Selected Student and Professor Variables
Related to Cognitive Achievement in
College of Agriculture Courses

Thesis

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by

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* * * *

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This study is dedicated

... to my parents, John and Barbara Chandler, for their love and wisdom as parents, their belief in the worth of the inquiring mind, and their values of respect for life and service to others.

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CHAPTER I

NATURE OF THE STUDY

Introduction

The decade of the 1980's has witnessed mounting concern in society about the quality of education from grade school through college. In 1981 The National Commission on Excellence in Education was created to examine and report to the nation about the quality of education in the United States. The Commission resulted from "the widespread public perception that something is seriously remiss in our educational system" (National Commission on Excellence in Education, 1983, p. 1). The Commission argued that our nation was at risk:

"...the educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people. What was unimaginable a generation ago has begun to occur--others are matching and surpassing our educational attainments." (p. 1)

One of the themes considered by the National Commission has been variously labelled critical thinking,
higher level thinking, or problem solving ability. Bloom et al. (1956) used the term intellectual skills and abilities and argued its presence when the individual can locate and bring to bear appropriate information or techniques from previous experience on new problems or situations (p. 38). The National Commission heard evidence that indicated that many students did not possess "higher order" intellectual skills (National Commission on Excellence in Education, p. 9). For instance, they were told that forty percent of 17-year-olds could not draw inferences from written material and only one-third could solve multiple step mathematics problems. The lack of emphasis on comprehension, analysis, and problem solving was viewed with concern (p. 10). The Commission recommended that problem solving skills be developed in the first eight grades (p. 27). Recommendations for the high school curriculum included English instruction which would equip students to comprehend, interpret, evaluate and use written material and science instruction in the methods of scientific inquiry, reasoning, and application to everyday life (p. 25).

Reflection on student needs at the college level has indicated concerns similar to those voiced for secondary school students. Looking at a national level, Boyer (1987) summarized, "Clear and effective writing and
critical thinking are, we said, the most essential skills both for further education and for work."

Concern regarding the development of intellectual skills and abilities has also been voiced both by agricultural educators and by the Curriculum Review Committee of The Ohio State University. The Babcock Report (1987) argued that universities must be "chiefly concerned with developing and enhancing the inquiring mind" (p. 1). This report maintained that "the ability to engage in careful logical thinking and critical analysis..." (p. 5) is one attribute of the educated person.

Regarding education in agriculture at the college level, Poulton (1985) argued that critical thinking and applied problem solving techniques are a major goal. Fincher (1977) contended further that one of the variables affecting learning was discussion which focused on student cognitive development and not just facts and figures. The reasoning for increased emphasis on intellectual skills and abilities is explained well by Kuhn (1977).

...the total mass of knowledge learned is so great that none of it can be learned well. Too often students are required to memorize a body of facts which are much easier to forget than to remember. Teaching for permanent learning must go beyond
dissemination of information to the development of student interest and thinking abilities.

Through thinking, students become actively involved in learning. This leads to increased retention...the number of associations made with the material is increased [and] the likelihood that a needed fact will be recalled is directly proportional to the number of its associations. Second, thinking results in the arrangement of facts in memory...associations with well organized material are retained much longer than a disorganized mass of associations. (p. 14)

The dilemma that agriculture instructors face at the college level is pronounced. Knowledge in agriculture is expanding rapidly across a wide range of subject areas (Newcomb & Trefz, 1987). Thus agriculture instructors must carefully and critically examine both the content and the skills and abilities to be taught in their courses.

The theory for cognitive research was laid by Bloom et al. (1956) in *Taxonomy of educational objectives*. Handbook I: The cognitive domain, referred to herein as Bloom's Taxonomy. The Taxonomy is based on a cumulative hierarchy of cognitive levels beginning with knowledge, and moving through comprehension, application, analysis, synthesis and evaluation. Bloom et al. (1956) postulated that higher levels included and were dependent upon the
lower levels. For instance, a student must be able to recall and understand facts before these facts can be applied to a new situation.

Bloom and his colleagues justified the importance of the higher level intellectual abilities and skills based on an analysis of society, available knowledge, and the kinds of citizens we need to develop. They argued that since we live in an unpredictable and rapidly changing society, there is a need for education which helps students develop methods and processes of attacking problems (p. 40). Additionally, since it is not possible to give students all the knowledge they will ever need, especially in fields in which knowledge is expanding rapidly, the acquisition of knowledge should be based upon what has been most useful in the past and what will most likely enable the student to adapt that knowledge to new situations (p. 41).

Societal values also indicate the need for intellectual skills and abilities. Mature individuals are expected to independently solve problems based on their own thinking. This maturity and independence is considered critical not only to individuals but to a democratic society. Citizens must be capable of making informed judgments about governmental problems and the political future in an effective democracy (Bloom et al., p. 41).
In addition to the need for intellectual skills and abilities based on values, a theoretical justification can be made for the development of higher level thinking skills based on learning efficiency. That is, since higher level thinking includes knowledge, the higher order intellectual skills and abilities should be more widely applicable (Bloom et al., 1956). Ryan (1973) confirmed this theory at the elementary level. He found that higher level classroom questioning was more efficient than low-level questioning in promoting both high and low-level understanding on both achievement and retention tests. However, similar studies are lacking at the college level.

Since Bloom and his colleagues laid a theoretical basis for the importance of the development of intellectual skills and abilities, the theories have been tested and applied both in research and in the classroom. Much of the application and research, though, has focused on grades K - 12. The taxonomy has been used to train teachers to analyze and improve their cognitive level of teaching at the primary and secondary level (Clegg, Farley, & Curran, 1957; Willson, 1973). It has also been used as a basis for developing tests at the sixth grade (Hunkins, 1968).

At the college level, the taxonomy has been both proposed and used as a basis for classifying the cognitive levels of tests and assignments (Chuatong, 1985; Newcomb
and Trefz, 1987). Fischer and Grant (1983) studied the cognitive processes used by both teachers and students in undergraduate classrooms at both small and large institutions. They found that the range of cognitive processes used was limited, with most discourse occurring at the lower levels. Further research is needed to describe existing levels of instruction at the college level. Further, if the level of cognitive achievement is to improve, educators need additional information about instructional variables which correlate with student achievement at higher cognitive levels. However, few studies have been conducted at the college level which have sought to explain or predict student acquisition of intellectual skills and abilities based on either instructional or evaluation variables.

**Problem Statement**

The purpose of this study was to determine the level of cognitive achievement by students in selected College of Agriculture classes. The study sought to relate cognitive achievement in these classes to selected teacher and student variables including cognitive level of instruction and cognitive level of tests and assignments. Previous experience with course content, professor expectations for the course, student cognitive abilities before entry in the course, and interest in and value of the course to the student were also considered.
Research Questions

The questions which this study sought to answer were:

1. What cognitive level was achieved by students in selected College of Agriculture courses?

2. At what cognitive level of instruction did selected College of Agriculture professors teach?

3. To what extent were selected variables correlated with student's cognitive level of achievement? The following variables were examined:
   a. cognitive level of instruction
   b. instructor's cognitive expectations for the course
   c. cognitive level of assignments, quizzes and mid-term examinations
   d. students' prior experience with course content through previous college courses, high school courses, and work experiences
   e. motivation of students regarding the course
   f. students' academic rank
   g. instructor's academic preparation, previous course experience, work experience, and professional interests
Need for the Study

The development of quality teaching is especially important at this time. Not only is there widespread concern throughout the nation about education, but those teaching agriculture face additional hurdles. Knowledge continues to grow rapidly, especially in certain areas of agriculture, so instructors are faced with difficult decisions about what content is critical. Additionally, the College of Agriculture has faced declining enrollments every year but one since 1980 (Darrow, 1988).

Selected instructors in the College of Agriculture at The Ohio State University have expressed interest in and have worked with faculty in the Department of Agricultural Education with the goal of examining and improving the quality of instruction in the college at the undergraduate level. Newcomb and Trefz (1987) conducted a study which determined the levels of performance required on tests and assignments and found that 37% of the learning was at the remembering or knowledge level for all sixteen classes. This proportion at the remembering level is lower than that found by other researchers. In a summary of research on the types of classroom questions asked by the instructor at the primary and secondary levels, Gall (1970) reported that 60% were recall and only 20% required student thinking. However, Newcomb and Trefz (1987) studied a purposive sample, and comparisons between
classroom questions and tests and assignment may not be sound.

While there is some research indicating the important variables to consider in developing intellectual skills and abilities, little of this research has been conducted at the college or university level. If instructors in the College of Agriculture are to improve their ability to teach students the intellectual skills and abilities necessary, they need additional research. The aim of this study was to contribute to the knowledge about the factors which are most important in providing students a foundation for increasing their abilities to think critically and to solve problems.

Limitations of the Study

Due to a change in research staff at the very time this study was scheduled to begin, several limitations in this research were present. Description of the major limitations follows.

Only three instructors and classes were used in the study. With such a small number of classes, it is not possible to generalize beyond these classes.

Second, arrangements with instructors were not finalized until the second week of classes. This fact had several consequences. One was that the number of observations of teaching had to be reduced from five to three. The second consequence related to the
administration of student instruments. Two of these instruments were to be completed in class; instead they were distributed in class and completed at home. This led to a poor return rate for both instruments and questionable data for the instrument that was designed to be a timed test.

The instrument that should have been a timed test was designed to measure cognitive abilities before entry into the class. In addition to the lack of control over completion of this test, the instructions for completing the test were found to be incomplete after all the data had been collected. Finally, the returns for this instrument were very uneven among classes. As a result of this combination of problems, this instrument was not utilized in the final data analysis; thus the study was not able to examine the relationship of previous cognitive abilities to cognitive achievement.

An unforeseen problem was encountered in measuring the dependent variable, each instructor's final exam. None of the exams contained questions at each of the levels, so measuring student achievement was only possible at the levels tested. In addition, the levels tested showed wide variation between the three instructors; thus comparisons of achievement among classes was difficult.
CHAPTER II
REVIEW OF LITERATURE

A survey of literature related to cognitive achievement of students was conducted which revealed a considerable amount of information. This review begins with the theoretical foundation for evaluating cognitive levels based on Bloom's Taxonomy (1956). The uses of the Taxonomy will be considered, including an examination of levels of cognition in classrooms. Factors affecting or related to cognitive achievement will be surveyed. Finally, a theory supporting classroom observation will be explicated.

Theoretical Basis for Cognitive Levels

The foundation for research into and application of levels of cognition was laid by Bloom et. al. (1956) in Taxonomy of Educational Objectives, Handbook 1: Cognitive Domain. The Taxonomy was built on a theory of varying levels of cognitive complexity. It has been used in hundreds of research projects since its inception (Furst, 1981).
Taxonomy of Educational Objectives: Cognitive Domain

The Taxonomy was developed to provide a basis for communication between educators. Specifically, the authors of the Taxonomy intended it to be used for the classification of educational goals, as an aid for the development of curricula, and as a basis for the construction of evaluation procedures (Bloom et al., 1956). The Taxonomy includes six levels. The top five levels involve intellectual abilities and skills which refer to "organized modes of operation and generalized techniques for dealing with materials and problems" (Bloom et al., 1956, p. 204). A brief description of each level follows.

Knowledge - Knowledge entails the recall of specific facts, rules, processes, and methods. It also includes knowledge of structures, principles, theories, and generalizations within a given field. This level involves remembering as the major psychological process (Bloom et al., 1956) and is the lowest level of cognition. Higher levels of cognition in any field build on and depend upon knowledge.

Comprehension - This level is considered the lowest level of understanding. Comprehension reflects an understanding of and ability to use knowledge. The individual will not necessarily be able to relate this knowledge to other material or to see the full
implications of the material. Comprehension includes translation (the rephrasing of information), interpretation (the rearrangement or reordering of material), and extrapolation (the extension of information in accordance with the original details) (Bloom et al., 1956).

**Application** - This level involves the use of knowledge of facts and abstractions in concrete situations.

**Analysis** - Analysis entails the division of material into component parts so that subordinate ideas are made evident or a hierarchy of ideas is clarified. Analysis is intended to clarify information through an understanding of the arrangement and organization of the material as well as how the material communicates (Bloom et al., 1956). Bloom et al. detailed three components of analysis: analysis of elements, analysis of relationships, and analysis of organizational principles.

**Synthesis** - In synthesis, one must put together components or constituent parts to form or create a new whole. It involves "working with pieces, parts, elements, etc., and arranging and combining them in such a way as to constitute a pattern or structure not clearly there before" (Bloom et al., 1956, p. 206). Synthesis includes production of a unique communication, a plan or proposed
set of operations, or the derivation of a set of abstract relations.

**Evaluation** - This level involves judgments of value regarding material or methods for given purposes. Evaluation entails the use of criteria or standards which may be externally provided or derived by the student. Criteria are used to make quantitative or qualitative judgments about materials or methods (Bloom et al., 1956).

The Taxonomy is based on the assumption of a cumulative hierarchy. That is, each level makes use of and builds on the preceding levels. The educational behaviors described in the Taxonomy begin with the simple and move toward the complex, thus implying that achievement at higher levels entails greater difficulty.

**Confirmation of and Challenges to Bloom's Taxonomy**

Although the Taxonomy has been widely used, it has not been without critics. Criticism of the Taxonomy has been based in two major areas, reliability and validity.

If the Taxonomy is valid it must, in fact, measure what it purports to measure. The issue of validity has been examined from a number of perspectives, including philosophical and practical considerations. Although the Taxonomy seeks to maintain neutrality (Bloom et al., 1956), Furst (1981) points out that the Taxonomy is based on certain philosophical assumptions. One assumption is that cognitive activities can be classified as intended
student behaviors. Thus, it is limited to an evaluation of intended student behaviors which may not adequately cover outcomes not easily specified in such a manner.

Furst (1981) also criticizes the Taxonomy for separating the cognitive from the affective. The Taxonomy "may well be a classification of cognitive processes but whether it can then serve as a classification of educational objectives is a further question" (p. 445).

The validity of the hierarchy of the Taxonomy has also been questioned. Furst (1981) raises doubts as to the philosophical basis for this hierarchy noting that "dissecting the cognitive domain into distinct, linearly ordered categories has drawbacks. Inversions occur and there is frequent overlap between and within categories" (p. 447).

The most comprehensive studies of the validity of the hierarchy were conducted over a three year period by Kropp and Stoker (1966) and Stoker and Kropp (1964). Their research used 1,000 high school students in a variety of subject areas. The results of these studies showed that as the cognitive level increased the mean performance scores decreased for all grades in social studies. In science, the same results occurred except that synthesis and evaluation were reversed. Kropp and Stoker concluded that their data supported the imputed hierarchical structure, although they reported a lack of conformity of
evaluation to the hypothesized order. Additional studies further confirmed the assumption of the cumulative hierarchy (Roberts, 1974; Smith, 1968).

A second comprehensive analysis of the Taxonomy was conducted by Madaus, Woods, and Nuttall (1973) in which the researchers sought to measure the links between the various levels. They also took into consideration the "g" factor. The "g" factor was a measure of mental ability and was considered because of Ebel's contention (1969) that achievement tests constructed using the Taxonomy measured mental ability rather than command of knowledge. Using Kropp and Stoker's data, Madaus et al. (1973) found eight out of ten strong indirect links between non-adjacent levels, although only one indirect link, between comprehension and analysis, remained upon removal of the "g" factor. They found that the direct links between adjacent levels were also very dependent on the "g" factor. In addition, the strength in the magnitude of the direct link declined as the levels became more complex.

Madaus, Woods, and Nuttall (1973) raised questions similar to those raised by Kropp and Stoker (1966) regarding evaluation and synthesis. The results of the Madaus, Woods, and Nuttall study (1973) and work by Seddon (1978) suggest that evaluation and synthesis are not strongly linked with each other and that they may not be highly dependent on integration with lower level
behaviors. Preliminary analyses from the Madaus et al. (1973) research suggested a Y-shaped structure (Figure 1).

