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LEVELS OF COGNITION REACHED IN AGRICULTURAL DISTANCE EDUCATION COURSES IN COMPARISON TO ON- CAMPUS COURSES AND TO FACULTY PERCEPTIONS CONCERNING AN APPROPRIATE LEVEL

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Abstract

The purpose of this study was to describe and compare the assessed cognitive level of instruction in agricultural courses taught at a distance to findings from previous research involving on-campus courses and to professors' perceptions of an appropriate level. The populations for the study consisted of all Iowa State University College of Agriculture distance education courses (N=13) and their instructors (N=11) during a two-year period. Instructors desired to achieve practically identical cognitive level outcomes in on- and off-campus versions of their courses. Results of this study and previous studies of on-campus courses showed that instructors' actions did not match their aspirations. They surpassed their aspirations related to lower level (remembering and processing) cognitive outcomes and fell short of their aspirations related to higher level (creating and evaluating) cognitive outcomes. It was concluded that instructors teach to the same levels of cognition in on- and off-campus courses. In addition, results of this study show a relationship between the cognitive level of instruction and the delivery method used. The cognitive level of instruction in off-campus courses delivered by the Iowa Communications Network (ICN) was assessed to be higher than the other three delivery methods studied (i.e., videotape, ICN and videotape, videotape and live). Rival explanations for the ICN advantage were acknowledged.

Introduction

Do educators aspire to teach at higher cognitive levels and do they challenge their students to think? The role of the educator is not to transmit knowledge, but to challenge students to analyze, diagnose, and plan effective strategies (Knowles, 1970). In addition, the educator should encourage students to answer "why" questions. The process of asking and answering questions fosters critical thinking (Ennis as cited in Jones & Safrit, 1994).

Bloom, Engelhart, Furst, Hill, and Krathwohl's (1956) taxonomy of educational objectives can be used to define higher order thinking, or an interchangeable term – critical thinking (Jones & Safrit, 1994). Bloom et al. identified the cognitive levels of learning as: knowledge, comprehension, application, analysis, synthesis, and evaluation. Their taxonomy is hierarchical. Mastery at each cognitive level is dependent on the student being able to successfully complete tasks associated with the subordinate levels (Gilbert, 1992). Higher order or critical thinking requires students to utilize the higher level cognitive skills such as application, analysis, synthesis, and evaluation (Miller, 1990).

Newcomb and Trefz (1987) examined Bloom et al.'s taxonomy and condensed it into four cognitive levels. More specifically, they classified knowledge as remembering; collapsed comprehension, application, and analysis into processing; classified synthesis as creating; and aligned evaluation with evaluating. Newcomb and Trefz's model was developed for application to the college of agriculture teaching context. Their model provided the theoretical framework for this study.

Critical thinking is generally accepted as an important outcome of education by all academic disciplines (Presseisen, 1992; Resnick, 1987; Torres & Cano, 1995). In preparation for a more complex and technologically advanced society, agricultural faculty must challenge their students to attain the cognitive ability to solve problems, make decisions, and

integrate new technology (Torres & Cano, 1995). According to Newcomb (1995, p. 4) "the agricultural education way of packaging learning somewhat automatically ensures students will have to think at the higher levels of cognition." Is the agricultural education way of packaging used in college of agriculture courses? If so, does that necessarily mean that professors are teaching at high cognitive levels?

Studies have shown that professors in agriculture do not teach at higher cognitive levels. Whittington and Newcomb (1993) reported that less than 1% of instructional time was spent at the evaluation level of cognitive discourse in courses taught by 10 College of Agriculture faculty at The Ohio State University. In addition, high cognitive levels were not reached in agriculture courses regardless of class size or course level in courses taught by 16 faculty members in the College of Agricultural Sciences at the Pennsylvania State University (Whittington, Stup, Bish, & Allen, 1997). Furthermore, Whittington (1995) found that College of Agriculture professors at the University of Idaho aspired to devote approximately 46% of their instructional time to the highest levels of cognition (creating and evaluating), but the professors actually reached these levels less than 3% of the time.

Researchers have evaluated the level of cognitive discourse in the on-campus classroom, but no research has been published about the level of cognition reached in agricultural distance education courses. According to Verduin and Clark (1991), faculty and administrators often view distance education as inferior. However, studies have shown that distance education methodologies are as effective as traditional methodologies in terms of cognitive outcomes (Verduin & Clark, 1991). Jones and Safrit (1994) claim that distance education can provide a unique opportunity to incorporate and foster critical thinking through interaction and collaborative inquiry. Do instructors capitalize on this unique opportunity in the distance education environment?

