

IMPROVING THE COGNITIVE LEVEL OF COLLEGE TEACHING: A SUCCESSFUL FACULTY INTERVENTION

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Abstract

Cognitive psychologists portray learners as processors of information "and assign critical roles to the knowledge and **perspective** students bring to their learning. Experience suggests that this **concept** from cognitive psychology holds considerable power for **educational** practices.

How are professors in a College of Agriculture performing? A variety of instruments including an attitude scale, a demographic form, and an assessment instrument were used in a three-year study of 28 purposefully selected faculty members from eight departments/schools in a College of Agriculture. The purpose of the study was to examine assessed cognitive level of discourse during year one, randomly engage participants in three levels of intervention during year two, and then reassess cognitive level of discourse during year three.

Following the nine-month intervention, percentage of discourse (when comparing year one to year three) delivered at the knowledge level decreased while percentage of higher level discourse increased. Also the number of participants who experienced positive change in delivering higher cognitive level discourse increased at the more-intense treatment level.

Educating professors regarding their cognitive level of instruction is necessary if change in cognitive level of teaching is to occur. Professors must rethink their approach to the use of in-class time if they are to conduct discourse at the higher cognitive levels.

Introduction

The arrival of the 1990s found the cognitive revolution moving forward at full speed. No longer were psychologists adhering to the traditional associationism (applying elementary laws of behavior and learning to more complex settings) and behaviorism (predicting and controlling behavior) as stand-alone theories. Instead, psychologists began studying subjects in light of individual observations, actions, and perspectives. This new "cognitive psychology" claimed that the purpose of scientific psychology was to notice observable responses of individuals in order to make inferences about unobservable, underlying factors that could potentially explain the actions seen (Glover, 1990, p. 2).

Cognitive psychologists portray learners as "processors of information" and assign critical

roles to the knowledge and perspective students bring to their learning. In the view of cognitive psychology, "that which learners do determines the level of understanding they ultimately achieve" (Glover, 1990, p. 1). Experience suggests that this concept from cognitive psychology holds considerable power for educational practices. For example, Perry (1978) suggested that consistent underlying cognitive structures acted as filters through which individuals viewed the world and that these structures assisted the individual in organizing and interpreting the classroom experience at hand. Simon (1976) suggested that when cognitive scientists do information-processing analyses of complex skills, they find the same kinds of basic problem-solving processes used in task after task. These "metacognitive skills" have been shown by Brown *et. al* (1983) to be characteristic of effective learners, good readers and writers, and

strong problem solvers. What, then, are professors doing inside classrooms to engage students in their roles as “processors of information”?

Practices Inside Classrooms

Professors have been accused of falling short of encouraging students to think beyond rote memorization of facts. Paul (1993) wrote, “Approximately 80% of teaching is at the didactic [knowledge] level, 14% at the tactical [comprehension, application] level (engagement without intellectual skill development), 4% at the analytic [analysis] level, 0.9% at the holistic [synthesis] level, and 0.1% at the exemplary [evaluating] level” (p. 27). Whittington and Newcomb (1993) studied 10 professors in a college of agriculture and reported that participants’ cognitive level of classroom discourse was distributed as follows: remembering [knowledge] level discourse was present 42% of the time, processing [comprehension, application, and analysis] oriented activities were used 31% of the time, while creating [synthesis] level discourse occurred 5% of the time and evaluating level discourse was present in the classroom less than 1% of the time.

In a study of college professors, Miller (1989) found that a preponderance of oral presentations by teachers typically reflected **thinking** at the lower levels of cognition. Fisher and Grant (1983) found that discourse in college courses was predominantly at the lowest levels of cognition, regardless of the kind of institution, course level, subject area, or length of topic or session. These findings are consistent with those of Pickford (1988) who reported that professors conducted 94% of their discourse at the knowledge, comprehension, application, and analysis levels of cognition.

Granted, fundamental instruction focusing upon facts, dates and theories is necessary and provides students with an essential foundation for

further learning, but the mere knowledge of facts is not a sufficient goal in education (Newcomb and Trefz, 1987; Cano, 1988). According to Beyer (1988), the ability to transfer knowledge and skills learned to other situations is the implicit goal of any educational endeavor. Gibson and Chandler (1988) wrote that the goal of education was to challenge students “to learn how to apply facts in new situations, to analyze and synthesize the information they take in, and, finally to make judgments about what they have found” (p. 433). Their goal of education was derived from a classification system for cognitive abilities developed by Bloom (1956).

