

The use of authentic, problem-based cases is one method of creating a learning environment more similar to the types of problems encountered in professional contexts (Jonassen, 2000). Ill-structured problems tend to be highly bound by context. As such the context of teaching and learning for teachers of agriculture is potentially shaped by student, teacher, school, and FFA program related factors.

Thus, pre-service teachers of agriculture who learn how to manage, supervise, and discipline students in the role of an FFA advisor by reflecting upon *ill-structured* as opposed to *well-defined* problems would feel more prepared to handle difficult student problems in the future. The utilization of ill-structured problem-based cases has been determined to develop students' abilities to think and process at higher cognitive levels (Hernandez-Serrano, & Jonassen, in press). Further, problem-based case methods have been established as sound pedagogical tools for pre-service teacher education (Silverman, Welty, & Lyon, 2000). Yet, a paucity of research exists regarding the outcomes of utilizing ill-structured problems, as a pedagogical tool for the preparation of pre-service teachers of agriculture for the problems unique to the context of their practice. Research is needed to determine the outcomes of utilizing problem-based cases in agricultural education. The findings of such research could serve as a mechanism to help developing teachers solve ill-structured and complex problems related to the practice of supervising FFA activities.

Purpose and Objectives

The purpose of this study was to understand the outcomes of using problem-based learning cases by pre-service teachers to learn how to manage difficult student problems related to FFA supervision. The objectives of the study were to: (1) understand the perceptions of pre-service teachers regarding the *problem-solving outcomes* of utilizing the problem-based learning method to solve ill-structured problems; (2) identify the common themes of pre-service teachers' *learning outcomes* about FFA supervision that prepared them to deal with ill-structured student problems as future teachers; and, (3) identify common themes of *difficulties* pre-service teachers' faced when making decisions related to the ill-structured problems.

Methods and Procedures

The researchers of this collective case study (Stake, 2000) sought to explore and

understand the population of a cohort group of pre-service teachers in agricultural education at the University of Illinois. The target population that the researchers sought to generalize to consisted of a census of 22 pre-service teachers in a teacher education seminar. The seminar was conducted one semester before the student teaching internship. The students were randomly assigned ill-structured problems designed to prepare future agriculture teachers to solve difficult student problems related to the supervision of the FFA chapter. The ill-structured problems were written by the researchers based on authentic cases and involved: (1) theft on a field trip; (2) sexual activity in a motel room; (3) drug and alcohol use on a camping trip; (4) violation of good conduct policy; (5) academic ineligibility of the FFA chapter president; and (6) horseplay on the school bus at a convention. Three to four pre-service teachers were randomly assigned the same ill-structured problems and the groups discussed how to solve the problems using the satisficing or administrative decision-making model (Hoy & Miskel, 2001). The satisficing decision-making model is a model for solving ill-structured problems that involves defining a problem, considering the factors related to the problem, reflecting upon all possible problem-solution outcomes, and selecting the problem-solution that is most satisfactory relative to all of the factors involved (Hoy & Miskel, 2001).

In short, the satisficing model is a model of decision making for program managers, who in ill-structured contexts, recognize that multiple solution paths exist, but that the solution chosen should maximize positive outcomes while minimizing the negative outcomes of a problem. The pre-service teachers were encouraged to discuss their decision-making strategies in groups, but were asked to turn in assignments that were completed independently. The students were given three weeks to work on the assignment, which included three 50-minute sessions of in-class instruction: (a) establishing expectations; (b) making decisions using the administrative, satisficing model; and, (c) writing a 'bad news' letter. Students processed their ideas

among assigned groups, and the class shared individual problem-solving strategies among the large group, upon completion of the individual decision-making tasks.

Each pre-service teacher identified the short-term and long-term problems, analyzed the difficulties, defined a set of criteria for a satisfactory solution, outlined 17 alternatives and explained a plan of action for their assigned ill-structured problem. This protocol including: identification of short and long term problems, analysis, defining criteria, outlining alternatives and designating a plan of action is in accordance with the satisficing decision-making model (Hoy & Miskel, 2001). Then, pre-service teachers were taught how to write a 'bad news' or indirect letter to a parent of one of the students involved in the ill-structured problems. The pre-service teachers were provided scaffolding and examples of how to complete the major steps of the satisficing model and 'bad news' letter. Students completed a self-reflection in the seminar on problem-based learning on the day that they turned in their completed assignments. All of the pre-service teachers ($N = 22$) completed the reflection activity.