Purpose and Objectives

The primary purpose of this study was to determine the cognitive level of instruction in agricultural courses taught at a distance. The objectives of the study were to:

1. Describe and compare professors' perceptions of appropriate cognitive levels of instruction for on-campus and off-campus versions of the same course.
2. Compare professors' perceptions of the appropriate cognitive level of instruction with the assessed level of instruction for their off-campus courses.
3. Compare assessed cognitive levels of instruction in off-campus agriculture courses to results of previous research pertaining to on-campus agriculture courses.
4. Compare cognitive levels of instruction in off-campus agriculture courses by delivery methods used.

Procedures

The populations for the study consisted of all Iowa State University College of Agriculture distance education courses and their instructors during the 1995 and 1996 calendar years. The populations consisted of 13 courses and 11 instructors from the departments of agricultural systems technology, agronomy, animal ecology, animal science, biochemistry and biophysics, entomology, horticulture, and sociology. The coordinator of the Off-Campus Professional Agriculture Degree Program provided the list of courses. The coordinator also confirmed the instructor of record and the method(s) of delivery used for each course. Each of the 13 courses was delivered in one of four ways. Three courses were delivered only through the Iowa Communications Network (ICN). The ICN is a two-way full motion video and audio delivery system linked through fiberoptics. Four courses were offered only by videotape. Five courses were offered by ICN and videotape. For these five courses, students in the ICN section(s) received instruction in real time while students in the videotape section(s) received videotapes of the ICN sessions. In one course, videotapes

were made from traditional on-campus classes and distributed to off-campus students. Videotapes were routinely made of all ICN- delivered courses. Therefore, videotapes were available for all 13 College of Agriculture distance education courses.

Courses ranged from freshman level to first year graduate level. Table 1 shows the relationship between course level and the delivery method used. There was a very strong (Davis, 1971) association between course level and delivery method (Cramer's V = .71). Notably, all courses offered by ICN only were at the senior or first year of graduate school level.

Tools used to gather data for this study included a form with six demographic questions and a place for instructors to grant permission to analyze videotapes of their course(s), an appropriate cognitive level of instruction instrument, and the Florida Taxonomy of Cognitive Behavior (Webb, 1970). The appropriate cognitive level of instruction instrument was patterned after one developed by Whittington and Newcomb (1993). It was designed to assess instructors' desired level of cognition for their courses. Instructors were asked to indicate the percentage of instructional time that they perceived to be appropriate to spend at each of Newcomb and Trefz's (1987) levels (remembering, processing, creating, evaluating) of cognition for on-campus and off- campus versions of the same course. To assist them in understanding each cognitive level, instructors received a list of verbs associated with each level of cognition.

Table 1
The relationship of course level to delivery method

	Delivery Method									
	ICN		Videotape		ICN and Videotape		Videotape and Live		Total	
Course Level	f	%	f	%	f	%	f	%	f	%
Freshman	-	-	2	50	1	20	-	-	3	23.10000000000000001
Sophomore	-	-	-	-	-	-	1	100.0	1	7.7
Junior	-	-	-	-	1	20	-	-	1	7.7
Senior	1	33.2999999999999997	2	50	1	20	-	-	4	30.80000000000000001
Graduate	2	66.70000000000000003	-	-	2	40	-	-	4	30.80000000000000001
Total	3	100	4	100	5	100.0	1	100.0	13	100.0

Note. Frequencies represent the number of courses. Cramer's V = .711

A memorandum was sent to each of the 11 instructors responsible for teaching the 13 off- campus courses explaining the purpose of the study and encouraging them to participate. The memorandum was followed by a phone call to schedule a face-to-face interview with each instructor. Interviews lasted approximately 30 minutes. During the interview, each instructor answered several demographic questions, completed an appropriate level of cognition instrument, and was asked to grant the researchers access to videotapes of their course. All instructors agreed to allow researchers access to course videotapes, and the response rate for demographic questions and the appropriate level of cognition instrument was 100%.

Videotapes from all 13 courses included in the population were analyzed. The videotapes were arranged chronologically, numbered, and divided into four equal periods of time. A stratified random sample of four videotapes was selected from each course for analysis. The sample was stratified by time period.