Bloom’s Classification of Thinking Processes

The Taxonomy of Educational Objectives: Cognitive Domain, developed by Bloom et al. (1956), was built on a theory of varying levels of cognitive complexity. In Bloom’s hierarchy, students think beyond the two lower levels of mental processing, “knowledge” and “comprehension,” to the higher levels of, “application,” “analysis,” “synthesis,” and “evaluation”. Using Bloom’s Taxonomy as a framework for classifying levels of thinking provides focus and direction for professors interested in improving the quality of learning in their classrooms (Newcomb and Trefz, 1987; Cano, 1988).

Statement of the Problem

With increasing emphasis on students’ ability to demonstrate critical thinking skills, the need for instructors to “teach-by-example” and to provide structure for students to practice that type of higher order cognitive activity also increases. According to Meyers (1986, p. 47), “By modeling reflective thought in lectures and discussions, teachers can do much to encourage this frame of mind in their students.”

Purpose and Objectives of Study

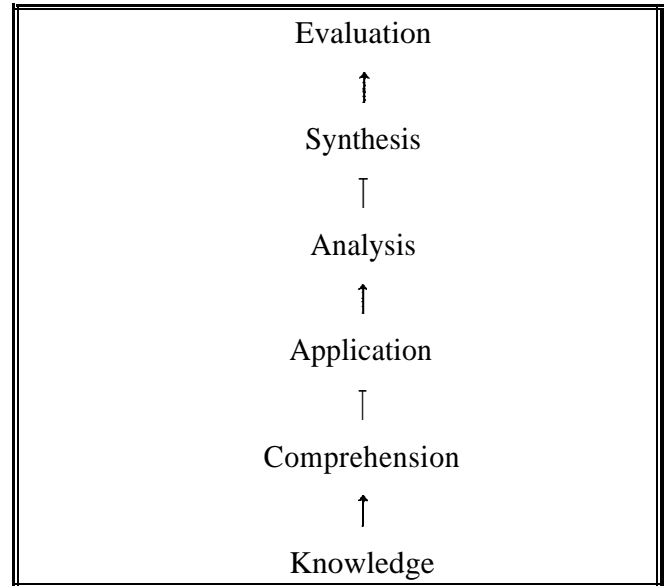
The purpose of this three-year quasi-experimental study was to assess the cognitive level of instruction in college of agriculture classrooms, design and implement a nine-month intervention, and determine the effects of the intervention among selected faculty members in a College of Agriculture. The study included an in-depth examination and compilation of 28 case studies. Specific research questions were:

1. At what level of cognition were participants teaching?
2. What treatment(s) can be developed and implemented that will influence the cognitive level at which professors teach?
3. Which observable classroom behaviors, found to enhance opportunities for students to think at higher cognitive levels, can be modified through intervention?

Procedures

Year one focused on gathering baseline data related to the cognitive level at which participants were teaching (Whittington, 1995). Thus, the cognitive level of classroom discourse (the formal speech or conversation delivered during class) was described using the Florida Taxonomy of Cognitive Behavior ("FTCB" by Webb, 1970). The FTCB utilized 55 categories of observable behaviors indicative of the various cognitive levels identified by Bloom's Taxonomy (see Figure 1). Validity for this instrument was based upon its direct development from Bloom's Taxonomy and the support generally given to this hierarchy of cognitive behaviors. Reliability for this instrument was established by coding audio-tapes of lectures and establishing Spearman Rho reliability coefficients. Intra-rater reliability was approximately $r = .96$. Inter-rater reliability between previous researchers and the two researchers in this study was approximately $r = .98$.

Figure 1 Bloom's Taxonomy -- A Hierarchy of Thought Processes



Participants were observed and audio-taped during **six** randomly selected class sessions, approximately every two weeks, but avoiding the first ten days and the **final** ten days of the semester. Participants were aware of the days the researchers would be in attendance. The observations were split evenly between two raters.

Year two involved the implementation of a nine-month exploratory intervention. Participants were randomly divided into three treatment levels designed to explore potential for influencing the cognitive level at which professors teach. The nature of the treatment level was explained to participants along with their random assignment to one of the levels. Descriptions of the treatment levels follow:

Awareness (Level I) - The researchers brought together participating faculty for a two-hour workshop to share and discuss results of previous cognition studies and to suggest techniques for teaching at higher cognitive levels.