The reflection instrument used to collect the data of this study was a questionnaire containing nine items. The researchers created the instrument based on Jonassen's (2000) meta-theory of ill-structured problems. To measure objective one, five summated rating scale items (see Table 1) were included in the questionnaire that were designed to assess pre-service teachers' beliefs of problem-based learning. The scale was: (1) strongly disagree; (2) moderately disagree; (3) slightly disagree; (4) slightly agree; (5) moderately agree; and (6) strongly agree. In addition, four open-ended questions were used to ascertain the teachers' thoughts regarding the use of ill-structured problems related to FFA supervision in agricultural education. Two open-ended questions on the reflection instrument addressed Objective 2: *Learning Outcomes*: What do you know now about FFA supervision that you didn't know before you completed this assignment? How did this case study prepare you to deal with student problems as an agriculture

teacher? Finally, two open-ended questions on the reflection instrument addressed Objective 3: *Difficulties*: What was the most difficult aspect of trying to make a decision regarding your case? As a future agriculture teacher, how will you approach making difficult decisions related to supervising students?

Students were asked not to put their names on the questionnaires to protect the anonymity of, thereby preserving the integrity of, student responses. A panel of three teacher educators in Agricultural Education at the University of Illinois established content validity. The instrument was field tested with graduate students, in agricultural education, to establish face validity. A post hoc reliability test was conducted to establish reliability. Cronbach's (1951) alpha coefficient was 0.79 for the five, summated rating scale items (see Table 1) in the problem-solving domain.

Descriptive statistics were used to analyze the numerical data for Objective 1. The data set was analyzed using SPSS. The ordinal-level data from the five summated rating scale items were reported as frequencies. These five items were summed as the problem-solving domain and was reported as a population mean and standard deviation. For Objectives 2 and 3, the researchers' collected and interpreted the data using qualitative methods from a post-positivist epistemological stance (Lincoln & Denzin, 2000). Paper, pencils, and highlighter markers were used to help create organizers to code and summarize the qualitative data. Coding was used to analyze the qualitative data from the open-ended questions. The researchers created a coding scheme of the major concepts, central ideas, or related responses (Glesne, 1999). Trustworthiness and believability was established through the use of peer debriefing, member checks, an audit trail, and a reflexive journal (Donmoyer, 2001; Lincoln & Guba, 1985).

Results and Findings

Objective one was to understand the perceptions of pre-service teachers regarding the problem-solving outcomes of utilizing

the problem-based learning method to solve ill-structured problems. The mean of the problem-solving domain was $\mu = 4.89$ ($\sigma = .70$, $N = 22$). Table 1 reports the frequencies as percentages (N in parentheses) of the five items that comprised the problem-solving domain. Approximately 90% of the pre-service teachers agreed that they learned how to make decisions. Approximately 86% of the pre-service teachers agreed that they were more prepared to deal with student problems after the problem-based learning experience. Approximately 95% of the pre-service teachers agreed that the problem-based learning experience engaged them to think reflectively. Approximately 95% of the pre-service teachers reported that the ill-structured problems helped prepare them for similar situations they would face as agriculture teachers. All of the pre-service teachers agreed that the ill-structured problems engaged them to think of creative alternatives.

Objective two was to identify the common themes of pre-service teachers' *learning outcomes* about FFA supervision that prepared them to deal with ill-structured student problems as future teachers. The eight themes that subsequently emerged from coding the data for this objective are discussed in order of the most frequently mentioned to the least frequently mentioned by pre-service teachers.

Decision-Making Process

The first theme centered on aspects of engaging in the decision-making process. Pre-service teachers noted this outcome two times more often than any other theme. The pre-service teachers emphasized that the process of generating 17 alternatives caused them to think creatively. Pre-service teachers also stressed that they considered many factors when outlining the consequences for each alternative. They also stated that they learned to reflect upon the implications of the consequences for the students, parents, and the school community. A representative response from a pre-service teacher was, "There are many ways to think of solutions. Many will work, but some are more right than others."

Table 1
Pre-service Teachers' Perceptions of Learning Outcomes as a Result of a Problem-Based Learning Experience (N = 22)

Reflection Item	Level of Agreement, % (f)					
	1	2	3	4	5	6
I learned how to make decisions about resolving difficult student problems through this case study.....	0 (0)	9.1 (2)	0 (0)	18.2 (4)	59.1 (13)	13.6 (3)
I am more prepared to deal with student problems as an FFA advisor than I was before I studied this case.....	0 (0)	9.1 (2)	4.5 (1)	31.8 (7)	27.3 (6)	27.3 (6)
This case study engaged me to think reflectively.....	0 (0)	0 (0)	4.5 (1)	22.7 (5)	50.0 (11)	22.7 (5)
Completing this assignment helped me prepare for similar situations that I will face as an FFA advisor.....	0 (0)	0 (0)	4.5 (1)	22.7 (5)	40.9 (9)	31.8 (7)
This case study engaged me to think of creative alternatives.....	0 (0)	0 (0)	0 (0)	18.2 (4)	36.4 (8)	45.5 (10)