**Figure 1**

*Proposed Linkages Between Levels of Cognition*

---

**Evaluation**

**Analysis**  **Synthesis**

**Application**

**Comprehension**

**Knowledge**

Further studies have raised questions about the hierarchical assumption for specific levels. Smith (1965) found no support for the hierarchy between knowledge and comprehension for a group of college students. Seddon (1978) argued that the strongest support for the hierarchy exists among the bottom four levels, knowledge, comprehension, application, and analysis. A researcher with first year medical students designed parallel tests which assessed knowledge at different levels (Blumberg,
1982). This researcher found that when content was held constant, students had no more difficulty answering higher-level questions than those requiring less complex thinking. These results could be explained by the population used, but do indicate some caution in accepting the cumulative hierarchy. However, the overall conclusions of most of the research on the cumulative hierarchy of the Taxonomy give general support. This favor is also evidenced by the wide acceptance and use of the Taxonomy.

The second major area of critique of the Taxonomy relates to its reliability. Does the Taxonomy consistently measure the same cognitive levels within and between studies? This issue is closely tied to the problem of communicability. If the Taxonomy is to be an effective tool for communication between educators, then results obtained within and between observers and studies must be consistent; that is, they must be reliable.

Several studies have found no significant differences between observers (Clegg, Farley, and Curran, 1967; Stanley and Bolton, 1957; Stoker and Kropp, 1964). In a study which compared observer agreement of previous studies, a mean inter-rater agreement of .85 (over categories) was reported (Davis et al., 1969). Fairbrother (1975) found inter-rater correlations
supportive of the Taxonomy if the items could be easily categorized.

Other researchers have raised questions as to the consistency of meaning of the categories across research studies. Fain and Bader (1983) argued that the categories of the Taxonomy are not interpreted in a similar manner from study to study; therefore, generalizations about average levels of cognition or the preponderance of one level over others may not be understood or interpreted properly outside the research. This problem was also reported by Fairbrother (1975) in a study in which teachers were asked to judge abilities being tested on an exam. Fairbrother encountered the problem of acceptable criteria upon which abilities could be categorized. More recent research by Furst (1983) indicated that inter-rater agreement decreased as the number of raters increased.

The issue of reliability and communicability is intricately tied to the extent of training of observers. Where training has been limited, inter-rater reliability is lower. However, in the Davis study (1976) and others, training was considered a critical factor in obtaining the high degree of reliability between observers. Nevertheless, a high degree of agreement in classification of objectives and test items does not appear to be within easy reach (Furst, 1983).
Related to this problem is the question of whether the Taxonomy can be utilized across grades and subject areas. Furst (1981) questions the validity of this claim, arguing that instruments are needed which are subject oriented. However, Kropp and Stoker (1966) concluded that the Taxonomy could be generalized across grades and subjects at least at the high school level, especially regarding the levels of knowledge and evaluation. Certainly the Taxonomy has been used at all grade levels and for a wide variety of subject areas.

Another issue of reliability is the degree to which observers can accurately assess intended student behaviors. The authors of the Taxonomy accept that intended student behaviors are implicit; that is, observers must judge what cognitive level is used by given students in response to a given objective or question. In actual practice, observers must either know or assume the nature of examinees' prior educational experience, especially when evaluating test items (Bloom et al., 1956). Several researchers have suggested procedures to control this potential problem. Furst (1983) suggested that the teacher will be the best judge of the objectives of test items since the teacher's judgment of the student and conditions of instruction will be superior to that of an outsider. A procedure to control for this is suggested by Gall (1970) and involves control by the researcher of
the lesson material upon which the test questions are based.

Despite the problems of the Taxonomy, it has endured relatively intact for almost twenty-five years. Its use has been extensive. Furst (1981) reports that in his view most users have been satisfied. The Taxonomy has been cited in many bibliographies covering hundreds of applications (Furst, 1981). Gall (1970) believes that the Taxonomy "best represents the commonalities that exist among systems" (p. 710). Given this history, it remains a solid foundation upon which further research can be based.

**Cognitive Achievement of Students**

The Taxonomy was originally developed to provide organization and direction to the development and assessment of the cognitive domain in the classroom (Bloom et al., 1956). As such, a major purpose of the Taxonomy was to facilitate communication between educators. As a communication device, it could be used to develop goals and curricula, to develop evaluation instruments for student achievement, and as an aid for evaluating cognitive levels of instruction.

An underlying premise of the Taxonomy, however, was to prompt educators to purposefully and consciously consider desirable outcomes for student cognitive
achievement. The development of intellectual abilities and skills was deemed to be vital.

Justification for the development of intellectual abilities and skills can readily be derived from a consideration of the nature of the society and culture in which we live, the knowledge that is available to us, and the kind of citizen the schools seek to develop. Further justification may be derived from what is known in educational psychology about the permanence of various kinds of learning and the extent to which various kinds of learning can be transferred to new situations (Bloom et al., 1956, p.39).

Research which seeks information to improve students' cognitive abilities must, therefore, consider several factors. First, what are the present levels of cognition in classrooms? Are these levels considered adequate? Second, to what extent can the Taxonomy assess the development of student cognitive abilities based on a variety of learning experiences? What is the scope of activities to which the Taxonomy has been applied? Finally, what does research indicate are the major factors affecting cognitive development?

**Cognitive Levels of Teaching and Learning**

Cognitive achievement in the classroom takes place against the backdrop of existing levels of questions and
statements to which students are exposed. Theoretically, a student will have greater difficulty in attaining and mastering cognitive skills such as analysis or synthesis if opportunities for the development and practice of these skills is not provided.

Unfortunately, the literature does not paint a rosy picture of the average levels of cognition used orally by teachers, on tests, or from textbooks. Davis et al. (1969) report that an emphasis on fact or memory questions dominates objectives, textbook questions, classroom tests, and other instructional materials as well as verbalizations by teachers at both the primary and secondary levels. In a summary of research on the types of oral questions used, Gall (1970) reported that 60% of the questions involved recall of facts, 20% required student thinking and 20% were procedural. The predominance of recall was found from elementary through high school. Similar results prevailed even in junior high and high school classes of talented and gifted students (Gallagher, 1968).

At the college level, analogous conclusions have been reached, albeit from limited research. Discourse at the lowest level dominates regardless of the kind of institution, the course level, the subject area or the length of time in session (Fischer and Grant, 1983). Cognitive levels required by tests and assignments in
sixteen undergraduate courses in a College of Agriculture revealed that 37% of the learning took place at the knowledge level (Newcomb & Trefz, 1987). This same study did find, though, that tests and assignments of upper division courses involved fewer items at the remembering level than did those in lower division courses. They also found that out-of-class assignments in all courses demanded higher-level cognitive behaviors than did tests and assignments. However, in a review of studies regarding the cognitive level of tests at the college level, Milton (1982) found that instructors tend to rely heavily on text questions and that 95 percent of the items in the surveyed tests just required recall.

Unfortunately, little research has been conducted on cognitive emphases of teaching, questions, assignments, or tests, especially at the college level. As a basis for assessing student cognitive achievement, further study is needed to determine existing cognitive levels of a variety of teaching and learning activities.

Applications of Bloom’s Taxonomy

To address the question of what factors influence the development of student cognitive abilities, it is necessary to examine possible and acceptable uses of the Taxonomy as a means of assessing cognitive levels. The Taxonomy was designed to classify "intended behavior of students—the ways in which individuals are to act, think,
or feel as the result of participating in some unit of instruction" (Bloom et al., 1956, p. 12). It was originally conceived as applying primarily to the written word: objectives and test items. Since its development, the Taxonomy has been used extensively in constructing, evaluating, and classifying instructional objectives and test items. Sanders (1966) argued that applications to verbal situations and environments would also be a valuable and effective use of the Taxonomy. It is not meant to include either affective or psychomotor behaviors.

**Using the Taxonomy to Classify Questions**

Since the Taxonomy depends on an evaluation of intended outcomes, it should be able to be used to classify questions, both written and oral. The original work did indeed classify questions and test items according to cognitive levels (Bloom et al., 1956). Clegg et al. (1967) developed a protocol for classifying questions based on the Taxonomy which included both operational definitions and the use of key words.

The Taxonomy has also been used to classify oral questions and statements in classrooms. Willson (1973) applied the Taxonomy in grades 1 - 8 in which classroom observers scored verbal interaction. This study was based on the assumption that verbal interactions reflect levels
of thinking, an assumption made by others including Flanders (1963) and Aschner (1962).

**Training Teachers to Apply Bloom’s Taxonomy**

The Taxonomy has been used as the basis for a variety of training programs for teachers. Research indicates that teachers can be trained to use higher level questioning in the classroom (Rogers and Davis, 1970; Taba, 1966; Willson, 1973). Studies also show a strong positive relationship between this training and subsequent increased use of higher cognitive level questions by teachers and an increase in the cognitive level of classroom interaction (Willson, 1973). For instance, Clegg, Farley, and Curran (1967) found the level of knowledge questions asked by K – 6 grade teachers to be much lower (26.7%) than previously reported norms of 42% (Floyd, 1960).

While the effectiveness of training teachers in the use of Bloom’s Taxonomy appears to be widely accepted, it should be noted that all of the current research focuses on classroom interaction and on primary and secondary schools. This author found no studies related to teacher training or evaluation following training at the college level, nor were there studies which sought to evaluate training of teachers to apply the taxonomy to instructional objectives, assignments, or tests.
Factors Affecting Student Cognitive Achievement

While numerous and complex factors appear to affect cognitive achievement, researchers have sought to identify major factors. Taba (1966) concluded after studying the effects of curriculum, teaching strategies, and learning experiences that "the impact on cognitive processes of specific teaching strategies is greater than the impact of the curriculum guide which only gives general sequences of learning experiences and generic teaching strategies" (p.228). However, rival explanations abound ranging from existing student ability to level of motivation to affective behavior of teachers.

Cognitive Level of Teaching

"The centrality and power of the teacher's role in initiating cognitive operations and determining which kinds are open to students" is one of Taba's concluding statements (1966, p. 228). Yet, while substantial research has been conducted in the training and evaluation of training programs for teachers in the use of Bloom's Taxonomy, only a handful of studies have been conducted which examined teacher strategies associated with student cognitive achievement or other factors influencing teacher use of higher level cognitive behaviors.

One way to approach the cognitive level of teaching is to examine factors which have been found to correlate with teaching at higher cognitive levels, although research
in this area is slim. The work of Bane (1969) and Brown (1968) indicates a significant positive relationship between teaching at higher cognitive levels and a teacher's fundamental philosophical beliefs as assessed by a measure of Dewey's experimentalism. This same research, however, did not find any significant relationship between educational beliefs and the cognitive measures. Bane (1969) concluded that "the number of significant relationships found between the subject taught and the behavior of teachers suggests very convincingly that what teachers teach influences to a great extent how they teach" (p. 65).

Sanders (1966) raised a further issue related to teacher philosophy by arguing that at the level of synthesis, asking synthesis questions was not sufficient. Since synthesis involves creativity, an atmosphere must exist in which divergent thoughts and new or unusual ideas are respected, listened to, discussed, and challenged.

A few studies have been carried out which seek to answer the question of whether the use of higher levels of discourse in the classroom is correlated with higher levels of cognitive achievement for students. One of the first studies was completed by Hunkins (1968), in which it was found that teacher questions at the evaluation and analysis levels did produce significantly greater scores in social studies achievement of sixth graders than did
the use of lower level questions. The study also considered the impact of higher level questions in text type materials but concluded that the level of questions in text-type materials did not produce significant differences in achievement. A similar study used pretests and posttests to examine the effects of high-level questions. Posttest scores were found to be significantly correlated with teacher inquiry level (Ladd, 1969).

Taba (1966) studied two groups of elementary social studies students, one taught by teachers trained to use the Taxonomy and the other group taught by untrained teachers. Her data not only confirmed increased use of higher level interactions but indicated that the trained groups produced a greater number of ideas or thought units and longer units of greater complexity. The trained groups in this study also showed generally superior achievement over the untrained groups in the ability to discriminate, to infer from data, and to apply principles to new situations.

However, the correlation between using more higher level cognitive questions and pupil achievement has not always been found. Rogers and Davis (1970) found that pupil achievement in groups taught by student teachers using higher cognitive levels did not differ significantly from pupil achievement in the control group. This study did use a short time period. Buggey (1972) found that
achievement in two groups of second-graders was similar despite the fact that one group was taught using 70 percent recall and 30 percent high level questions while the other group encountered 30 percent recall and 70 percent high level questions. However, both groups did show superior achievement over the control group which was not taught using questions.

The only other major studies of the relationships between cognitive achievement and increased teacher use of varying cognitive levels were conducted by Ryan (1973, 1974), also using elementary social studies classes. In the first study, the students were divided into three groups, one receiving high-level questions, one receiving low-level questions, and a control group which was not taught with questions. Findings indicated that high-level or low-level questions were superior over the control on the posttest. For the retention test, high-level questions were more efficient in moving students toward both low and high-level achievement than were low-level questions.

In a follow-up study, Ryan (1974) sought to determine whether the differentiated achievement results would be replicated if extended use of questioning were utilized in both the high-level and low-level question groups. The results showed that both groups using questions outperformed the control group on both posttest and
retention tests, indicating the importance of not only the cognitive level of questions but also the degree of student involvement in the process.

Other work has raised questions about the optimal level of cognitive discourse. A common assumption is that the higher the level of cognition, the more likely it is that critical thinking abilities will be developed. Several studies (Gall et al., 1976; Gall, Ward, et al., 1978) found that achievement was lower when teachers used 50 percent high cognitive level questions than when the teachers used either 75 or 25 percent high cognitive level questions. In fact, results at the 75 percent and 25 percent levels were similar.

The results from these researchers adds to the body of knowledge which supports the training of teachers in the use of Bloom's Taxonomy. The training generally appears to not only produce higher levels of classroom interaction, but also to be correlated with superior student achievement, retention, and other cognitive abilities. Unfortunately, research is lacking which would confirm these correlations across a broader range of ages and subject areas, even though additional knowledge in this area could make a significant contribution to furthering goals of increased intellectual skills and abilities of students.
Cognitive Abilities of Students

A scant number of studies have examined the question of a relationship between intellect or IQ and the various levels of cognitive achievement. Kropp and Stoker (1966) linked general ability which included intelligence with all levels of Bloom's hierarchy, although the links to synthesis and evaluation were the weakest. This finding was generally affirmed in another study which found that IQ was not a significant determinant of higher-level cognitive achievement (Roberts, 1974).

Another related factor was raised in work by Taylor and Dunbar (1983). They cited research which maintains that many college freshman still think concretely; formal thought may not yet be attained by many at this age. Formal thought is the fourth stage in Piaget's concept of intellectual development. It corresponds to the higher levels of thinking in Bloom's Taxonomy.

Cognitive Level of Tests and Assignments

Milton (1982) maintains that recall comprises 95 percent of the test items at the college level. He maintains further that test items and cognitive levels of tests influence student learning. For example, students will learn to focus on studying facts and separate pieces of information if previous tests were focused at this cognitive level. If this is the case, then researchers must examine the levels of cognition required for the
variety of evaluation completed during a course. Student's prior experience with tests or other assignments may very well influence their approach to and achievement on later tests and assignments.

Other Variables Affecting Cognitive Achievement

"Teaching and learning is an enormously complex business in which so many variables are involved that interaction effects, like methods effects, pop up only a little way above the apparent noise generated by other variables." (McKeachie, 1970). Nevertheless, it is vital to try to assess the relative importance of the many factors that can affect student cognitive achievement.

Several other factors have been reported in the literature as being positively related to the use of higher cognitive skills. The work by Fischer and Grant (1983) indicates that smaller classes and larger institutions at the college level were the only factors considered which correlated with greater use of higher levels of cognition. Regarding research on college teaching, McKeachie (1970) and McKeachie and Kulick (1975) noted several factors correlated with better application, transfer, and problem solving. These were small classes, discussions over lectures, and student-centered rather than instructor-centered discussions.

Gall (1970) suggested further avenues of research relating the use of questions to cognitive achievement.
First, what are effective sequences of questions; and second, what is the effect of using follow-up questions. Later work by Gall et al. (1976, 1978) suggested that probing and redirection questions may facilitate the ability for higher cognitive response, but concluded that the use of discussion was more significant than the types of questions used during discussion. The work of Ryan (1973, 1974) also indicates that this line of thought could be useful.