The Florida Taxonomy of Cognitive Behavior was used to determine the level of cognition in courses taught at a distance. Validity for this instrument was based upon its direct relationship to Bloom et al.'s (1956) Taxonomy. The instrument contained 55 action statements organized around Bloom et al.'s (1956) six levels of cognition. The data collector recorded whether or not each of the 55 actions occurred at six-minute intervals. Most of the videotapes were 120 minutes in length; thus, 20 intervals were analyzed for most tapes. To determine the percentage of instruction at each of Bloom's levels, the number of instructor actions observed at a given level was divided by the total number of actions observed. Finally, data were collapsed into Newcomb and Trefz's (1987) categories.

Inter- and intrarater reliabilities on the Florida Taxonomy of Cognitive Behavior were assessed. Intrarater reliability was enhanced by studying Bloom et al.'s (1956) Taxonomy, practicing on two videotapes not included in the study, and by discussing analysis procedures with Dr. Susie Whittington, a researcher with considerable experience in using this instrument. Intrarater reliability was measured by re-analyzing 10 videotapes one month after the initial analysis and determining the percentage agreement between the first and second analysis. Intrarater reliability was .98. Interrater reliability was determined by measuring the level of agreement between the data collector and Whittington in analyzing a tape used in this study. Interrater reliability was .82.

All data were analyzed with the SPSS for Windows personal computer program. Frequencies, percentages, means, and standard deviations were used for description.

Results

Of the 11 instructors, 10 (91%) were male. The instructors ranged in age from 39 to 64 years with a mean of 51.7 and a standard deviation of 6.7. A majority (63.6%) of instructors had a teaching appointment of 30% or less. The average teaching appointment was 38.4% with a standard deviation of 21.2. Instructors had, on average, taught for 23.5 years with a standard deviation of 7.5. Most (54.5%) instructors taught two courses per year. The average number of courses taught per year was 2.21 with standard deviation of 1.38. In regards to distance teaching, instructors had taught, on average, 1.64 course sections with a standard deviation of .67 at a distance in the last three years.

Table 2 shows that instructors perceived that it would be appropriate to spend 33.1% of their instructional time at the remembering level, 30.0% at the processing level, 19.2% at the creating level, and 17.7% at the evaluating level of cognition in on-campus versions of their courses. Similarly, they perceived that it would be appropriate to spend 31.2% of their instructional time at the remembering level, 30.8% at the processing level, 20.0% at the creating level, and 18.1% at the evaluating level of cognition in off-campus versions of their courses. Table 2 also shows the assessed level of instruction for the off-campus courses. Instructors spent 45.1% of their instructional time at the remembering level, 51.6% at the processing level, 3.1% at the creating level, and .1% at the evaluating level of cognition.

Table 2
Comparison of means and standard deviations for appropriate and assessed levels of cognition

Level of Cognition	Appropriate		Assessed
	Mean[a] (SD)	Mean[b] (SD)	Mean[b] (SD)
Remembering	33.1 (23.3)	31.2 (24.3)	45.1 (7.24)
Processing	30.0 (11.2)	30.8 (12.7)	51.6 (5.95)
Creating	19.2 (12.2)	20.0 (15.6)	3.1 (3.33)
Evaluating	17.7 (12.7)	18.1 (12.5)	0.1 (.49)

Note. Values presented are percentages.
[a] = On-campus. [b] = Off-campus.

Table 3 compares the assessed level of cognition from this study with the assessed level from three previous studies (Whittington & Newcomb, 1993; Whittington, 1995; Whittington et al., 1997b) of on-campus agriculture courses. Whittington and Newcomb (1993) studied 10 faculty members at the Ohio State University, Whittington (1995) studied 14 faculty members at the University of Idaho, and Whittington et al. (1997b) studied 16 faculty members at The Pennsylvania State University. Data show that the assessed cognitive level of instruction in off- campus courses was practically equal to the levels found in on-campus courses.

Table 4 compares the assessed cognitive level for off-campus courses by delivery method. Results show that courses taught through the ICN had less instructional time spent at the remembering level than courses taught using the three other modes of delivery. In addition, more instructional time was spent at the creating and evaluating levels in courses delivered by ICN than in courses taught using the three other modes of delivery.

Table 3
Comparing assessed level of cognition from this study with the assessed level from previous studies

Level of Cognition	Present Study %	1993[a] %	1995[b] %	1997[c] %
Remembering	45	42	43	47
Processing	52	53	55	51
Creating	3	5	1.5	1.5
Evaluating	<1	<1	<1	<1

[a] = Whittington and Newcomb (1993). [b] = Whittington (1995). [C] = Whittington et al. (1997b).