Scale: 1 = Strongly Disagree, 2 = Moderately Disagree, 3 = Slightly Disagree, 4 = Slightly Agree, 5 = Moderately Agree, 6 = Strongly Agree

Awareness of Problems

The second theme dealt with pre-service teachers developing a greater awareness of student problems than they had before participating in this problem-based learning experience. Pre-service teachers indicated that they were somewhat naïve in relation to the wide variety of problems that they may have to address in the future. An example of a frequent response from pre-service teachers stated, “It brought to life some real problems that we may think will never happen to us.” Pre-service teachers also stated that they are now aware of the stress that may occur when dealing with complex student problems as agriculture teachers.

Communicating Bad News

The third theme focused on what pre-service teachers learned about communication when dealing with ill-structured student problems. Pre-service

teachers stated that they learned how to write an effective ‘bad news’ letter to the parents of the students involved in the ill-structured problem. Pre-service teachers responded with comments such as, “I feel that I will be more prepared to address the parents if the need arises.”

Legal Issues, Liability Concerns, and School Policies

The fourth theme focused on pre-service teachers’ learning to consider legal issues, liability concerns, and school policies when faced with complex student problems. Pre-service teachers realized the necessity of understanding the proper procedures to follow when students are involved in illegal activity. Pre-service teachers also stated that they learned the importance of being informed about the policies contained within the school handbook. A pre-service teacher stated, “Now I realize that I must be aware of all school

policies and guidelines, and consider them each time I have to deal with a problem.” Furthermore, pre-service teachers also stressed that the criteria for establishing a solution should try to limit personal liability.

Teacher Comfort

The fifth theme to emerge was finding a decision that the pre-service teachers felt comfortable in making and implementing. Given the nature of the ill-structured problems, some decisions were considered difficult or challenging for students. Since no clearly right or clearly wrong solution path existed, teachers selected the problem-solution in which they ultimately felt the most comfortable with implementing. Pre-service teachers commented that their decisions must consider “...how I feel comfortable handling the situation.”

Dealing with the Individual

The sixth theme focused on dealing with ill-structured student problems on an individual basis. Pre-service teachers responded with comments such as, “I will always meet individually with the students.” Pre-service teachers also considered it was important to involve the individuals’ parents in determining the consequences for the students.

Career Preparation

The seventh theme to emerge was pre-service teachers feeling more prepared to deal with ill-structured student problems. Pre-service teachers indicated that they believed they were better equipped to deal with difficult situations as a result of engaging in the decision-making process. One pre-service teacher commented, “It showed me the procedure to follow when faced with a similar situation.”

Reaction Time

The eighth theme centered on pre-service teachers’ realization that they would need to reach a decision in a shorter amount of time in the real-world. Pre-service teachers felt that their reaction time should be faster than this assignment required it to be. A pre-service teacher

commented, “In the real world we won’t have 3 weeks to react. We will have 3 seconds.” Although this was an accurate observation, only a small proportion of pre-service teachers mentioned this particular learning outcome.

Objective three was to identify common themes of *difficulties* pre-service teachers’ faced when making decisions related to the ill-structured problems. Pre-service teachers discussed six common aspects that made their decision-making process difficult regarding the ill-structured problems. Although there were some similarities between learning outcomes and difficulties, the difficulties were reported separately from the learning outcomes because they represented a different aspect of the problem-solving process. The following themes are also presented in the order of frequency in which the pre-service teachers discussed them.

Deciding upon a Solution

The first theme to emerge identified the difficulties involved in deciding upon a solution to the ill-structured problem. Pre-service teachers stated that the solution must be fair, relevant, appropriate, and effective. Pre-service teachers frequently commented on difficulties they faced in “...deciding which action was best” and “...finding a solution that met all criteria.”

Teacher Reputation

The second theme focused on the need to protect the teacher’s reputation. Pre-service teachers found it difficult to determine a solution that was acceptable, yet maintained their authority and promoted respect among the students, parents, school, and community. A selected comment made by a pre-service student illustrated this concern, “The consequence had to help the program and my respect as an instructor.”

Keeping Other’s Interests in Mind

The third theme was that of considering others when making a decision. A typical response stated that it was difficult to “find a solution that is in the best interests of everyone involved.” The pre-service teachers were concerned about the

effects of their decision on students, parents, and the school community as a whole. Keeping other's interests in mind seemed to resonate in the minds of the pre-service teachers related to their consideration of the teacher's reputation and authority.