Another rival explanation for cognitive achievement could be the effect of prior experience, although research reveals contradictory results here. In a study on improving lectures McKeachie (1980) concluded, "background of the student in the area is probably more important than the student's level of intelligence" (p. 28). Insofar as achievement is accurately reflected by the final grade, a study of a light horse management course found no effect on the final grade related to prior experience (Lawrence, 1987). This same study did find that level of interest affected the final grade. Finally, motivation is another factor important in learning (McKeachie, 1969).

**Summary**

Research on cognition rests on a strong foundation built on Bloom's Taxonomy (1956). The Taxonomy has been in use for over thirty years as the basis for research and
application. Given the complexity and immensity of the task which the authors of the Taxonomy undertook, the survival and the extent of its use indicates both soundness and usefulness, despite some problems and criticisms. As such, the Taxonomy provides a sensible footing for additional research on cognition.

The bulk of research on student cognitive achievement has been conducted at the primary and secondary levels. Very little research is available to add insight into the unique needs for cognitive development of college students. A rare study of college-level intellectual development concluded that only a few college students confidently and reliably use all strategies of formal thought. Rather, the average freshman still functions at the level of concrete experiences (Collea, 1981).

The existing research on cognitive achievement provides only tentative answers even to the populations considered. How important is the cognitive level of teaching to cognitive achievement? Is the level of teaching more highly correlated with student cognitive achievement than other factors such as existing student abilities, student interests, teaching methods, or other variables? Tentative answers to these questions could give teachers and teacher educators needed information and direction as they seek to improve the quality of their
teaching and the quality of student achievement in courses in the College of Agriculture.
CHAPTER III
METHODOLOGY

Population and Sample

The population for this study consisted of eighty-three students enrolled in three undergraduate classes in the College of Agriculture at The Ohio State University during Winter Quarter of 1988. These classes were purposefully chosen on the basis of instructor willingness to participate in the study. Thus, the researcher used intact groups that were experimentally accessible.

The instructors in this study had all previously participated in the Newcomb and Trefz (1987) study and had expressed an ongoing interest in improving their instruction. One class was a freshman-level animal science class of fifty-five students. The second class was a sophomore-level agricultural economics class with twenty-two students enrolled. The third class was an upper-division horticulture class with ten students.

Design

This research was descriptive. Several different instruments were utilized to gather data and information
for each of the variables under study. The study sought to answer research questions regarding:
- the cognitive level achieved by students in the three selected courses;
- the cognitive level of instruction used by the three College of Agriculture professors;
- instructor's cognitive expectations for the course;
- cognitive levels of the assignments, quizzes, and mid-term tests;
- student's previous experience with course content;
- instructor's previous experience with the course;
- student motivation as reflected by interest in and value of the course; and
- student's academic rank.

**Instrumentation and Data Collection**

Due to the complexity of assessing factors related to cognitive achievement, several different instruments were used to collect the necessary data. A discussion of each of these instruments and the data collection methods for each instrument follows.

In the study of cognition, as in many educational studies, it is virtually impossible to isolate all the factors related to the phenomenon under study. The variables employed in this study sought to encompass many of the factors previously identified by other researchers
as being correlated with cognitive achievement by students.

**Cognitive Level of Instruction**

One of the major variables under study was the cognitive level of instruction. Taba has argued (1966) that teachers are by far the most important variable in learning by students. Other studies have concluded that the cognitive level of teaching was significantly correlated with higher levels of cognitive achievement (Hunkins, 1968; Ryan, 1973; Ryan, 1974). In this study, cognitive level of instruction was measured using the Florida Taxonomy of Cognitive Behavior (Brown, Ober, Soar & Webb, 1968). The Florida Taxonomy of Cognitive Behavior (FTCB) is based on Bloom's Taxonomy (Bloom et al., 1956). The developers of the FTCB used Bloom's Taxonomy as the basis for the broad categories and for specific, observable teacher or student behaviors.

The FTCB is comprised of fifty-five specific categories grouped under seven major levels (Table 1). Approximately one-third of the specific categories are grouped under knowledge, which is divided into three subcategories: knowledge of specifics, knowledge of ways and means of dealing with specifics, and knowledge of universals and abstracts. Since these subcategories all deal with recall, they are considered similarly difficult in terms of cognitive skills and abilities.
Table 1
Levels and Categories in the Florida Taxonomy of Cognitive Behavior

1.1 Knowledge of specifics
1. Reads
2. Spells
3. Identifies something by name
4. Defines meaning of term
5. Gives a specific fact
6. Tells about an event

1.2 Knowledge of ways and means of dealing with specifics
7. Recognizes symbol
8. Cites a rule
9. Gives chronological sequence
10. Gives steps of process, describes method
11. Cites trend
12. Names classifications system or standard
13. Names what fits given system or standard

1.3 Knowledge of universals and abstracts
14. States generalized concept or idea
15. States a principle, law, or theory
16. Tells about organization or structure
17. Recalls name of principle, law, or theory

2.0 Translation
18. Restate in own words or briefer terms
19. Gives concrete examples of an abstract idea
20. Verbalizes from a graphic representation
21. Translates verbalization into graphic form
22. Translates figurative statements into literal statements or vice versa
23. Translates foreign language to English or vice versa

3.0 Interpretation
24. Gives reason (tells why)
25. Shows similarities/differences
26. Summarizes or concludes from observation of evidence
27. Shows cause and effect relationship
28. Gives analogy, simile, metaphor
29. Performs a directed task or process

4.0 Application
30. Applies previous learning to new situations
Table 1 (cont.)

31. Applies principle to new situation
32. Applies abstract knowledge in a practical situation
33. Identifies, selects, and carries out process

5.0 Analysis
34. Distinguishes fact from opinion
35. Distinguishes fact from hypothesis
36. Distinguishes conclusion from statements which support it
37. Points out unstated assumption
38. Shows interaction or relation of elements
39. Points out particulars to justify conclusions
40. Checks hypotheses with given information
41. Distinguishes relevant from irrelevant statements
42. Detects error in thinking
43. Infers purpose, point of view, thoughts, feelings
44. Recognizes bias or propaganda

6.0 Synthesis
45. Reorganizes ideas, materials, processes
46. Produces unique communication, divergent idea
47. Produces a plan, proposed set of operations
48. Designs an apparatus
49. Designs a structure
50. Devises a scheme for classifying information
51. Formulates hypotheses, intelligent guesses
52. Makes deductions from abstract symbols, propositions
53. Draws inductive generalization from specifics

7.0 Evaluation
54. Evaluates something from evidence
55. Evaluates something from criteria

The translation level depends on information but is the first level at which knowledge is used by restating, giving examples, or translating from one form to another. At the interpretation level, the individual understands
and can explain relationships in a communication. At the remaining higher levels of the FTCB, the individual behaviors are similar to those developed by Bloom et al. (1956).

The FTCB was developed along with a manual by Brown, Ober, Soar, and Webb (Simon and Boyer, 1974) and was pilot and field tested and used in a number of studies in the late 1960's and early 1970's (Bane, 1969; Brown, 1968; Brown and Bane, 1970; Brown and Webb, 1973; Brown et al.; 1969; Wood, 1969). The argument for the validity of this instrument is based on the fact that it was directly developed from Bloom's Taxonomy. As such, the validity of the FTCB is supported by the general support given to Bloom's taxonomy in the literature.

Table 2 compares the broad levels of cognition between Bloom's Taxonomy and the FTCB. The only difference in these major levels is that the authors of the FTCB broke comprehension into translation and interpretation which, in the Taxonomy, had been included as subsets to comprehension. The authors of the Taxonomy argued that translation and interpretation are distinct intellectual processes (Brown, Ober, Soar, and Webb; 1968).

In using the FTCB, the observer used six minute observation periods during class time. Each time a cognitive behavior was observed, it was categorized by
Table 2
Comparison of the Cognitive Levels of Learning Between Bloom's Taxonomy and the Florida Taxonomy of Cognitive Behavior

<table>
<thead>
<tr>
<th>Bloom's Taxonomy</th>
<th>Florida Taxonomy of Cognitive Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>Knowledge</td>
</tr>
<tr>
<td>Comprehension</td>
<td>Translation</td>
</tr>
<tr>
<td></td>
<td>Interpretation</td>
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<tr>
<td>Application</td>
<td>Application</td>
</tr>
<tr>
<td>Analysis</td>
<td>Analysis</td>
</tr>
<tr>
<td>Synthesis</td>
<td>Synthesis</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Evaluation</td>
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</tbody>
</table>

Making a check mark in the appropriate box for the given time period. If the observed behavior represented more than one category, all categories that were involved were checked. In any given observation period each category was checked only once even if more than one observation of that cognitive behavior had been observed. For example, if the instructor gave four specific facts during one six-minute period, this behavior was checked only once. Recordings were based on verbalizations and written
materials (chalkboard, handouts) used during class. Appendix A shows the actual observational instrument used.

In this study, each class was audio recorded and notes were made to denote the transitions from one six-minute period to another. Notes were also made to capture the use of written materials that would not be indicated on the audio recordings (Appendix B). The actual recording of data for each class was completed using the audio tapes within twenty-four hours following the class. The dominant teaching method for all three classes was lecture/discussion, with the emphasis on lecture. Because of this emphasis and because the researcher was interested in the relationship of instructor behavior to the outcome measure, only teacher behaviors were recorded, even though the instrument can be used to classify both student and teacher behaviors.

Each class was observed three times during Winter Quarter, 1988. A schedule was arranged with each instructor during the third week of the quarter. Observations began the fourth and fifth weeks of the quarter and were spaced once every two weeks for each class. The last observation was completed during the ninth week.

Reliability for the use of this instrument in this study was established in the following way. Two raters were given training by a research associate previously
trained in the use of the FTCB. Training consisted of an explanation of the instrument and practice in using the instrument with video tapes, first as a group and then independently. Following training inter-rater reliability was measured using observations of two video tapes by the major researcher and a research assistant and calculated using the MacIntosh Statview program. The Spearman correlation coefficient was found to be .952. Intra-rater reliability of the major researcher was calculated using the Statview program using video tapes of instruction by Plimpton (1981) and Golden (1981). The Spearman correlation coefficients were .982 for the Golden tape and .994 for the Plimpton tape. In the actual study, all the classroom observations and coding of data were completed by the major researcher.

**Cognitive Levels of the Assignments**

Another factor theoretically related to the level of cognition achieved by students is the cognitive level of quizzes, assignments, and the mid-term examination. The original work of Bloom et al. (1956) and subsequent studies (Clegg, 1967; Newcomb and Trefz, 1987) have demonstrated that classification is both a possible and appropriate use for the Taxonomy.

Each of the evaluation measures used by the instructors was collected at the end of the quarter and subsequently classified into the seven cognitive levels of
the Florida Taxonomy of Cognitive Behavior (FTCB).
Assignments varied from one class to another, but were all completed outside of class and included homework, laboratory assignments, and projects. Assessment of these evaluation measures was completed by a research assistant. This assistant had no prior experience with this particular instrument, but was an expert with the Newcomb-Trefz model (Newcomb & Trefz, 1987). The Newcomb-Trefz model used four major categories rather than the seven in the FTCB. The major difference between the two instruments is that in the Newcomb-Trefz model, translation, interpretation, application, and analysis are combined into the processing level.

Interest in and Value of Course to Student

Several studies have concluded that student interest is a factor which appears to be related to learning (Fincher, 1977; Lawrence, 1987; McKeachie, 1980). McKeachie (1980) refers to this variable as student motivation. This study incorporated the variable of motivation into the design by administering an instrument labelled "Interest in and value of course to the student" (Appendix C) The questionnaire sought to identify the rationale for enrollment in the course and the relationship of the course to career expectations.

This instrument and a cover letter (Appendix D) was distributed by the instructors to their students during
the third week of classes. Students completed the instrument at home.

The original instrument was pilot tested in November, 1987 using ninety-nine students from two different undergraduate agricultural education classes. Results from the pilot test indicated that one question should be deleted and it subsequently was. Cronbach's Alpha reliability coefficient was found to be .75 using the updated version of the instrument.

Validity of the instrument was established by a panel of experts consisting of six agricultural educators. Several portions of the questionnaire were modified following recommendations from this panel.

The instrument consisted of two portions. In the first part, questions were asked to determine class rank and major area of study. This demographic information was used to describe study participants. The second portion of the instrument consisted of five questions used to assess motivation for enrolling in the course. Students chose one of three answers for the first question based on the degree to which the course was related to their major area of study. The remaining four questions were answered using a Likert-type scale. These four questions assessed reasons for enrollment related to career objectives, the reputation of the instructor, the challenging nature of the course, and interest in the area of study regardless
of graduation requirements. The five questions were summed for each student to give a single score for interest in and value of course.

**Student's Previous Experience with Course Content**

Research regarding the effect of students' previous experience with course content on the level of achievement has been contradictory (Lawrence, 1987; McKeachie, 1980). Thus, the researcher judged that a measure of previous experience with content should be included.

An instrument labelled "Students' previous experience" was developed in 1987 (Appendix E) and pilot tested along with the "Interest in and value of the course" instrument. Using Cronbach's Alpha the reliability coefficient was found to be .70. Validity for this instrument was established by a panel of six teacher educators and researchers.

The instrument consisted of eight questions; "yes" or "no" choices were circled as answers. The instrument measured prior experience with course content at the high school and college levels and extracurricular activities or work experience related to the course. The instrument was administered to the students in class by the instructor during the last week of regularly scheduled classes and returned to the instructor that same day.
Instructor's Expectations for the Course

Moody (1982) has argued that at the outset of any course, it is necessary for the student to understand both course content and performance or mastery expectations. To assure observation of this factor related to learning, the researcher planned to assess the course syllabus and course outline. However, although all three instructors used a syllabus and course outline, none of these materials described actual behavioral or cognitive objectives for the course; they were primarily oriented toward content. Thus, it was not possible to assess these materials in terms of cognitive objectives.

A personal interview with each instructor was conducted at the end of the quarter to assess instructor cognitive expectations. Instructors were asked to estimate their expectations for the cognitive levels to be reached by students in their courses.

Instructor's Previous Experience

Just as student motivation can influence student cognitive achievement, instructor experience with and interest in the course material has an impact on the instructor's teaching. Motivation seems to reflect an instructor's enthusiasm for content (Kittell and Moore, 1983). Fincher (1977) argued that the number of years teaching a course may explain the student's level of achievement in the course.
To assess these instructor characteristics, a questionnaire was developed. The instrument appraised previous involvement with the subject matter in prior education, teaching, research, and previous work and community experiences. The first portion of the instrument examined the years of university teaching, quarters/years of teaching the course, and years of previous related work experience. In the second portion the instructor rated the level of undergraduate, graduate, and research involvement in the subject area; the level of expertise in the course content; and the degree of involvement in the agricultural community on issues related to the course content. The six questions of the second portion were rated three, two, or one, with higher scores reflecting greater involvement.

Validity for this instrument was established by a panel of experts. Several recommended changes from the original instrument were incorporated into the final version.

Cognitive Level of Achievement

Cognitive level achieved by students in the course was measured by the final exam given to the students in each class. These exams were constructed by each course instructor and administered during exam week. Each final exam was evaluated by the same research assistant who
categorized the tests and assignments. The final exams were categorized into the seven levels of the FTCB.

Classification for one exam was completed with the assistance of the instructor. Furst (1983) considers instructor evaluation of questions a valid way of assessing cognitive level since the teacher is "the one person in the best position to understand the student and the conditions of instruction".

The exam questions were evaluated one at a time. Each question was categorized into one of the seven cognitive levels. Each question was weighted according to the number of points assigned to that question by the instructor for scoring purposes. Weighting according to points available was seen as a way to reflect the emphasis that the instructor placed on the cognitive level of the individual question.