Resources (Level II) - Participants attended

the same workshop (at the same time) as the participants in Treatment Level I. In addition, participants in Treatment Level II received, on a monthly basis for eight months (September-May, but avoiding March), reading materials and resources targeted at enhancing one's ability to teach at the higher levels of cognition. Each reading selection was accompanied by a cover sheet to be returned to the researchers. The cover sheet requested that readers describe how they would apply the concepts presented in the reading selection to their own teaching program. Returned cover sheets were used to assist in tracking readership and understanding of the materials presented to the participants. Specifically, resources included: Teaching for critical thinking (Chaffee, 1994); What happened to thinking? (Parker, 1993); Thought and knowledge (Halpem, 1984--divided into two readings); Critical thinking: How to prepare students for a rapidly changing world (Paul, 1993--selected excerpts); Discussion-method teaching: How to make it work (Wiley, 1989); Methods of teaching agriculture: Learning as Problem solving (Newcomb, McCracken, & Warmbrod, 1986--selected chapters); and, The Students Are... (Anonymous).

Development (Level III) - Participants attended the same initial two-hour workshop as participants in the other two groups. In addition, participants in Treatment Level III were involved in eight one-hour sessions (one per month from September-May, except March) to explore teaching so as to help learners operate at the higher levels of cognition. The monthly meetings took the form of a workshop and/or discussion group during which the following topics were addressed:

- Workshop #1. What did we learn (report of findings from year one)?
- Workshop #2. Writing objectives across the levels of cognition.

- Workshop #3. An introduction to learning styles.
- Workshop #4. Learning styles utilized in teaching across the levels of cognition.
- Workshop #5. Sharing your best-kept secret (a collection of thoughts and applications of techniques for teaching across the levels of cognition).
- Workshop #6. Questioning strategies for reaching higher cognitive levels.
- Workshop #7. Documenting your teaching effectiveness.
- Workshop #8. Barriers to teaching at higher cognitive levels.

During year three the baseline data collected during year one were collected again to determine the extent of change in the distribution of observed professor discourse, and thus opportunities presented for students to think across the levels of cognition.

Population and Sample

The accessible population for this study included faculty members on a college of agriculture campus who held a teaching appointment and were teaching at least one undergraduate course. To hold numerous variables constant, interviews were conducted with department chairs to determine faculty members who were "good teachers" as evidenced by interest in improving teaching, exit interview comments by students, attendance at teaching seminars, and student evaluations of teaching. From the list of nominees, 30 faculty members who taught freshman through senior level courses, were purposefully selected. These faculty represented all eight departments/schools in the college.

Dependent Variable

The previous three treatment levels were designed and implemented to allow researchers opportunities to measure change, if any, in the cognitive level of discourse used by professors in college of agriculture classrooms following the treatment.

Data Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) on the mainframe at the Pennsylvania State University. More specifically, frequencies of behaviors observed across all cognitive levels were totaled. Then frequencies within each cognitive level were divided by the overall total to acquire percentages of classroom discourse at each cognitive level. Cross-tabulations, frequencies, and means were calculated.

Results

Attitude Toward Teaching at Higher Cognitive Levels

Participants completed a 50-item Likert scale designed to measure their attitude toward teaching at higher cognitive levels. The mean score on this instrument was 232 (range = 181 to 266). A six-point scale would afford a low score of 50 and a high score of 300. Therefore, the mean score indicated that participants held attitudes which favored teaching at higher cognitive levels.

Assessed Cognitive Level of Instruction--Year One

The discourse of participants during year one was assessed to be approximately 88% at the lower cognitive levels (knowledge = 47%, comprehension = 33%, application = 8%). Participants' discourse was approximately 10% at the analysis level, 1.5% at the synthesis level with a range of 0 to 6%. Evaluation level discourse

was assessed at less than 1%

Discourse most frequently used in classrooms is noted in Table 1. As can be seen, a professor most often "Identifies something by name". "Gives a specific fact" was the item observed second most frequently. Note that items occurring most often (rated first, second, or third) were all at the "knowledge" (lowest) level of cognition. None of the 10 most observed items were at the "analysis, synthesis, or evaluation" (higher) levels of cognition.

Table 1 Classroom Discourse Most Often Presented in Year One

Discourse by Cognitive Level	Rating
Knowledge	
Identifies something by name	1
Defines meaning of term	3
Gives a specific fact	2
Tells about an event	10
Gives steps of a process	9
Comprehension	
Gives concrete example	4
Verbalizes from a graphic	5
Gives a reason/tells why	6
Shows similarities/differences	8
Application	
Applies previous learning	7

Note. No analysis, synthesis, or evaluation occurred in the 10 most frequently observed items.