Table 4
Comparing assessed cognitive level by delivery method

Level of Cognition	Mean[a] (SD)	Mean[b] (SD)	Mean[c] (SD)	Mean[d] (SD)
Remembering	39.4 (3.5)	46.8 (7.0)	47.3 (8.1)	45.0 (4.1)
Processing	53.5 (5.1)	50.6 (5.0)	51.0 (7.3)	53.3 (4.3)
Creating	6.6 (3.4)	2.6 (3.2)	1.7 (2.00)	1.8 (2.2)
Evaluating	.5 (.9)	0.0 (0.0)	0.1 (0.2)	0.0 (0.0)

Note. Values presented are percentages.
[a] = ICN only, 12 observations taken from 3 courses. [b] = Videotape only, 16 observations taken from 4 courses. [c] = ICN and videotape, 20 observations taken from 5 courses. [d] = Videotape and traditional on-campus, 4 observations taken from 1 course.

Conclusions, Recommendations, and Implications

Instructors desired to achieve practically identical cognitive level outcomes in on- and off- campus versions of their courses. Results of this study like those of previous studies (Whittington & Newcomb, 1993; Whittington, 1995; Whittington et al., 1997b) of on-campus courses show that instructors did not achieve the levels of cognitive discourse to which their aspired. They surpassed their aspirations related to lower level (remembering and processing) cognitive outcomes and fell short of their aspirations related to higher level (creating and evaluating) cognitive outcomes. It was concluded that instructors teach to the same levels of cognition in on- and off-campus courses. This finding provides evidence to contradict faculty perceptions (Miller & Shih, 1998) that off-campus courses result in lower level cognitive outcomes than on-campus courses. While this may be viewed as positive by proponents of off-campus agriculture courses, the fact remains that the assessed levels of cognition were low in relation to what instructors perceived to be appropriate. Results of this study were shared with the participating instructors along with suggestions on how they might adapt their teaching to reach the levels of cognition to which they aspired. It was believed that positive change might result from individual faculty consultation. Whittington, Bowman, and Tirima (1997a) demonstrated that faculty development interventions can lead to a positive shift in the cognitive level of discourse of professors.

Results of this study show a relationship between the cognitive level of instruction and the delivery method. The cognitive level of instruction in off-campus courses delivered by ICN was assessed to be higher than the other three delivery methods studied. ICN is more like the traditional classroom than the other delivery methods. ICN-delivered courses allow for more real-time interaction between instructors and students, and this interaction may be a plausible explanation as to why instruction in ICN-delivered courses was assessed at higher cognitive levels. Why would interaction make a difference in ICN-delivered courses but not in the traditional on-campus setting? Off-campus learners are typically older and have more relevant real-world experience than the traditional undergraduate on-campus student. When given the opportunity to synchronously interact with the instructor, they may stimulate higher cognitive level discourse.

It is important to note that all ICN-delivered courses were at the senior or first year graduate level. Course level may have been a factor in selection of the delivery method and may provide a rival explanation for the finding that ICN-delivered courses were assessed at higher levels of cognition than the other three delivery methods studied. This study does not provide unequivocal evidence that delivery method influences cognitive level of instruction. Further research with larger samples allowing the potential influence of delivery method to be demonstrated across all course levels is needed. In addition, larger samples might make it feasible to statistically control for other potentially extraneous factors. In the mean time, it is recommended that instructors preparing to deliver courses off-campus consider the cognitive levels of the outcomes they desire for students. If a significant proportion of the outcomes is at higher cognitive levels, instructors should consider using ICN or other synchronous delivery media.

Faculty and administrators in universities are still interested in evidence that specific delivery media are effective in comparison to other media and to more traditional forms of education. In spite of evidence (Murphy, 1997) to the contrary, off-campus course are often perceived to be of lower value than on-campus courses (Olcott, 1991; Olcott & Wright, 1995; Wilson, 1991, Wolcott, 1996). This study provides further evidence that distance education courses in agriculture compare favorably to courses offered on campus. This is perhaps the most significant implication of the study. Special interventions designed to enhance the cognitive level of instruction in off-campus agricultural courses are not necessary. The perceived uniqueness of distance teaching by faculty might stimulate some otherwise disinterested parties to seek out workshops and other opportunities to enhance teaching. Getting faculty to participate in professional development opportunities because of personal concerns or interests related to teaching on- or off-campus has the potential to enhance teaching in both contexts.

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