Additionally, each cognitive level was weighted to reflect the cumulative hierarchy of the seven levels of cognition in the FTCB. Weighting was utilized to incorporate general support by research of the cumulative hierarchy of Bloom's Taxonomy (Kropp and Stoker, 1964; Kropp and Stoker, 1966; Roberts, 1974; Seddon, 1978; Smith, 1968), especially for the levels of knowledge, comprehension, application, and analysis. The greater weight given to competence at a higher level reflects mastery both at the higher level and at all lower levels.
Since researchers (Kropp and Stoker, 1966; Madaus, Woods, and Nuttall, 1973; Seddon, 1978) have not agreed on an order for synthesis and evaluation, these two levels were weighted equally. Table 3 shows the weighting factors used.

Table 3
Cognitive Weighting Factors

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Weighting Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>.10</td>
</tr>
<tr>
<td>Translation</td>
<td>.20</td>
</tr>
<tr>
<td>Interpretation</td>
<td>.25</td>
</tr>
<tr>
<td>Application</td>
<td>.30</td>
</tr>
<tr>
<td>Analysis</td>
<td>.40</td>
</tr>
<tr>
<td>Synthesis</td>
<td>.50</td>
</tr>
<tr>
<td>Evaluation</td>
<td>.50</td>
</tr>
</tbody>
</table>

These weighting factors were developed by the following procedure. Factors for each level were arrived at independently by two different researchers (Newcomb & Straquadine, 1988). These two researchers arrived at a consensus for the factors. Subsequently a third researcher with expertise in cognition (Newcomb & Trefz, 1987) independently developed weighting factors which concurred with the first set.

Using the FTCB, knowledge was weighted at .10, translation at .20, interpretation at .25, application at
.30, and analysis at .40. Both synthesis and evaluation used cognitive weighting factors of .50.

Analysis of Data

This study produced an enormous quantity of data. The following procedures were employed to properly utilize the data produced.

Statistical analyses were completed using the Statistical Package for the Social Sciences (SPSSx). Data were placed on floppy disk using IBM Freestyle and then uploaded into the WYLBUR system at The Ohio State University.

For each variable in the study, frequency distributions were generated and then used to describe the sample in the study. Pearson product moment correlation coefficients were calculated between the cognitive level of achievement and each of the following variables:

1. cognitive level of instruction;
2. cognitive abilities of student before entering the class;
3. interest in and value of the course to the student;
4. student's previous experience with course content;
5. student's academic rank;
6. instructor's cognitive expectations for the course;
7. instructor's previous experience with the course content;
8. cognitive level of assignments, quizzes, and mid-term examinations;

Each student in the study was considered a case within the data set and was identified by the last six digits of his/her social security number. The information and data concerning the instructor was entered into a separate data set. The instructor data was computed and reduced before being merged with the appropriate student data sets.

The Florida Taxonomy of Cognitive Behavior (Brown, Ober, Soar, & Webb, 1968) was used to evaluate three different variables: the cognitive level of instruction used by the selected faculty members; the cognitive level of assignments, quizzes, and the mid-term examinations; and the cognitive level of student achievement.

Cognitive Level of Teaching

Several steps were taken to calculate the cognitive level of teaching. For each class observation a calculation was made of the number of times that cognitive behaviors occurred during each observation period for each of the fifty-five categories within the seven levels. For example, all occurrences under analysis for the first six-
minute period were totalled so that results after running the data showed one frequency value for analysis for that period. The computer then calculated total frequencies for each category and at each level for each class observation.

The three class observations were summed for the total frequencies at each level for each instructor. Percentages for each level were calculated for each class observation and for each instructor. The percentage values for each cognitive level times the cognitive weight (Table 3) yielded a weighted cognitive score for each level. These weighted cognitive scores were summed to obtain a cognitive score of instruction for each instructor which was then used as one of the variables for statistical analysis with other variables. The three cognitive scores of instruction were also combined to yield a mean cognitive level of instruction for the three instructors combined.

**Cognitive Level of Assignments, Quizzes, and Mid-terms**

The cognitive level of quizzes, assignments, and the mid-term exam was evaluated by the research assistant. For both tests and assignments, percentage of points at each level was calculated and then multiplied by the cognitive weighting factors (Table 3) to yield a weighted cognitive score at each level. The weighted scores for each level were summed to obtain separate composite scores for the
cognitive level of tests and the cognitive level of assignments for each instructor. These scores were then combined into a single score based on the proportion given to the tests and assignments for grading purposes. This combined score was labelled the cognitive level of tests and assignments.

The value for the cognitive level of tests and assignments was an interval measure since the weighting factors were utilized to compute these scores. This composite value for each instructor was added to the respective student data sets for statistical analysis with other variables.

**Cognitive Level of Achievement**

Student cognitive level of achievement was evaluated using the FTGB based on performance on the final exam. Table 4 illustrates the method utilized to calculate cognitive achievement for each student.

The student's percent score correct at each level was multiplied by percentage of questions at that level on the exam and then multiplied by the cognition factor for that level to yield the student's weighted cognition score by level. Scores by level were then summed to generate the weighted cognition score. In this example the student had a weighted cognition score of 15.075. The highest cognition score possible in this example would have been
Table 4
Example of the Method for Calculating
Cognitive Weight of Achievement Score

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Student's % Score</th>
<th>Percent of Final Exam*</th>
<th>Cognition Factor</th>
<th>Cognition Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>100</td>
<td>.60</td>
<td>.10</td>
<td>6.00</td>
</tr>
<tr>
<td>Translation</td>
<td>95</td>
<td>.20</td>
<td>.20</td>
<td>3.80</td>
</tr>
<tr>
<td>Interpretation</td>
<td>80</td>
<td>0.0</td>
<td>.25</td>
<td>0.0</td>
</tr>
<tr>
<td>Application</td>
<td>75</td>
<td>.10</td>
<td>.30</td>
<td>2.25</td>
</tr>
<tr>
<td>Analysis</td>
<td>70</td>
<td>.05</td>
<td>.40</td>
<td>1.40</td>
</tr>
<tr>
<td>Synthesis</td>
<td>65</td>
<td>0.0</td>
<td>.50</td>
<td>0.0</td>
</tr>
<tr>
<td>Evaluation</td>
<td>65</td>
<td>.05</td>
<td>.50</td>
<td>1.625</td>
</tr>
</tbody>
</table>

TOTAL                  |                   |                        |                 | 15.075          |

*Expressed by decimal

17.5. This would only occur if a student scored 100% on all levels.

The cognitive weight of achievement score was considered interval data since it utilized the cognitive weighting factors. This single score for each student was coded into the student data sets for statistical analysis.

Other Student Variables

The instrument used to collect data regarding student's previous experience with the course content yielded an ordinal measure since coding was based on "yes" or "no" answers to questions. Each response was coded and
then a total value was computed to reflect student's previous experience. Higher scores reflected greater prior experience. Each question, or sub-group of previous experiences, as well as the composite was coded into the data set. The composite score was used for statistical purposes.

The "Interest in and value of course" instrument provided an interval measure. Responses to the five questions on this instrument were summed to give one value for interest in and value of the course to the student. The academic rank and major area of study were coded separately into the student data set.

Other Instructor Variables

The instructor's cognitive expectations for the course (Appendix F) yielded an interval measure since the cognitive weighting factors were used in calculating cognitive expectation scores. The cognitive expectations value was expressed as a single numerical score. The expectations score was derived by multiplying the percentage values indicated by the instructor for each level by the cognitive weighting factor (Table 3). This score was then transferred to the appropriate student data sets. Instructor cognitive expectation scores could range from 10, representing all knowledge, to 50, representing all synthesis and/or evaluation.
The instructor's previous experience yielded a single interval value based on the amount of time instructors had with various course related experiences. The instructor's previous experience score was the sum of scores on the nine separate questions (Appendix G). This score was also transferred to the appropriate student data sets for use in statistical analysis.
CHAPTER IV
FINDINGS

This chapter presents the findings of the study and was designed to answer the research objectives. The questions which this study sought to answer were:

1. What cognitive level was achieved by students in selected College of Agriculture courses?

2. At what cognitive level of instruction did selected College of Agriculture professors teach?

3. To what extent were selected variables correlated with students' cognitive level of achievement? The following variables were examined:
   a. cognitive level of instruction;
   b. instructor's cognitive expectations for the course;
   c. cognitive level of assignments, quizzes and mid-term examinations;
   d. students' prior experience with course content through previous college courses, high school courses and work experiences;
e. student's level of motivation as measured by student interest in the course and the value of the course for career objectives;

f. student's academic rank; and

g. instructor's academic preparation, previous course experience, work experience, and professional interests.

A purposeful sample was used which consisted of eighty-three students enrolled in three different courses in the College of Agriculture at The Ohio State University. Generalization beyond these three classes was not possible.

Cognitive level of achievement was measured by the final examination administered by each of the three instructors. All but seven of the final exams were collected and used for analysis.

Two instruments were used to measure student variables of interest. The "Interest in and value of course" instrument was completed at home and returned by 44 students or 53% of the sample. This included demographic data such as academic rank and major area of study. The "Previous experience" instrument was completed by students in class and generated an 80% return rate with 67 returned.

Two instructor instruments were completed in this study: instructor's previous experience and instructor's
cognitive expectations for the course. Both of these instruments were completed and returned by all three instructors.

The cognitive level of teaching and the cognitive level of evaluation materials used were assessed by the researcher and another expert using the Florida Taxonomy of Cognitive Behavior (Brown, Ober, Soar, & Webb; 1956).

**Characteristics of University Instructors**

**Previous Experience**

Teaching, coursework, and work experience related to the course materials are presented in Table 5. University teaching experience ranged from 10 to 25 years with an average of over 16 years. The three instructors had taught the course or a similar course for 11 to 40 quarters or semesters ($\overline{X} = 23$). Employment or experience outside the university ranged from 5 years to 24 years with an average of 15.3 years. The reader should note that in responding to these questions instructors could count years of experience in the community during the same time that teaching or work experience was counted.

Instructors also responded to six questions designed to assess the extent of undergraduate, graduate, research, and community involvement they had related to the course material. The results of these questions were combined and are presented along with the years of teaching and
Table 5
Instructor Teaching Experience, Coursework Experience and Work Experience Related to the Course

<table>
<thead>
<tr>
<th>Teaching and Work Experience</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Experience</td>
<td>1</td>
</tr>
<tr>
<td>Number of years of university teaching experience</td>
<td>14</td>
</tr>
<tr>
<td>Number of quarters/semesters responsible for teaching course or similar course</td>
<td>18</td>
</tr>
<tr>
<td>Number of years of employment or experience outside the university related to course content</td>
<td>17</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>49</td>
</tr>
</tbody>
</table>

* Estimated
work experience in Table 6 as a composite measure of instructor's previous experience.

<table>
<thead>
<tr>
<th>Type of Experience</th>
<th>Instructor Previous Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Degree of educational, research, and community involvement(^{(a)})</td>
<td>11</td>
</tr>
<tr>
<td>Level of expertise(^{(b)})</td>
<td>3</td>
</tr>
<tr>
<td>Years of teaching and work experience(^{(c)})</td>
<td>49</td>
</tr>
<tr>
<td>TOTAL</td>
<td>63</td>
</tr>
</tbody>
</table>

\(^{(a)}\) Based on five questions with possible scores ranging from 5 to 15

\(^{(b)}\) 3 = primary area of expertise, 2 = secondary area, 1 = area of limited expertise

\(^{(c)}\) Includes years of university teaching experience, quarters responsible for teaching course, and years of other employment or experience related to the course

Composite total previous experience scores ranged from 59 to 80 with a mean of 67.3. Prior teaching and work experience accounted for the bulk of this score with an average of 54.6 points. The combination of the degree
of educational, research and community involvement and the level of expertise scores accounted for 10 to 14 points, thus explaining little of the variation in the total scores of instructor's previous experience. The reader should note that these scores could conceivably range from as low as 6 for a novice instructor up to more than 200 for an instructor close to retirement who had taught the course several times a year since the start of his or her teaching career.

**Cognitive Expectations for the Course**

Instructor's cognitive expectations for the course were assessed through a personal interview conducted at the end of the quarter. Using the seven levels of the Florida Taxonomy of Cognitive Behavior (FTCB), each instructor was asked to rate his expectations for the percentage of learning that should have occurred at each level for the course as a whole. Table 7 compares the cognitive expectations by level for each instructor.

Averages were not computed for each level since there were only three instructors. It should be noted that the range in cognitive expectations for several levels is quite wide. The expectation for the acquisition of knowledge ranged from 20% for one instructor to 60% for the instructor teaching the freshman level course. The second greatest range occurred at evaluation which was
rated from 5% for instructor 2 teaching the freshman-level course to 25% for the senior-level course taught by instructor 3. Instructor's cognitive expectations at the translation level also showed some variation, ranging from 0 to 20% of the expected learning.

To enable the researcher to compare the overall cognitive expectations for the course with other variables, a weighted value for instructor expectations was obtained for each instructor. Using the weighting factors listed in Table 3 it should be noted that the

Table 7

Instructor's Cognitive Expectations for Learning by Percentage at Each Level of the FTCB

<table>
<thead>
<tr>
<th>FTCB Level</th>
<th>Instructor 1</th>
<th>Instructor 2</th>
<th>Instructor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Knowledge</td>
<td>20</td>
<td>60</td>
<td>25</td>
</tr>
<tr>
<td>Translation</td>
<td>20</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Interpretation</td>
<td>5</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Application</td>
<td>20</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Analysis</td>
<td>5</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Synthesis</td>
<td>10</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>Evaluation</td>
<td>20</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
cognitive expectation scores could range from a low of 10 (if 100% occurred at the level of knowledge) to a high of 50 (if 100% occurred at either or both the levels of evaluation and synthesis). The range of these scores is presented in Table 8.

Table 8
Range in Possible Cognitive Expectation Scores

<table>
<thead>
<tr>
<th></th>
<th>%</th>
<th>Weighting Factor</th>
<th>Weighted Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>100</td>
<td>.10</td>
<td>10.0</td>
</tr>
<tr>
<td>Translation</td>
<td>100</td>
<td>.20</td>
<td>20.0</td>
</tr>
<tr>
<td>Interpretation</td>
<td>100</td>
<td>.25</td>
<td>25.0</td>
</tr>
<tr>
<td>Application</td>
<td>100</td>
<td>.30</td>
<td>30.0</td>
</tr>
<tr>
<td>Analysis</td>
<td>100</td>
<td>.40</td>
<td>40.0</td>
</tr>
<tr>
<td>Synthesis</td>
<td>100</td>
<td>.50</td>
<td>50.0</td>
</tr>
<tr>
<td>Evaluation</td>
<td>100</td>
<td>.50</td>
<td>50.0</td>
</tr>
</tbody>
</table>

Table 9 displays an example of the computations used to obtain a weighted value of instructor cognitive expectations using the cognitive weighting factors (Table 3) for instructor 1. The percentage expectation at each level was multiplied by the cognitive weighting factor (see Table 3) for that level to obtain a weighted cognitive value. The sum of the weighted values provided a weighted cognitive score of instructor expectations.
Table 9
Weighting Factors and Computations Used to Obtain the Weighted Value Score for Instructor Expectations (Example for Instructor 1)

<table>
<thead>
<tr>
<th>FTCB Level</th>
<th>Instructor 1 Percentage Expectations</th>
<th>Weighting Factor</th>
<th>Weighted Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>20</td>
<td>.10</td>
<td>2.0</td>
</tr>
<tr>
<td>Translation</td>
<td>20</td>
<td>.20</td>
<td>4.0</td>
</tr>
<tr>
<td>Interpretation</td>
<td>5</td>
<td>.25</td>
<td>1.25</td>
</tr>
<tr>
<td>Application</td>
<td>20</td>
<td>.30</td>
<td>6.0</td>
</tr>
<tr>
<td>Analysis</td>
<td>5</td>
<td>.40</td>
<td>2.0</td>
</tr>
<tr>
<td>Synthesis</td>
<td>10</td>
<td>.50</td>
<td>5.0</td>
</tr>
<tr>
<td>Evaluation</td>
<td>20</td>
<td>.50</td>
<td>10.0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100</td>
<td></td>
<td>30.25</td>
</tr>
</tbody>
</table>

The total weighted values for each of the three instructors are reported in Table 10. Note that these three instructors showed a relatively wide variation in their cognitive expectations for each course, from 20.65 for instructor 2 to 35.75 for instructor 3.