Assessed Cognitive Level of Instruction--Year Three

The discourse of participants during year three (following the intervention) was assessed to be approximately 79% at the lower cognitive levels (knowledge = 36%, comprehension = 37%, application = 6%). Participants' discourse was approximately 14.5% at the analysis level and 4% at the synthesis level. Evaluation level discourse was assessed at 2%. Discourse most frequently used in classrooms during year three is noted in Table 2. As can be seen, professors most often

“gave concrete examples.” “Giving reasons/telling why” was the item observed second most frequently. Note that items occurring most often (rated first or second) were at the “comprehension” level of cognition. The third most observed item, “shows interaction or relationships” was an “analysis” level item. No items in the ten most observed were “synthesis, or evaluation” (higher) cognitive level items.

Table 2 Classroom Discourse Most Often Presented in Year Three

Discourse by Cognitive Level	Rating
Knowledge	
Identifies something by name	5
Defines meaning of term	8
Gives a specific fact	6
Tells about an event	9
Gives steps of a process	4
Comprehension	
Gives concrete example	1
Verbalizes from a graphic	7
Gives a reason/tells why	2
Shows similarities/differences	4
Shows cause/effect	4
Application	
Applies previous learning	10
Analysis	
Shows interaction or relationships	3

Note. No synthesis or evaluation occurred in the 10 most frequently observed items. Three items are listed as fourth most frequent.

Change in Prevalent Classroom Discourse

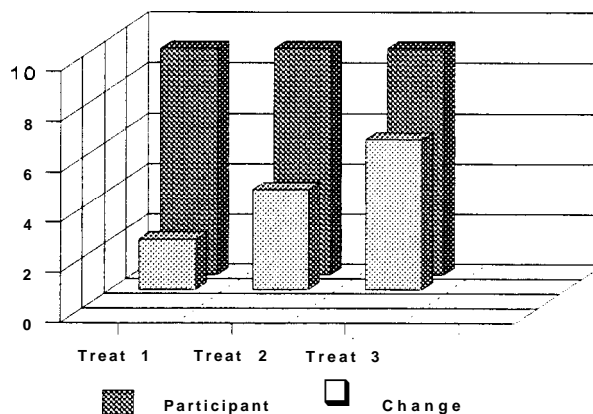
As noted above, the frequency of knowledge level discourse decreased while the frequency of observed behaviors at the higher cognitive levels increased. More specifically, the frequency of knowledge level discourse presented in selected college of agriculture classrooms decreased from 47% to 36%, comprehension level discourse increased from 33% to 37%, and application level discourse decreased from 8% to 6% while analysis

level discourse increased from 10% to 14.5%, synthesis level discourse increased from 1.5% to 4%, and evaluation level discourse increased from .6% to 2%.

Change in Participants per Treatment Level

As can be seen in Figure 2, of the nine participants in Treatment Level I (Awareness), one professor experienced at least a 10% cognitive level shift in discourse delivered in the classroom. In other words, there was at least a 10% decrease in frequency of discourse delivered at the knowledge level while there was a 10% increase in frequency of discourse delivered at the analysis, synthesis, and evaluation levels. For Treatment Level II (Resources), four professors changed by at least 10%, while at Treatment Level III (Development), six professors experienced at least a 10% cognitive shift in observed discourse delivered in the classroom.

Figure 2 Change in Participants per Treatment Level



Note. Treatment Level I = Awareness, Treatment Level II = Resources, Treatment Level III = Development

Conclusions

The following conclusions were drawn from the data analysis. Since the population was purposefully selected, these conclusions cannot be

generalized beyond the participants of this study.

1. During year one, faculty members in this study delivered discourse primarily assessed to be at the knowledge level of cognition; none of the ten most frequently observed behaviors were delivered at the higher cognitive levels.
2. During year three, participants in this study delivered discourse items that were primarily assessed to be at the comprehension level of cognition; one of the ten most frequently observed behaviors was delivered at the analysis level of cognition.
3. Following the nine-month intervention, the percentage of classroom discourse delivered at the knowledge level decreased while the percentage of classroom discourse delivered at the analysis, synthesis, and evaluation levels increased.
4. Following the nine-month intervention, at least one participant in each group -- awareness, reasons, and development, experienced a change in the frequency of classroom discourse delivered at the higher cognitive levels. The percentage of participants who experienced positive change in delivering higher cognitive level discourse, increased as the treatment became more intense. Thus, a greater number of participants in the "monthly workshop" group, were found to have increased their cognitive level of classroom discourse.
5. Although cognitive level of discourse in college classrooms was altered through intervention, a preponderance of discourse continues to be delivered at the lower levels of cognition.