Developing Alternatives

The fourth theme to emerge was the difficulty pre-service teachers faced in developing 17 different alternatives for the situation. The pre-service teachers stated that this activity challenged them to think of creative alternatives. One pre-service teacher commented, "It was hard to think of 17 different alternatives that weren't completely off-the-wall." Although a few commented that they thought 17 different alternatives appeared to be a bit too much to do at first, several commented that it made them be more creative in thinking of possible alternatives.

Legal Actions

The fifth theme concerned issues pertaining to legal actions. Pre-service teachers stated that they faced several complications in making decisions that would require them to take legal action against their students. One pre-service teacher commented, "You don't want to call the cops on your own kids, but that may be the legal thing to do."

Teacher Comfort

The sixth and final theme of difficulties focused on finding a decision that was best for the teacher. In relation to evaluating the alternatives, a pre-service teacher stated that it was difficult to "...figure out which ones would work best for me." Pre-service teachers said they felt compelled to arrive at a decision that made them comfortable.

Conclusions, Recommendations, and Implications

Problem-based learning engaged pre-service teachers to be creative and reflective problem-solvers in making decisions related to ill-structured student problems. This is consistent with Schön's (1983) assertions of teachers as practitioners who must be reflective both in and about

action. The pre-service teachers learned how to creatively generate alternatives, become informed of personal interest, school policies, and liability concerns, determine potential consequences for each alternative, consider possible implications of the consequences, and make decisions in a more reasonable period of time. Furthermore, pre-service teachers reflected on several factors in making decisions through the use of ill-structured problems. The pre-service teachers reflected on their own comfort levels in making decisions and limiting liability concerns. They also considered students as individuals and including parents in reaching a decision or understanding the actions taken. Moreover, pre-service teachers reflected on school policies, liability concerns, and possible legal implications of their decisions.

Problem-based learning prepared pre-service teachers to solve similar ill-structured problems related to FFA supervision similar to those that they may face as future agriculture teachers. Anticipation and preparation are important variables to solving student problems (Hedges, 1997). Therefore, pre-service teachers felt that engaging in solving the ill-structured problems exposed them to a variety of situations that they did not consider before the problem-based learning experience. Pre-service teachers also learned how to apply the satisficing decision-making process to real-life problems and communicate their decisions to parents through a 'bad news' letter. Research in solving ill-structured problems indicates that students must experience ill-structured problems for those problem-solving skills to transfer to other ill-structured problems of every day practice (Jonassen, 2000).

Pre-service teachers faced difficulties in making decisions regarding the ill-structured problems. This finding is consistent with research in ill-structured problem solving practices in that students faced difficulties with the challenge of processing at higher cognitive levels, and processing cases that have multiple solution paths (Hernandez-Serrano & Jonassen, in press). They expressed the challenges associated with

thinking of creative alternatives, considering the interests of others, and taking legal action if necessary in reaching solutions that were fair, relevant, appropriate, and effective. The pre-service teachers felt that the solution should support their authority and reputation as a teacher and be one that they felt comfortable implementing.

Several recommendations emerged from the findings and conclusions. Teacher educators seek to prepare pre-service teachers for the challenges that they will face in the future as agriculture teachers. A problem-based learning experience with the same nature as the one described in this study may help prepare pre-service teachers to address ill-structured student problems. Teacher educators should reconceptualize the nature of the problems and approaches they use to teach pre-service teachers to solve authentic, real-world problems. Further, the satisficing decision-making model should be considered as an appropriate strategy to teach pre-service teachers to make decisions regarding complex student problems. Teacher educators should challenge pre-service teachers with ill-structured problems based on their own, and other, real-life experiences and problems faced in the field of teaching.

Agriculture teachers at the secondary education level often incorporate problem-solving techniques into classroom instruction and activities. These teachers may benefit from using ill-structured problems with their students. Activities and assignments that require students to derive solutions for ill-structured problems help to instill problem-solving skills within students. Students will be challenged to think creatively and reflectively about the problem.

This study was an exploratory investigation of the learning outcomes and difficulties of problem-based learning in a pre-service teacher education seminar. This study appears promising for further investigation and should be continued longitudinally and be replicated with more participants for greater generalization and transferability. Moreover, further investigation should use quasi-experimental or experimental designs to determine if problem-based learning is more effective

than other teaching methods. The ill-structured problems should be compared to determine if they result in different learning outcomes. Follow-up studies should be conducted to determine if the problem-based learning experiences helped pre-service teachers solve real problems they faced in the field.

Agriculture teachers face many ill-structured problems in their professional practice. It appears that engaging pre-service teachers in problem based learning to solve ill-structured problems of practice engages them to think and anticipate what they may face someday as agriculture teachers. Pre-service teachers who solve ill-structured problems will be more likely to anticipate student problems as FFA advisors and resolve them more quickly if, or when they occur.

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