These scores indicated that the average of the cognitive expectations for these instructors was at the translation, interpretation, and application levels.
Table 10

Total Weighted Values of Instructor Cognitive Expectations for Student Learning

<table>
<thead>
<tr>
<th>Instructor 1</th>
<th>Instructor 2</th>
<th>Instructor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>30.25</td>
<td>20.65</td>
<td>35.75</td>
</tr>
</tbody>
</table>

MEAN = 28.88
Possible Range = 10 - 50

Characteristics of Enrolled Students

Demographics of the Sample

The eighty-three students in the three classes who served as the sample for this study reported both their academic rank and their major area of study. Academic rank is displayed in Table 11. The typical student was completing the sophomore year. The median rank was at the very beginning of the junior year. Complete data were received for 72 of the students or 87% of the sample.

Findings regarding major area of study are reported in Table 12. Complete data were collected for 72 students or 87% of the sample. Fifty of the students (70%) were studying in the three areas corresponding to the courses in the study: animal science, agricultural economics, and horticulture. The remaining students had their major area
Table 11
Academic Rank of Students

<table>
<thead>
<tr>
<th>Academic Rank</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>29</td>
<td>36.3</td>
</tr>
<tr>
<td>Sophomore</td>
<td>12</td>
<td>15.0</td>
</tr>
<tr>
<td>Junior</td>
<td>16</td>
<td>20.0</td>
</tr>
<tr>
<td>Senior</td>
<td>23</td>
<td>28.7</td>
</tr>
</tbody>
</table>

TOTAL = 80*  100
MEDIAN = 3.00  *3 unclassified

Table 12
Student's Major Area of Study

<table>
<thead>
<tr>
<th>Major Area of Study</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal Science</td>
<td>23</td>
<td>31.9</td>
</tr>
<tr>
<td>Ag Economics</td>
<td>15</td>
<td>20.8</td>
</tr>
<tr>
<td>Horticulture</td>
<td>12</td>
<td>16.7</td>
</tr>
<tr>
<td>Ag Education</td>
<td>6</td>
<td>8.3</td>
</tr>
<tr>
<td>Food Science</td>
<td>5</td>
<td>6.9</td>
</tr>
<tr>
<td>Ag Communications</td>
<td>2</td>
<td>2.8</td>
</tr>
<tr>
<td>Agronomy</td>
<td>2</td>
<td>2.8</td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
<td>9.8</td>
</tr>
</tbody>
</table>

TOTAL = 72*  100

*11 missing cases
of study either in another agricultural field or outside of agriculture.

**Previous Experience**

Student's previous experience related to the course was evaluated through an eight question instrument completed by the students. The instrument assessed student familiarity with course materials and content based on previous coursework, FFA or 4-H involvement or work experience. Students could score between eight and sixteen points with higher scores reflecting greater previous experience. Results are presented in Table 13.

Of the 83 students in the sample, 67 or 81% returned this questionnaire. The mean previous experience for the group that returned the questionnaire was 11.9. A mean score of 12.0 would indicate that the typical student had experience in 50% of the eight areas in question.

**Interest in and Value of Course**

Student motivation was assessed through the use of the instrument called "Interest in and Value of Course". This instrument consisted of five questions. Questions assessed the reason for enrolling, coursework related to student's career objectives, the good reputation of the instructor, the challenging nature of the course, and interest in the course regardless of graduation requirements.
Table 13

Students' Previous Experience Related to Course Content and Materials

<table>
<thead>
<tr>
<th>Previous Experience Score</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
</tr>
<tr>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>11</td>
<td>18</td>
</tr>
<tr>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TOTAL</th>
<th>67*</th>
<th>100</th>
</tr>
</thead>
</table>

MEAN = 11.9  *16 cases missing
SD = 2.2
MEDIAN = 11.0

The scores from these five questions were combined to yield one composite score reflecting student motivation in relation to the course. The interest in and value of the course to the student composite scores are presented in Table 14 for all three classes of students.

Composite scores could range from as low as 5 up to 47. Actual scores ranged from 16 to 46, with a mean of 30.7. Forty-four or 53% of the questionnaires were returned. In addition, it should be noted that 64% of the
Table 14
Interest in and Value of Course to the Students

<table>
<thead>
<tr>
<th>Score Range</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 16</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>16 - 19</td>
<td>2</td>
<td>4.5</td>
</tr>
<tr>
<td>20 - 23</td>
<td>2</td>
<td>4.5</td>
</tr>
<tr>
<td>24 - 27</td>
<td>8</td>
<td>18.2</td>
</tr>
<tr>
<td>28 - 31</td>
<td>15</td>
<td>34.2</td>
</tr>
<tr>
<td>32 - 35</td>
<td>7</td>
<td>15.9</td>
</tr>
<tr>
<td>36 - 39</td>
<td>6</td>
<td>13.6</td>
</tr>
<tr>
<td>40 - 43</td>
<td>3</td>
<td>6.8</td>
</tr>
<tr>
<td>44 - 47</td>
<td>1</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Total | 44* | 100

Mean = 30.65
SD = 6.39
*39 questionnaires not returned
Possible Range = 5-47

Upper-division students (juniors and seniors) returned their questionnaires whereas only 32% of the lower-division students (freshmen and sophomores) returned the questionnaire. This low rate of return was also reflected in the 39% return rate for the freshman level course. As a result of these uneven returns, caution must be used in generalizing these results to the three classes.
Cognitive Level of Courses

The cognitive level of each course was evaluated using two separate methods. First, the cognitive level of teaching was assessed by classroom observations and analysis of audio tapes and coded using the Florida Taxonomy of Cognitive Behavior (Brown, Ober, Soar, & Webb, 1968). Evaluation of tests and assignments was also assessed. The FTCB was used to classify quizzes, assignments and the mid-term examination. Results from these assessments follow.

Cognitive Level of Teaching

Table 15 reports the total number and the mean frequency of cognitive behaviors observed during the three class observations of each of the three instructors and the totals for the three instructors combined.

Table 16 summarizes the percentage of behaviors observed per level of the FTCB for each instructor for all three observations combined. It also reports the average percentage at each level for the three instructors combined.

Slightly less than one-half (46%) of the teaching behaviors were at the knowledge level. The next two lowest levels of cognition, translation and interpretation, accounted for 13% and 15% of the teaching behaviors, respectively. Application accounted for 6% of the teaching behaviors. Fourteen percent of the teaching
Table 15
Total and Mean Number of Observed Cognitive Teaching Behaviors of Instructors

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Total Number of Cognitive Behaviors Observed (3 observations)</th>
<th>Mean Frequency of Observed Cognitive Behaviors Per Class Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>406</td>
<td>135.3</td>
</tr>
<tr>
<td>2</td>
<td>366</td>
<td>122.0</td>
</tr>
<tr>
<td>3</td>
<td>293</td>
<td>97.7</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1065</td>
<td></td>
</tr>
<tr>
<td>MEAN</td>
<td>355</td>
<td>118.3</td>
</tr>
</tbody>
</table>

behaviors were at the analysis level. About 3% of the teaching behaviors were at each of the two highest levels, synthesis and evaluation.

The total number of teaching behaviors at each level can also be approximated. Class observations totaled approximately six hours and observed cognitive behaviors totalled 1,065. Cognitive teaching behavior at the knowledge level occurred nearly 490 times during the six hours observed. Teaching at knowledge, translation, and interpretation combined occurred approximately 780 times. Teaching at the level of analysis transpired 152 times. Teaching behaviors at synthesis and evaluation were each
Table 16
Percentage of Cognitive Teaching Behavior by Level of the FTCB and by Instructor

<table>
<thead>
<tr>
<th>FTCB Level of Cognition</th>
<th>Instructor 1</th>
<th>Instructor 2</th>
<th>Instructor 3</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Knowledge</td>
<td>41.86</td>
<td>48.09</td>
<td>47.10</td>
<td>45.68</td>
</tr>
<tr>
<td>Translation</td>
<td>14.29</td>
<td>12.84</td>
<td>11.26</td>
<td>12.80</td>
</tr>
<tr>
<td>Interpretation</td>
<td>13.30</td>
<td>13.93</td>
<td>17.06</td>
<td>14.76</td>
</tr>
<tr>
<td>Application</td>
<td>6.16</td>
<td>9.56</td>
<td>3.75</td>
<td>6.49</td>
</tr>
<tr>
<td>Analysis</td>
<td>16.50</td>
<td>11.20</td>
<td>15.02</td>
<td>14.24</td>
</tr>
<tr>
<td>Synthesis</td>
<td>2.96</td>
<td>2.19</td>
<td>4.10</td>
<td>3.08</td>
</tr>
<tr>
<td>Evaluation</td>
<td>4.93</td>
<td>2.19</td>
<td>1.71</td>
<td>2.94</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
<td></td>
</tr>
</tbody>
</table>

observed approximately 32 times during this six-hour period.

While tests of variance between instructors by level were not conducted, it is noteworthy that little variation is evident. Teaching behaviors at the knowledge level varied slightly more than 6% from 41.9% to 48.1% among the three professors. The incidence of translation behaviors varied from 11.2% to 14.3%; interpretation varied from 13.3% to 17.1%; application varied from 3.8% to 9.6%; analysis varied from 11.2% to 16.5%; synthesis varied from 2.2% to 4.1%; and evaluation varied from 1.7% to 4.9%.
Weighted values of teaching behaviors at each cognitive level were also calculated to portray the summated scores for these observations. The first step in calculating an overall weighted cognitive value was to obtain weighted cognitive scores at each level for each instructor. These were calculated using the same weighting factors shown in Table 3. A total weighted cognitive teaching score for each instructor was then obtained by summing the scores for each level. These scores are presented in Table 17. Also presented are the mean weighted cognitive scores for each level of cognition and for the three instructors.

Table 17

Weighted Cognitive Teaching Scores by Level of the FTCTB for Each Instructor

<table>
<thead>
<tr>
<th>FTCTB Level of Cognition</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>4.19</td>
<td>4.81</td>
<td>4.71</td>
<td>4.57</td>
</tr>
<tr>
<td>Translation</td>
<td>2.86</td>
<td>2.57</td>
<td>2.25</td>
<td>2.56</td>
</tr>
<tr>
<td>Interpretation</td>
<td>3.33</td>
<td>3.48</td>
<td>4.27</td>
<td>3.69</td>
</tr>
<tr>
<td>Application</td>
<td>1.85</td>
<td>2.87</td>
<td>1.13</td>
<td>1.95</td>
</tr>
<tr>
<td>Analysis</td>
<td>6.59</td>
<td>4.47</td>
<td>6.00</td>
<td>5.69</td>
</tr>
<tr>
<td>Synthesis</td>
<td>1.48</td>
<td>1.09</td>
<td>2.05</td>
<td>1.54</td>
</tr>
<tr>
<td>Evaluation</td>
<td>2.46</td>
<td>1.09</td>
<td>0.85</td>
<td>1.47</td>
</tr>
</tbody>
</table>

**TOTAL** 22.76 20.40 21.26 21.47

Total Score Possible Range = 10 - 50
The total weighted cognitive teaching score could theoretically range from 10 (100% of teaching behaviors at knowledge) to 50 (100% of teaching behaviors at synthesis or evaluation). Lower cognitive teaching scores, thus, reflect a greater emphasis on the recall of facts whereas higher scores indicate a greater use of the higher levels of cognitive skills and abilities.

The actual weighted cognitive teaching scores ranged from 20.40 to 22.76, with a mean of 21.47. This reflected a cognitive level of teaching concentrated around the translation level. If 100% of the teaching had been at translation, the weighted cognitive score would be 20 (100 * .20 = 20). While this is a very small range in scores among the three instructors, the reader should note that it was based on an average of 308 observed cognitive behaviors for each instructor.

In examining the detail in the specific levels, several levels predominated after the weighting factors were applied. Weighted cognitive scores were highest for analysis, ranging from 4.47 to 6.59, with a mean of 5.69. Knowledge scores followed ranging from 4.19 to 4.81, with a mean of 4.57. For the three instructors, knowledge accounted for 20% of the weighted cognitive scores while knowledge, translation, and interpretation combined accounted for over 50% of the total score.
Cognitive Level of Assignments and Tests

For each of the instructors, the cognitive level of assignments and the cognitive level of tests was assessed. The two scores reflecting cognitive weight of assignments and cognitive weight of tests were combined in the same proportion as that used by the instructor for grading purposes. This combined score was labeled the total cognitive level of tests and assignments. A description follows of the weighted cognitive values for tests and assignments, individually and combined.

Each question from each of the evaluation measures was classified into one of the seven levels of the FTCB. The percentage of points at each level, according to the instructor's grading procedures, was computed for both tests and assignments. Total percentages by level were then multiplied by the appropriate cognitive weighting factors (Table 3) to yield weighted values by level for both tests and assignments. Table 18 illustrates the method used to compute a weighted knowledge test value.

Table 19 reports the percentage and weighted values of tests by cognitive level for each instructor. A wide variation in percentage of points at individual cognitive levels and in the total weighted values between the three instructors is evident. Percentage of points at the knowledge level ranged from 4% to 86%. Interpretation ranged from 5% to 16% and application ranged from 5% to
Table 18

Illustration of Computing a Composite Weighted Value for Tests

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Points Available</th>
<th>Percent of Exam</th>
<th>Weighting Factor</th>
<th>Weighted Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>154*</td>
<td>38.50</td>
<td>.10</td>
<td>3.85</td>
</tr>
</tbody>
</table>

*400 points available on tests

Table 19

Percentage and Weighted Value of Cognitive Levels of Tests* for each Instructor

<table>
<thead>
<tr>
<th>Cognitive Level of Tests</th>
<th>Instructor 1</th>
<th>Instructor 2</th>
<th>Instructor 3</th>
<th>Weighted Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of Cognition</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Knowledge</td>
<td>38.50</td>
<td>85.7</td>
<td>4.4</td>
<td>3.85</td>
</tr>
<tr>
<td>Translation</td>
<td>4.25</td>
<td>3.9</td>
<td>0.0</td>
<td>.85</td>
</tr>
<tr>
<td>Interpretation</td>
<td>15.75</td>
<td>5.2</td>
<td>21.8</td>
<td>3.94</td>
</tr>
<tr>
<td>Application</td>
<td>41.5</td>
<td>5.2</td>
<td>13.0</td>
<td>12.45</td>
</tr>
<tr>
<td>Analysis</td>
<td>0.0</td>
<td>0.0</td>
<td>39.1</td>
<td>0.0</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0.0</td>
<td>0.0</td>
<td>21.7</td>
<td>0.0</td>
</tr>
</tbody>
</table>

| TOTAL                    | 100          | 100          | 100          | 21.09          | 12.21         | 36.28          |
| MEAN                     |              |              |              | 23.19          |               |                |

*Tests include quizzes and mid-term examinations
42%. All questions were in the bottom four levels for two instructors. More than 60% of the third instructor's points occurred at the analysis and evaluation levels.

The range in cognitive levels of tests is seen clearly in the total weighted values for the three instructors. Total weighted value of tests ranged from 12.21 to 36.28 with a mean of 23.19.

A comparison of cognitive levels between tests and out-of-class assignments can be made by contrasting Table 19 with Table 20. Table 20 shows the levels of cognition of assignments for each instructor by percentage and by weighted values.