Discussion

Participants in this study taught courses in various subject matter areas. They taught the courses to freshman through senior level students. However, professors conducted the predominant percentage of classroom discourse at the two lowest levels of cognition regardless of the course level, class size, semester, or subject matter. This issue is consistent with a concern of Fisher and Grant (1983) who also found that discourse in college courses was predominantly at the lowest levels of cognition, regardless of the course level or subject area. This seems to defy logic that would suggest that the distribution of discourse towards the higher levels of cognition would tend to occur as students moved toward the conclusion of their studies in most fields of agricultural sciences.

Professors in this study conducted discourse at lower levels of cognition 88% of the time in year one and 79% of the time in year three. These data are consistent with findings of Pickford (1988) and Miller (1989) who reported that professors conducted a preponderance of discourse at the lower levels of cognition. However professors in their studies conducted much higher percentages, 94% and 98%, respectively, of their discourse at lower levels than did the professors in this study.

Newcomb and Trefz (1987) found that professors wanted to change their cognitive level of discourse. Underbakke et al. (1993) reported that the thinking ability of students could be improved. This study revealed that behaviors known to demonstrate increased cognitive activity during class could be changed through intervention. For example, following the nine-month "Development" intervention, participants experienced an increase in the frequency of classroom discourse delivered at the analysis, synthesis, and evaluation levels. Specifically, a positive change occurred in the opportunities given to students to "show cause and effect relationship", "apply previous learning to new

situations”, “show interaction or relation of elements”, “check hypotheses with given information”, and “evaluate from a given criterion”. Thus, professors, following the intervention, increased the opportunities given for students to utilize their thinking capacities at the higher cognitive levels.

The power of intervention was revealed through this study. Faculty members in departments of agricultural and extension education possess a knowledge base in methods of teaching and pedagogy that must be shared in a non-obtrusive manner with colleagues; a faculty intervention model is worth exploring. Faculty intervention has now been used to make a positive difference in the cognitive level at which professors deliver classroom discourse.

Recommendations

1. Professors must change their approach to the use of in-class time if they are to conduct discourse at the higher cognitive levels. In fact, it is likely that there must be less teacher-discourse if there is to be more opportunity for students to improve their ability to operate at the highest levels of cognition.
2. Educating professors regarding their cognitive level of instruction is necessary if change is to occur. Professors aspire to teach at higher cognitive levels because they theoretically see the benefits of teaching at higher cognitive levels, but they are not reaching the higher cognitive levels. The problem, therefore, could be lack of knowledge of techniques and methods used to model higher cognitive levels of instruction. Intensive, long-term workshops and seminars need to be developed and offered to those faculty who desire changes in their cognitive level of teaching.
3. As agricultural educators with expertise in pedagogy, important responsibilities accruing to faculty, not only include preparing preservice teachers of secondary agriculture and extension personnel, but also educating colleagues in colleges of agriculture on current teaching issues. The issue of teaching higher order thinking skills must be addressed in today’s learning environment. Every reason exists for teacher educators in agriculture to lead this cause.
4. Agricultural educators who possess the capability to prepare persons for teaching at higher cognitive levels will be called upon by university and college-wide teaching committees, curriculum committees, assessment committees, and planning committees to offer valuable input into the enhancement of teaching. The challenge must be accepted and fulfilled.
5. Professors should stimulate higher order thinking in students by, first, becoming familiar with the literature on critical thinking skills. Next professors can develop and distribute to students at the beginning of the course a list of critical questions to ask oneself about the course materials. Then encourage use of the list through homework assignments and through classroom questioning techniques. Working through the list aloud, in front of the classroom, will be necessary at first such that students see the thinking process modeled verbally in class.
6. A nine-month intervention, one hour each month, on developing thinking skills through class sessions should be designed and offered to faculty members as an approach to enhancing thinking skills of students in college of agriculture classrooms.

Recommendations for Further Research

1. Exploring the barriers to teaching at higher cognitive levels. Are the barriers suggested by the members of this study valid? Are there others? What can be done to overcome the barriers to teaching at higher cognitive levels?
2. Examining variables, other than the teacher, which influence cognitive levels reached in classrooms. What proportion of the students' cognitive development is acquired through academic challenges (i.e. tests, quizzes, and assignments), labs, or field trips? What are professors doing with this opportunity? Does the weighting of academic challenges (when figuring final grades for the course) reward higher cognitive activity?
3. Establishing a clear positive effect between cognitive level of instruction and long-term learning and transfer of learning. How much of that which is tested is remembered six months after the test? Does the cognitive level at which items were asked contribute to long-term knowledge attainment and use?
4. Describing the procedures currently in place for improving college teaching. Are faculty aware of higher order thinking literature and the techniques available to assist faculty in teaching thinking skills? Where in the existing higher education faculty development structure is there opportunity for intervention with small groups of faculty?

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