In contrast to the cognitive level of the tests, the assignments did not include any knowledge questions and only one instructor had 6% translation. Similar to the cognitive level of tests, percentages at certain cognitive levels displayed some variation. Synthesis was the only cognitive level required in the one assignment given by instructor 2. Seventy-eight percent of the questions from laboratory assignments in class 3 entailed interpretation. While instructors 2 and 3 questioned at one and two levels respectively in the assignments, instructor 1 incorporated questions from five levels, with an emphasis on application and analysis.
Table 20
Percentage and Weighted Value of Cognitive Level of Assignments* for Each Instructor

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Instructor 1</th>
<th>Instructor 2</th>
<th>Instructor 3</th>
<th>Weighted Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Knowledge</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Translation</td>
<td>5.7</td>
<td>0.0</td>
<td>0.0</td>
<td>1.14</td>
</tr>
<tr>
<td>Interpretation</td>
<td>12.6</td>
<td>0.0</td>
<td>78.6</td>
<td>3.15</td>
</tr>
<tr>
<td>Application</td>
<td>42.7</td>
<td>0.0</td>
<td>21.4</td>
<td>12.80</td>
</tr>
<tr>
<td>Analysis</td>
<td>26.0</td>
<td>0.0</td>
<td>0.0</td>
<td>10.40</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0.0</td>
<td>100.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Evaluation</td>
<td>13.0</td>
<td>0.0</td>
<td>0.0</td>
<td>6.5</td>
</tr>
</tbody>
</table>

TOTAL 100 100 100 33.99 50.0 26.07
MEAN 36.69

*Assignments consisted of out-of-class work such as laboratory assignments, homework, and projects

It is evident from Table 20 that higher levels of cognition were required in the assignments than in the tests. The total weighted values of assignments ranged from 26.07 to 50.0 with a mean of 36.69. The weighted score of 50.0 for instructor 2, however, was based on only one assignment.

For the three instructors the composite scores of tests and assignments combined are presented in Table 21.
Table 21
Total Weighted Cognitive Scores of Tests and Assignments for Each Instructor

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Tests and Assignments Total Weighted Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>27.54</td>
</tr>
<tr>
<td>2</td>
<td>18.51</td>
</tr>
<tr>
<td>3</td>
<td>31.18</td>
</tr>
</tbody>
</table>

Possible Range = 10 - 50

These scores were calculated using the proportions each instructor designated for tests and assignments for grading purposes. Cognitive level of tests and assignments for the three instructors were 27.54 for instructor 1, 18.51 for instructor 2, and 31.18 for instructor 3.

**Cognitive Level of Achievement**

A value for cognitive achievement was derived for each student based on performance on the final examination. The following discussion reports the cognitive levels present on the final exams, the cognitive levels achieved by students, and factors related to student cognitive achievement.
Cognitive Level of Final Exams

The cognitive level of the final exam was calculated by multiplying the percentage of the exam which fell at each level of cognition by the cognitive weighting factor for that level. Using this method, cognitive levels of the final exams for all instructors could range between 10 and 50. If 100% of the final exam was at the knowledge level, the cognitive level of the exam would be 10. If 100% of the final exam was at either synthesis or evaluation, the cognitive level of the exam would be 50. Table 22 summarizes the actual cognitive levels of the exams for each instructor.

Several points in Table 22 should be noted. First, the instructors did not test at every level. Instructors 1, 2, and 3 tested at five, three, and two different levels, respectively.

Second, the instructors did not test at the same levels. Two instructors tested at the knowledge, interpretation, application, or analysis levels. Questions at the translation or evaluation levels were present on only one exam and none of the instructors tested at the synthesis level. The three instructors did not commonly test at any of the cognitive levels. The discrepancy between cognitive levels tested by the instructors should also be noted. Instructor 3 tested only at two levels and these were two of the highest levels, analysis and
Table 22

Percentages and Weighted Values of Cognitive Levels on the Final Exams by Instructor

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Instructor 1</th>
<th>Instructor 2</th>
<th>Instructor 3</th>
<th>Weighted Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>66.0</td>
<td>77.4</td>
<td>0.0</td>
<td>6.6</td>
</tr>
<tr>
<td>Translation</td>
<td>2.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.4</td>
</tr>
<tr>
<td>Interpretation</td>
<td>14.0</td>
<td>2.6</td>
<td>0.0</td>
<td>3.5</td>
</tr>
<tr>
<td>Application</td>
<td>16.0</td>
<td>20.0</td>
<td>0.0</td>
<td>4.8</td>
</tr>
<tr>
<td>Analysis</td>
<td>2.0</td>
<td>0.0</td>
<td>60.0</td>
<td>0.8</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0.0</td>
<td>0.0</td>
<td>40.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>16.1</td>
</tr>
</tbody>
</table>

evaluation. This exam contrasts sharply with the other two in which the lower levels predominated.

Third, of the four commonly tested cognitive levels (knowledge, interpretation, application and analysis), some variation was evident at two cognitive levels. Analysis questions ranged from 2% to 60% of the exams and interpretation questions ranged from 3% to 14%. The percentage of knowledge questions on two exams was high, comprising 66% and 77% of these two exams.
As a result of all these differences, the total cognitive weighted values for the three instructors showed a wide variance. The exam for instructor 2 had the lowest score of 14.4, followed closely by the exam of instructor 1 with a score of 16.1. In contrast, the cognitive weight of the exam of instructor 3 was 44.0.

Student Cognitive Level of Achievement

Student Percentage Achievement

Students' cognitive level of achievement was examined from several perspectives. Table 23 reports the statistics for percentage correct on the exams for all students and by instructor.

Table 23
Percentage of Final Exam Correct For all Students and by Instructor

<table>
<thead>
<tr>
<th>Percentage Correct on Final Exam</th>
<th>Instructor</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistics</td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>MEAN</td>
<td></td>
<td>70.75</td>
<td>62.11</td>
</tr>
<tr>
<td>S. D.</td>
<td></td>
<td>10.85</td>
<td>11.32</td>
</tr>
</tbody>
</table>

The mean percentage correct for all students was 67%. The mean percentage correct for instructors 1 and 2 showed minor variation (71% and 62%). However, the mean
percentage correct for instructor 3 differed markedly at 89%.

Percentage achievement scores by level of cognition were also computed. The average percent correct at each cognitive level is reported in Table 24. These scores again demonstrated the limited number of levels at which students had the opportunity to perform.

Table 24

Percentage Correct by Level on the Final Exam for Each Instructor

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Instructor 1</th>
<th>Instructor 2</th>
<th>Instructor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>71.1</td>
<td>61.4</td>
<td>-</td>
</tr>
<tr>
<td>Translation</td>
<td>76.7</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Interpretation</td>
<td>59.9</td>
<td>45.9</td>
<td>-</td>
</tr>
<tr>
<td>Application</td>
<td>76.0</td>
<td>67.2</td>
<td>-</td>
</tr>
<tr>
<td>Analysis</td>
<td>86.7</td>
<td>-</td>
<td>97.6</td>
</tr>
<tr>
<td>Synthesis</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Evaluation</td>
<td>-</td>
<td>-</td>
<td>76.8</td>
</tr>
</tbody>
</table>

In examining this data, one would expect that as the cognitive level increases from knowledge to evaluation that percentage correct would decrease. This is based on the presupposition of a hierarchical relationship between cognitive levels in Bloom's Taxonomy (Bloom et al., 1956). However, some of the data in Table 24 do not show this
relationship. A decrease in percentage correct was evident between knowledge and interpretation. For two instructors, though, percentage correct exhibited an increase from interpretation to application; and for instructor 1, percentage correct increased further at the analysis level (87% correct). The data for instructor 3 includes only two levels and a decrease in percent correct was noted between analysis and synthesis. The average percent correct at the analysis level for instructor 3 was 98%.

**Calculating Weighted Cognitive Achievement**

The value for weighted cognitive level of achievement (referred to as student cognitive level of achievement) was computed by summing students' weighted cognitive scores of achievement at each level. Students' weighted cognitive scores of achievement at each level were calculated by multiplying the proportion of the cognitive level on the exam by the student's percent score at that level on the exam and then the appropriate cognitive weighting factor (Table 3). An example of the calculations used is presented in Table 25.

Student scores using this method could range from 0 to 50, with 0 representing failure to achieve at any level and 50 representing a score of 100% on an exam consisting only of synthesis and evaluation questions.
Table 25

Illustration of the Calculations Used to Compute One Level of the Student Cognitive Level of Achievement Score

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Proportion of Level on Exam*</th>
<th>Student's % Score</th>
<th>Weighting Factor</th>
<th>Student's Weighted Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis</td>
<td>.20</td>
<td>80.0</td>
<td>.40</td>
<td>6.4</td>
</tr>
</tbody>
</table>

*Expressed in a decimal

**Weighted Cognitive Level of Achievement**

A composite value for cognitive level of achievement based on the final exam was calculated for every student for whom final exam data was available. These composite values, computed using the procedures reported in Table 25, are presented in Table 26.

Exams for 76 of the 83 students were utilized. As indicated in Table 26, total weighted student achievement scores ranged from approximately 4 up to 44. The mean score was 12.43; the standard deviation was 8.72. Note should be taken of several points. First, the weighted student achievement score frequencies were distributed bimodally to some extent. No scores are found between 16.0 and 33.0. Second, the seven highest scores, from 34 to 44, were all obtained on the exam with the cognitive
Table 26
Student Cognitive Levels of Achievement Scores for All Students

<table>
<thead>
<tr>
<th>Student Cognitive Level of Achievement Score Ranges</th>
<th>Student Frequency</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.00 - 5.99</td>
<td>3</td>
<td>3.9</td>
</tr>
<tr>
<td>6.00 - 7.99</td>
<td>10</td>
<td>13.1</td>
</tr>
<tr>
<td>8.00 - 9.99</td>
<td>24</td>
<td>31.7</td>
</tr>
<tr>
<td>10.00 - 11.99</td>
<td>24</td>
<td>31.7</td>
</tr>
<tr>
<td>12.00 - 13.99</td>
<td>6</td>
<td>7.9</td>
</tr>
<tr>
<td>14.00 - 15.99</td>
<td>2</td>
<td>2.6</td>
</tr>
<tr>
<td>16.00 - 17.99</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>18.00 - 19.99</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td>20.00 - 21.99</td>
<td>2</td>
<td>2.6</td>
</tr>
<tr>
<td>22.00 - 23.99</td>
<td>2</td>
<td>2.6</td>
</tr>
<tr>
<td>24.00 - 25.99</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td>26.00 - 27.99</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>28.00 - 29.99</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td>30.00 - 31.99</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td>32.00 - 33.99</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td>34.00 - 35.99</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>36.00 - 37.99</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td>38.00 - 39.99</td>
<td>2</td>
<td>2.6</td>
</tr>
<tr>
<td>40.00 - 41.99</td>
<td>2</td>
<td>2.6</td>
</tr>
<tr>
<td>42.00 - 43.99</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td>44.00</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td>Total</td>
<td>76*</td>
<td>100</td>
</tr>
</tbody>
</table>

MEAN = 12.43  *7 missing cases
SD = 8.72
Possible Range = 0 - 50

level of 44. All students were not given the opportunity to perform at the higher levels or to achieve scores reflecting a higher level of achievement.

Factors Related to the Cognitive Level of Achievement

One goal of this study was to assess the relationship of various factors to the cognitive level of achievement.
of students. The relationships reported in this study were based on the scale suggested by Davis (1971).

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.70 - 0.99</td>
<td>Very High</td>
</tr>
<tr>
<td>0.50 - 0.69</td>
<td>Substantial</td>
</tr>
<tr>
<td>0.30 - 0.49</td>
<td>Moderate</td>
</tr>
<tr>
<td>0.10 - 0.29</td>
<td>Low</td>
</tr>
<tr>
<td>0.01 - 0.09</td>
<td>Negligible</td>
</tr>
</tbody>
</table>

Correlations were computed and are reported in the following three tables. However, the reader should interpret the correlations with caution because of the previously reported concern of comparing the three exams.

Student Characteristics

Correlations between students' cognitive level of achievement scores and selected student characteristics are shown in Table 27.

The correlations between students' previous experience and students' cognitive level of achievement scores were negative but at a low level (Rho = -.26). A low positive correlation was found between academic rank and students' cognitive level of achievement (Rho = .22). However, a substantial positive correlation was found between students' cognitive level of achievement and interest in and value of the course to the student (r = .52).
Table 27

Correlations Between Students' Cognitive Level of Achievement Scores and Selected Student Characteristics

<table>
<thead>
<tr>
<th>Selected Student Characteristics</th>
<th>Correlations with Students' Cognitive Level of Achievement Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous Experience</td>
<td>-.25(a)</td>
</tr>
<tr>
<td></td>
<td>(N = 60)</td>
</tr>
<tr>
<td>Interest in and Value of the Course</td>
<td>.52(b)</td>
</tr>
<tr>
<td></td>
<td>(N = 38)</td>
</tr>
<tr>
<td>Academic Rank</td>
<td>.22(a)</td>
</tr>
<tr>
<td></td>
<td>(N = 76)</td>
</tr>
</tbody>
</table>

a. Spearman Rank Order Correlations
b. Pearson-Product Moment Correlations

Instructor Variables

The relationship of students' cognitive level of achievement scores to instructor variables is shown in Table 28.

Instructor previous experience was found to be substantially negatively correlated with the students' cognitive level of achievement scores ($r = -0.62$). This indicated that as instructor experience increased, students' cognitive level of achievement scores decreased. A very high positive correlation was found between
instructor's cognitive expectations for the course and students' cognitive level of achievement \( (r = .72) \).

### Table 28

Pearson-Product Correlations Between Students' Cognitive Level of Achievement Scores and Selected Instructor Variables

\( N = 76 \)

<table>
<thead>
<tr>
<th>Selected Instructor Variables</th>
<th>Correlations with Students' Cognitive Level of Achievement Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous Experience</td>
<td>( -.62 )</td>
</tr>
<tr>
<td>Cognitive Expectations for the Course</td>
<td>( .72 )</td>
</tr>
</tbody>
</table>

### Course Variables

The final correlations calculated were between the students' cognitive level of achievement scores and selected course variables. These correlations are reported in Table 29.

A low correlation was found between students' cognitive level of achievement scores and the cognitive level of teaching \( (r = .17) \). A substantial relationship was found between the cognitive level of tests and assignments and students' cognitive level of achievement scores \( (r = .67) \).
Table 29
Pearson-Product Correlations Between Students' Cognitive Level of Achievement Scores and Selected Course Variables
N = 76

<table>
<thead>
<tr>
<th>Selected Course Variables</th>
<th>Correlations with Students' Cognitive Level of Achievement Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive Level of Teaching</td>
<td>.17</td>
</tr>
<tr>
<td>Cognitive Level of Tests and Assignments</td>
<td>.67</td>
</tr>
</tbody>
</table>

Summary of Findings
A summary of the results of the questions posed in this study follows. First, this research was able to obtain a measure of the cognitive level of achievement of the students in the selected courses based on performance on the final examination and adjusted to reflect the hierarchy of the different levels of cognition. Second, a measure of the cognitive level of teaching was obtained for the three instructors. Cognitive levels of teaching varied little between instructors and were centered at the translation level. Third, the relationship of selected student and professor variables to student cognitive level of achievement was examined. Difficulties were present in
comparing cognitive level of achievement scores between instructors. Yet, the correlation between student cognitive level of achievement and instructors' cognitive expectations was found to be very high; and the correlation between instructors' cognitive expectations and students' cognitive level of achievement was substantial. Correlations with most other variables, including the cognitive level of teaching, were found to be low, negligible, or negative.
CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to determine the level of cognitive achievement by students in selected College of Agriculture classes and the factors related to student cognitive achievement. The following research questions guided the study.

1. What cognitive level was achieved by students in the selected College of Agriculture courses?

2. At what cognitive level of instruction did selected College of Agriculture professors teach?

3. To what extent were selected variables related to higher cognitive levels of achievement by the students in selected College of Agriculture courses? The following variables were examined.

a. cognitive level of instruction;

b. instructor's cognitive expectations for the course;

c. cognitive level of assignments, quizzes and mid-term examinations;
d. student's prior experience with course content through previous college courses, high school courses and work experience;

e. motivation of students regarding the course;

f. student's academic rank;

g. instructor's academic preparation, previous course experience, work experience and professional interests;

Procedure

The target population for this study consisted of undergraduates in the College of Agriculture at The Ohio State University. The actual sample was a purposefully selected sample of students enrolled in three classes in the College of Agriculture during Winter Quarter of 1988 (N = 83). One class was a freshman level animal science class (N = 51). The second was a middle-to upper-division agricultural economics course (N = 22); and the third was an upper-division horticulture class (N = 10).

Several different instruments were utilized to assess the variables in the study. Cognitive level of achievement was assessed by student performance on the final examination. Final exam questions were categorized using the seven levels of the Florida Taxonomy of
Cognitive Behavior (Brown, Ober, Soar, & Webb; 1968). Students' cognitive level of achievement scores were derived by summing weighted performance scores at each level.

Cognitive level of instruction was evaluated through three separate class observations for each instructor which were audiotaped and subsequently classified using the FTCB. A composite cognitive level of teaching score was derived for each instructor by summing weighted scores for each cognitive level of the FTCB.

The FTCB was also used to classify the cognitive level of assignments and tests. All questions from any evaluation procedures used prior to the final exam were classified. These included laboratory assignments, class projects, homework, quizzes and mid-term examinations. A cognitive level score was derived by summing the scores at each level for both tests and assignments. These two scores were then combined into one value for cognitive level of tests and assignments.

Students' prior experience with course content through previous college courses, high school courses and work experience was evaluated using the instrument labeled Student Previous Experience. The instrument consisted of eight "yes" or "no" questions and was administered in class by the instructor during the last week of the quarter.
Student motivation regarding the course was assessed using the instrument labeled "Interest in and value of course". This instrument consisted of five questions regarding reasons for enrollment and relation of the course to career objectives.

Academic rank of students was reported on the "Interest in and value of course" instrument. Missing data were obtained from the class rosters.

Descriptive information about the three instructors was also obtained. Instructor's cognitive expectations for the course was assessed using personal interviews conducted following the close of the quarter. Instructor's academic preparation, previous course experience, work experience and professional interests were evaluated by the instrument labeled "Instructor previous experience".

Reliability and Validity

Validity of the FTCB was based on validity studies of Bloom's Taxonomy (Kropp & Stoker, 1966; Madaus, Woods, & Nuttall, 1973; Stoker & Kropp, 1964). Reliability for the FTCB was established by pilot and field testing (Brown et al., 1968). Intra-rater reliability for the classroom observer using the FTCB in this study was found to be .99 and .98.

The validity of the weighting factors used to compute weighted cognitive values by level were also based on the
validity studies regarding Bloom's Taxonomy. Reliability for the weighting factors was established by three agricultural educators.

The two student instruments were pilot tested for reliability. Pilot testing revealed a Cronbach's Alpha reliability coefficient of .70 for the Student's previous experience instrument. Results from pilot testing of Interest in and value of the course instrument resulted in a Cronbach's Alpha reliability coefficient of .75. Both student instruments and the Instructor's previous experience instrument were validated by a panel of six teacher educators.

Summary of Findings

Characteristics of the Instructors and Students

An instructor experience score was obtained for each instructor which reflected previous university teaching experience, employment or experience outside the university related to the course, level of expertise in the course material, and the extent of previous education, research or community involvement related to the course. Total scores for instructor previous experience ranged from 63 to 80 for the three instructors.

Instructors also evaluated the cognitive level of learning at which they expected their students had learned. The summative scores for each instructor ranged
from a low of 20.65, which would be centered at the translation level, to 30.25 and 35.75, both centered at the application level.

Information regarding students was also obtained. The typical student was completing the sophomore year majoring in an agriculture-related field. Students' previous experience scores indicated that the typical student had background in one-half of the previous experiences related to the course materials. These prior experiences included past coursework, work experience, FFA or 4-H involvement. Interest in and value of the course to the student was also assessed, although the return rate for this instrument was slightly greater than 50%. The typical student scored 31 in a possible range of 5 to 47.

**Cognitive Level of Courses**

The cognitive level of courses was evaluated in two different ways. The cognitive level of teaching was assessed through classroom observations and analyses of audio-tapes. The cognitive level of tests and assignments was evaluated by classifying the questions from all evaluation procedures used during each of the classes.

**Cognitive level of teaching**

The cognitive level of teaching was assessed through three separate class observations for each instructor. Notes were taken during each observation as it was audio-
taped. Each class was then subsequently classified using six-minute intervals into the fifty-five categories of the Florida Taxonomy of Cognitive Behavior (Brown, Ober, Soar, & Webb; 1968). An average of 388 cognitive behaviors were recorded per instructor.

Frequencies and percentages were calculated for each of the seven levels of the FTCB for each instructor. The level of knowledge predominated for all three instructors with a mean of 45.7% of the teaching behaviors for the three instructors combined at this level. The lowest three levels, knowledge through interpretation, accounted for just over 72% of the total frequencies of all cognitive behaviors observed. Analysis accounted for 14.2% of the observed frequencies; 6.5% was at the level of application; and approximately 3% occurred at both synthesis and evaluation.

Weighted cognitive teaching scores were also calculated for each cognitive level and then summed to yield a total weighted cognitive teaching score for each instructor. Weighting factors were .10 for knowledge, .20 for translation, .25 for interpretation, .30 for application, .40 for analysis, and .50 for both synthesis and evaluation.

The total weighted scores could range from 10, if 100% of the instruction was at the knowledge level, to 50, if 100% of the observed teaching behaviors were at either
synthesis or evaluation. Total scores for the three instructors exhibited a very small range, from 20.40 to 22.76. These scores represent a cognitive level of teaching centered around translation.

For the three instructors combined, analysis accounted for the greatest proportion of the average total weighted cognitive teaching score of 21.47. The mean for knowledge accounted for the second greatest proportion, despite the fact that the weighted value for knowledge was attained using the lowest weighting factor, .10.

Cognitive level of assignments and tests

All evaluation measures used for grading purposes were assessed using the FTCB by cognitive level. This included homework, laboratory assignments, class projects, quizzes and mid-term examinations. Separate combined scores were obtained for tests and assignments and then compressed into one score of total cognitive level of tests and assignments.

The weighted values of tests (including tests and quizzes) were 12.2, 21.1, and 36.2 for the three instructors reflecting cognitive emphases on tests at the knowledge, translation, and application levels. Overall the cognitive level of out-of-class assignments was higher for the three instructors who had scores of 26.1, 34.0, and 50.0. It should be noted that less than 2% of the
total points for assignments occurred at either of the two lowest levels.

**Cognitive Level of Achievement**

Student cognitive achievement was evaluated by performance on the final exam. The three instructors showed wide variation in the cognitive levels emphasized on the final examinations. Instructors 1 and 2 asked 66% and 77% knowledge questions respectively. Instructor 3 included only two levels and had 60% of the points at the analysis level with the remainder at evaluation. Instructor 2 tested at three levels. Instructor 1 included questions at five levels, but two of these levels had only 2% of the questions. As a result of this variation in cognitive emphasis, weighted cognitive scores of the exams ranged from a low of 14.4 to a high of 44.0. Unfortunately, the discrepancies in levels tested and emphasis of the three exams generated tests and consequently levels of performance that were not comparable from one professor to the next.

Using the percentage of the exam at each level for each instructor, percentage correct at each level for each student, and the cognitive weighting factors, a composite student cognitive level of achievement score was calculated. Student scores could range in this study from a low of 0, representing a score of 0 on the exam, to a
high of 44, representing a perfect score on the exam from instructor 3.

Actual scores in this study ranged from 4.39 to 44.0. However, scores in the class with a possible cognitive score of 44 ranged from 34.0 to 44.0. Scores in the other two classes ranged from 4.0 up to 16.0. The bimodal distribution is a reflection of the contrasting available cognitive scores possible in the three classes.

This study also sought to assess the relationship between the cognitive level of performance and other selected variables. Since the exams were not comparable by levels or by total cognitive weights, the results of correlations must be viewed with caution. Additional caution is due because of the low number of instructors in the study (N = 3) and the resulting few instructor variables.

With the above cautions in mind, several relationships will be noted. First, correlations between two of the student variables (student previous experience and academic rank) and cognitive level of achievement were found to be low. The correlation with academic rank was positive but the correlation between student previous experience and student cognitive level of achievement was negative. A substantial positive relationship was found between students' cognitive level of achievement and interest in and value of the course to the student.
A substantial positive correlation was found between student cognitive level of achievement and two different instructor and course variables: instructor cognitive expectations and cognitive level of tests and assignments. A low correlation was found between instructor's cognitive level of teaching and students' cognitive level of achievement scores. However, these correlations may be inaccurate because of the lack of comparability of the final exams.

A similar problem occurs in interpreting the significant negative relationship between student cognitive level of achievement and instructor previous experience. The instructor with the greatest experience administered the test with the lowest cognitive score possible.

**Discussion**

The overarching goal of research such as this study is to provide information about and insight into the complex workings of the classroom so that student learning and development is improved. Specifically, this study was based on the argument that students need to develop their cognitive skills and abilities because of the demands of employment and to function as citizens in a democracy. The major assumption of this study was that the development of cognitive skills and abilities in college
students can be influenced by the cognitive level of courses. The fundamental question which guided this research was how can instructors help their students to increase their cognitive skills and abilities.

**Previous Research**

An extensive amount of research has been conducted which provides both a foundation and framework for this study. The theory of cognitive levels was made explicit through the development of Bloom's Taxonomy (Bloom et al., 1956). The Taxonomy has been tested for both validity and reliability, it has been used extensively and it has withstood, overall, the test of time. Applications using the Taxonomy have been diverse. Procedures in this study rested on previous research which demonstrated that the Taxonomy can be used to classify written questions, objectives, and oral questions and statements.

Previous studies have also indicated that teachers can be trained to use the Taxonomy. Following training in the Taxonomy, teachers have shown increased use of questions and other discourse at the higher cognitive levels. Additional research has linked the use of higher cognitive level questions to improved scores on both achievement and retention tests, although these results are complex. For example, both low and high cognitive level questions have had a similar impact on achievement and retention scores in some studies.
While previous work has built both a theory and a respectable body of knowledge, researchers have failed to examine instructional or other variables which may influence the development of cognitive skills and abilities at the various levels of Bloom's Taxonomy. The focus of related research to this point has been to study the relationship between cognitive levels of instruction, specifically and primarily the use of questions, and overall student achievement. Thus, this study represents a divergence from much prior work. As such, several points should be noted.

In gathering information and assessing factors that might be related to the development of cognitive skills and abilities, one can begin by assuming that factors related to overall achievement may likely be related to higher cognitive level of achievement as well. However, additional variables not considered in this study may well be related to higher cognitive level abilities. Such considerations might include age of the student, the amount of discussion in a class, whether a class is student or teacher-centered or other factors. Since teaching and learning are complex processes and since this study represents a divergence in cognitive research, the potential influence of additional variables should be kept in mind.
Cognitive Level of Courses

Previous work on cognition in the College of Agriculture focused on a comparison of the cognitive level required by selected instructors on tests and exams with the cognitive level required on assignments (Newcomb & Trefz, 1987). Findings from the Newcomb and Trefz (1987) study indicated that higher cognitive levels were required in assignments than in exams.

One purpose of this study was to secure a broader picture of the levels of cognition required by various aspects of courses, including not only the cognitive level of tests and assignments (including final exam data) but also the cognitive level of teaching. A comparison of the total weighted cognitive scores present in the various aspects of each instructor's course is presented in Table 30.

The composite scores in Table 30 provide several contrasts and raise numerous questions. First, a comparison between the cognitive expectation scores and the scores for the remaining variables is revealing. One would expect that an instructor's cognitive level of expectations for learning would show a close correspondence to the cognitive level of teaching and evaluation. This appeared to be the case for instructor 2; the cognitive expectation score was close to the cognitive level of teaching and fell between the cognitive
### Table 30
Total Weighted Cognitive Scores of Course Variables by Instructor

<table>
<thead>
<tr>
<th>Variable</th>
<th>Instructor 1</th>
<th>Instructor 2</th>
<th>Instructor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive Expectations for the Course</td>
<td>30.25</td>
<td>20.65</td>
<td>35.75</td>
</tr>
<tr>
<td>Cognitive Level of Teaching</td>
<td>22.76</td>
<td>20.40</td>
<td>21.26</td>
</tr>
<tr>
<td>Cognitive Level of Assignments</td>
<td>33.99</td>
<td>50.00</td>
<td>26.07</td>
</tr>
<tr>
<td>Cognitive Level of Tests</td>
<td>21.09</td>
<td>12.21</td>
<td>36.28</td>
</tr>
<tr>
<td>Cognitive Level of Final Exam</td>
<td>16.1</td>
<td>14.39</td>
<td>44.00</td>
</tr>
</tbody>
</table>

*Possible range for all variables was 10 to 50

level of various evaluation measures. For instructors 1 and 3, there was a significant discrepancy between their cognitive expectations and the cognitive level of teaching. In addition, there appeared to be some discrepancy between cognitive expectations and the overall cognitive level of tests, assignments, and the final exam for instructor 1.

For all of the variables except one, cognitive level of teaching, there was wide variation between instructor
scores. (Note that all weighted scores potentially range from 10 to 50). That is, instructors had widely different cognitive expectations and used questions on evaluation measures at widely different cognitive levels. Yet, in the classroom, the teaching behaviors of these three instructors which were classified were astonishingly similar.

This similarity cannot be explained by a correspondence with the cognitive level of other aspects of each course. The cognitive level of other aspects of each course varied sharply from the cognitive level of teaching, except for instructor 2. Nor can the similarity be explained by such factors as size or level of the classes, since these also varied. Yet the concentration of discourse at the level of translation concurred with prior research findings of a majority of classroom discourse at the level of knowledge. Factors which might be related to the observed cognitive levels of discourse include lack of training in teaching at higher levels; lack of role models; felt pressures from colleagues and the compulsion to cover the technical material; the ease of teaching at the level of knowledge; or the threat of losing control over the classroom if greater latitude is given to explore and probe.

The reader should also note, from Table 30, the variation found in the assorted evaluation measures.
First, the cognitive level of assignments was appreciably higher for instructors 1 and 2 than the cognitive level of tests or the final exam. However, for instructor 3, the cognitive level of assignments was lower than the other evaluation measures. The results for instructors 1 and 2 support the findings of Newcomb and Trefz (1987).

Second, it should be noted that little variation was found between the cognitive level of tests and the cognitive level of the final exam for any of the instructors. Finally, the contrast between the cognitive level of the tests and final exams between instructors should be noted. Instructor 3 was testing at analysis and evaluation, whereas instructors 1 and 2 were testing primarily at knowledge. This contrast will be considered more thoroughly in the section regarding student cognitive achievement.

Several major questions are raised by the data in Table 30 regarding the development of students' cognitive abilities. First, given the discrepancies that students encountered in these classes, to what did these students pay attention? The likely answer is that students pay greater attention if they believe the material will be on the exam. Thus, students may have assessed the cognitive levels required by tests and assignments and adjusted their learning to concentrate at the emphasized levels.
For example, the students who were tested primarily at the knowledge level focused on recall.

If students do, in fact, adjust the cognitive level of their learning, there are profound implications for course design and implementation. In this study, one would expect that students who encountered high cognitive levels on tests and assignments would then learn to pay greater attention to higher level discourse in the classroom. In contrast, those students who were not tested at the higher cognitive levels, especially those students with lower motivation or less inquiring minds, would tend to deemphasize questions or discourse at the higher levels.

Therefore, to encourage the development of cognitive abilities for a range of students, instructors must pay a great deal of attention to the cognitive levels emphasized in tests and assignments. While higher level cognitive discourse may raise student interest in the classroom, it may fail to produce or to maximize learning at higher cognitive levels if these levels are not expected to be tested.

Students' Cognitive Level of Achievement

To aid in the development of students' cognitive skills and abilities, descriptive information about the cognitive level of courses is essential. In addition a measure of the students' cognitive level of achievement is
necessary. Using a measure of cognitive achievement, it is then possible to begin to explain the relationships between cognitive level of achievement and other factors.

If the differential effects of classroom variables are to be compared with students' cognitive level of achievement, it is essential that the measure of cognitive level of achievement be comparable between classes. This was the major obstacle encountered in this study. A discussion of the conditions found in this study and conditions necessary in further research follows.

Factors Influencing Student Cognitive Level of Achievement Scores.

In an ideal research setting, cognitive level of achievement could be measured by the same final exam given in a number of different classes. This ideal situation did not exist for this study. Yet given varying classes, the researcher must likewise be wary of imposing exams or exam questions which would not otherwise, in the natural course of events in the class, occur. If an accurate assessment of what exists is important, then a minimum amount of interference is necessary. However, the lack of interference in this study resulted in several problems.

Construction of exams was one problem. A review of exam questions revealed that questions at the lower cognitive levels were not always or necessarily easier than higher level questions. For example, a knowledge
question that tests for minor or obscure facts may be judged more difficult than a relatively easy application question. Also, the three exams used in this study were of different types. One consisted only of objective questions, one consisted of all essay questions, and the other mixed objective and short answer questions.

The different types of exams raised a further question regarding grading procedures. While objective questions are very straightforward to grade, subjectivity is more likely to enter into grading essay questions. Where there is subjectivity, instructors may grade leniently or stringently. This may have been a factor in the higher percentage scores found on the exams in the class with instructor 3 ($\bar{x} = 89\%$) than on the exams for all the students ($\bar{x} = 67\%$).

A third problem was the fact that instructors did not test at all seven levels of cognition, nor did they test at the same levels. Thus, students in different classes were not given equal opportunity to perform at all levels.

The influence of the differences in the exams becomes apparent if one supposes that the mean percentage scores in the class with instructor 3 were similar to those in the other two classes. Mean percentage scores with instructor 3 were actually 89% compared with the mean for all three classes of 67%. If students with instructor 3 had averaged only 67% on their exam, their mean weighted
cognitive level of achievement scores would still have been 29.5. If these students had averaged 75% correct, which might be expected since they were mostly upper-division students, their mean weighted cognitive level of achievement scores would have been 33.0. The highest score in the other classes was less than 16.0. In either case, students with instructor 3 would have scored markedly above students in the other classes.

One intention of this research was to compare student cognitive level of achievement scores with other factors. Theoretically, these scores should reflect the variation in cognitive performance abilities of the different students. However, in future research, the above problems will need to be addressed before attributing cognitive level of achievement scores to actual differences in student performance abilities. For this study, it appears that the cognitive levels at which students were tested had a greater effect on cognitive level of achievement scores than did actual student performance or other factors.

1 \[ [.67 \text{ (average percentage correct)} \times 60 \text{ (% of exam at analysis)}] + [.67 \text{ (average percentage correct)} \times 50 \text{ (% of exam at evaluation)}] \]
Factors Related to Student Cognitive Level of Achievement.

A discussion of the correlations found between students' cognitive level of achievement and selected variables follows. The reader is advised to keep the above reservations in mind. A low positive correlation was found between students' cognitive level of achievement scores and students' previous experience scores. Strong correlations between these variables had not been found previously so this finding is not surprising. However, given the bias of this study toward the upper-division class with higher cognitive level of achievement scores, this finding is puzzling. One would have expected the older students to have higher scores on the previous experience measure. The problem with student cognitive level of achievement scores may, in fact, be masking an even lower correlation between previous experience and cognitive level of achievement.

The substantial correlation between interest in and value of the course to students and students' cognitive level of achievement scores was expected. In fact, this correlation might have been exaggerated since the students in the class with high cognitive level of achievement scores were enrolled in the class of instructor 3 because of major requirements related to their career objectives. The fact that this instrument was completed at home and
returned by a greater proportion of upper-division students might also have contributed to the higher correlations found between interest in the course and cognitive level of achievement scores.

A low correlation was found between academic rank and students' cognitive level of achievement scores. One would expect that as students progress from lower to upper-division classes that cognitive level of achievement scores would increase. This expectation was not supported by the results.

A substantial negative correlation was found between instructor's previous experience scores and students' cognitive level of achievement scores. This finding runs counter to the expectation that as an instructor's experience with the subject matter increases, the instructor is likely to incorporate more higher level thinking into the course. However, in this study, this finding reflected the confounding influence of the different final exams. The instructor with the lowest value for previous experience had the exam with the highest cognitive score possible and consequently the highest cognitive level of achievement scores. The instructor with the highest previous experience score had the lowest potential cognitive level of achievement based on his final exam. Additionally, there was some question as to the accuracy of the self-reported data regarding
related work experience. Thus, it was not surprising that a significant negative correlation was found between instructor previous experience and student cognitive level of achievement.

A very high correlation was found between instructor's cognitive expectations for the course scores and students' cognitive level of achievement scores. One would expect a strong relationship between these two variables.

A low correlation was found between instructor's cognitive level of teaching scores and students' cognitive level of achievement scores. This finding was disturbing. One would anticipate that as the cognitive level of teaching increased, that the cognitive level of achievement would also increase. However, the small range in cognitive level of teaching scores should be noted. In addition, instructor 1 had the highest cognitive level of teaching score but his potential cognitive level of achievement scores were in the middle and much lower than those of instructor 3.

A substantial correlation was found between the cognitive level of tests and assignments and students' cognitive level of achievement scores. This finding would be intuitively expected; one would expect instructors' final exams to test at the same cognitive levels as previous evaluation measures. One would also expect that
students' prior experience with tests and assignments would enable superior performance on a final exam which tested at similar cognitive levels.

Conclusions

The following conclusions were based upon the findings of this study and the interpretation of the researcher.

1. Instructors in this study taught at the lower levels of cognition and the cognitive level of teaching was strikingly similar for the three instructors. This similarity was found despite the fact that each course was intended for and attended by students of different academic rank. Additionally, as a whole, the cognitive level of teaching was substantially below the instructors' cognitive expectations for learning for the courses.

2. As a group, the three instructors utilized tests and assignments at a higher cognitive level than their overall cognitive level of teaching, but at a lower level than their cognitive expectations for the course. However, these scores showed greater variation among instructors, both as composite scores and as individual scores of the cognitive level of tests and the cognitive level of assignments. In general, the cognitive level of assignments was found to be higher than the cognitive level of tests, confirming the conclusion drawn by Newcomb
and Trefz (1987) that assignments demand higher levels of performance by students.

3. The cognitive level of each instructor's final exam was similar to the cognitive level of prior tests in each course. Between instructors, a wide variation occurred in the cognitive emphasis of the final examinations.

4. Due to the lack of comparability between the final examinations, no definitive conclusions can be made which would explain the variation in student cognitive level of achievement for the three instructors in this study. However, the results indicated the following:

a. Instructors with higher cognitive level of expectations provided students greater opportunity for higher cognitive achievement on the both the final exam and on tests and assignments. Cognitive expectations for the course appeared to explain approximately one-half of the variance in student cognitive achievement scores.

b. The cognitive level of teaching appeared to be unrelated to students' cognitive level of achievement.

c. As the cognitive level of tests and assignments increased, the cognitive level of achievement also appeared to increase.
d. Students' cognitive level of achievement did not appear to be related to any of the student variables: previous experience, interest in and value of the course, or academic rank. Apparent relationships could be explained either by discrepancies in the final examinations or the small number of classes in the study.

Recommendations

Recommendations for Instructors and Teacher Educators

This study suggests several areas of pursuit for instructors interested in providing students with increased opportunities to develop higher level cognitive skills and abilities. The following recommendations would contribute to an increase in the use of the higher cognitive levels. In placing greater emphasis at the higher levels it is assumed that students will not only have the opportunity to become more skilled at higher levels but they will also learn to place value on achievement at the higher cognitive levels.

1. Instructors should consider placing a greater emphasis on assignments. Assignments will almost automatically move the student away from recall into the higher levels since recall-type questions are inappropriate in out-of-class assignments.
2. Instructors need to place a greater emphasis on the higher cognitive levels in their classroom discourse. Although this is not likely to be easily accomplished, several factors could help instructors with this task. First, instructors need increased knowledge about the cognitive levels at which they teach. Second, instructors could examine their courses with several questions in mind.

   a. One question would be a consideration of the essential and non-essential knowledge of the course. Teachers may well have to choose between time spent teaching non-essential knowledge and time spent with students as they utilize knowledge at the higher levels of cognition.

   b. A related question instructors can ask themselves, if they do not already do so, is what they expect students to be able to do upon completion of the course. The answer or answers to this question should provide a guide to the cognitive levels which must be incorporated into the classroom instruction and evaluation procedures.

   c. Closely related to the cognitive emphasis of instruction and evaluation is the question of the most effective teaching methods. Previous research suggests that overall achievement is
related to teacher use of discussion and questions (Gall et al., 1976; McKeachie, 1970) and to teacher use of higher level questions or discourse (Hunkins, 1968; Ryan, 1973; Taba, 1966). Thus instructors should examine their own use of questions and discussion. This may entail not only training in Bloom's Taxonomy but also in methods to increase the use of questions and classroom discussion.

3. Instructors need to design in-class testing instruments which incorporate higher cognitive level questions. Tests will almost certainly continue to be heavily used in classrooms. Exams provide an excellent method for testing recall; thus questions at the knowledge level on exams may continue to be represented disproportionate to the emphasis given knowledge in the course. However, other levels can be tested on exams, even though they are sometimes more difficult to evaluate. Instructor training in the construction of test questions at the various levels of cognition may be necessary.

Recommendations for Further Research

The results of this study suggest several avenues of further research.

1. Additional descriptive data regarding the cognitive level of teaching in the College of Agriculture is needed. This study included only three instructors who
were purposefully chosen and who had all expressed an interest in improving their teaching. Further research could examine not only the cognitive levels of teaching but also whether the cognitive levels of teaching change between lower-division and upper-division classes.

2. Further descriptive information is needed regarding the cognitive abilities of students before entry into a course. Several questions should be addressed. First, what are the cognitive abilities of these students? Is the thinking of most freshmen primarily concrete thinking which roughly corresponds to the lower levels of cognition? Do the cognitive abilities appear to develop as students progress from lower-division to upper-division classes? A second and related question is the instrument that should be used to measure cognitive ability. The Watson-Glaser Critical thinking appraisal (1980) has been validated and widely used. However, if this instrument is to be incorporated into research based on Bloom's Taxonomy, it must be considered a valid and reliable method for testing cognitive abilities at the various levels of Bloom's Taxonomy.

3. Research which probes the extent to which selected variables explain cognitive level of achievement is needed. This research should include most of the variables included in this study, since these variables were indicated by previous research, plus a measure of
students' cognitive abilities before entry into the course.

Procedural Recommendations

Further research which seeks to explain students' cognitive level of achievement will need to consider a number of methodological problems. Attention will need to be given to the following considerations and procedural changes.

1. All student instruments should be administered during class periods, preferably on days when attendance is high due to a quiz or assignments due. Following administration of each of the instruments, the researcher needs to follow up to obtain missing data.

2. The Watson-Glaser Critical thinking appraisal (Watson & Glaser, 1980) or another appropriate test of critical thinking abilities should be incorporated into the study. Use of the Critical thinking appraisal will entail instructor willingness to designate a whole class period and administer the test according to instructions.

3. The "Interest in and value of course" to the student instrument should also be administered in class during the first week of class. The researcher should use the administration of this instrument to explain the research to participating students.

4. A measure of instructor cognitive expectations should not be included. The present study could not
include an assessment of the cognitive level of the syllabus and course objectives because these documents were not written in behavioral terms. This problem will likely be encountered in other classes as well. In addition, the instructor's self-assessment of cognitive level of expectations poses serious validity and reliability problems. One of the participating instructors assessed self-evaluation of cognitive expectations as little more than guesswork.

Administration of this instrument through instructor interviews presupposes an understanding of the cognitive levels commonly shared by the participating instructors. Given little training in Bloom's Taxonomy or the FTCB, this assumption may be spurious. However, all participating instructors should use a course outline and/or syllabus to fulfill the students' need to know what to expect in a course.

5. A large enough number of instructors should be included in the study to enable the researcher to compare instructor characteristics and confirm the variance in instructor variables and the correlations between instructor variables and student cognitive achievement. The research may need to be conducted over a longer time period to accomplish this.

6. Inter-rater reliability should be tested if different researchers will be assessing different portions
of the research including cognitive level of teaching, cognitive level of tests and assignments, and cognitive level of the final examination.

7. A different method for assessing cognitive level of achievement will have to be built into the research design. A brief discussion of several possibilities follows.

a. The researcher could use a pre-test/post-test design utilizing a generic test which measures cognitive abilities. Such a test could be used across subject areas, but would have to be sensitive to the development of cognitive abilities over a short period of time. To fit with the use of Bloom's Taxonomy, it would also need to be comparable to the Taxonomy. This researcher is not aware of such a test.

b. The researcher could use the instructors' final exams to measure cognitive level of achievement.

8. The final examination appears to be the most feasible method for measuring short-term cognitive achievement among classes. The major problem with using final exams is comparability. Final exams will have to include questions at most or all levels. In addition, the following considerations will have to be addressed:

a. Instructors may have to be willing to construct the final exam with the aid of the researcher to
assure that questions occur at all levels. Unfortunately, this inserts a certain degree of artificiality into the final exam.

b. The researcher will have to establish a minimum number of questions or points at each level for each instructor to ensure comparability. Where questions in excess of the minimum occur, random sampling of questions could occur to further equalize the exams. The researcher may want to use sampling at all levels.

c. A measure of the relative difficulty of questions at each level between instructors will be needed. This procedure will avoid, for example, application questions which are very simple in one class and quite difficult in another.

d. The researcher will have to accept that the exams can not be completely comparable. Some will be primarily multiple choice while others may be short answer or essay. However, over time, as the number of exams increases, there will be an increased ability to compare by type of exam. It will also be burdensome and complex to equalize the difficulty of questions at the same level between instructors. Instructor differences in the allotment of points for the
grade are also likely to vary. These potential problems will need to be anticipated, but equalizing exams is not feasible and discrepancies in exams will likely remain a limitation in this line of research.

E. Since there were no synthesis questions on any final exams in this study, the researcher could consider either eliminating this category or combining it with evaluation. An additional argument for eliminating synthesis questions is based on Sanders' (1966) argument that successful use of synthesis depends on a positive classroom climate in which divergent thinking and ideas are accepted and encouraged. Eliminating synthesis questions would reduce the need to consider classroom climate as an important variable.

9. While a random sample of instructors would be ideal, a study of this kind will entail some self-selection. Instructors will need to be willing to allot not only more than one complete class period but also be willing to work with the researchers in constructing and classifying the final exam. The time requirements necessary for participating in such a proposed study should be clearly delineated to potential instructors.
10. Categorization of questions on the final exam, tests and assignments should be completed by consulting each instructor. This approach is supported in the literature (Furst, 1983). It is likely not necessary for every question but since the researcher will not be familiar with much of the content taught the instructor remains in the best position to judge whether questions are testing, for example, recall or interpretation.

11. Weighting factors for the seven levels of the Florida Taxonomy of Cognitive Behavior (Brown, Ober, Soar, & Webb; 1968) should be reconsidered. The concern of this researcher is the differential weight given to translation and interpretation. While Bloom et al. (1956) did break these apart as separate aspects of comprehension, no research has been completed to validate these levels as separate and hierarchically related.

12. Future research may want to consider additional variables. Is there a relationship between class size and student achievement? Is there a relationship between the extent of questionning used by an instructor and either the cognitive level of teaching or students' cognitive level of achievement?
APPENDIX A

FLORIDA TAXONOMY OF COGNITIVE BEHAVIOR
1. Knowledge of specifics

1. Reads
2. Spells
3. Identifies something by name
4. Defines meaning of term
5. Gives a specific fact
6. Tells about an event

1.2 Knowledge of ways and means of dealing with specifics

7. Recognizes symbol
8. Cites a rule
9. Gives chronological sequence
10. Gives steps of process, describes method
11. Cites trend
12. Names classification system or standard
13. Names what fits given system or standard

1.3 Knowledge of universals and abstracts

14. States generalized concept or idea
15. States a principle, law, theory
16. Tells about organization or structure
17. Recalls name of principle, law, theory

2.0 Translation

18. Restate in own words or briefer terms
19. Gives concrete examples of an abstract idea
20. Verbalizes from a graphic representation
21. Translates verbalization into graphic form
22. Translates figurative statements into literal statements or vice versa
23. Translates foreign language to English or vice versa

3.0 Interpretation

24. Gives reason (tells why)
25. Shows similarities differences
26. Summarizes or concludes from observation of evidence
27. Shows cause and effect relationship
28. Gives analogy, simile, metaphor
29. Performs a directed task or process
4.0 Application
30. Applies previous learning to new situations
31. Applies principle to new situation
32. Applies abstract knowledge in a practical situation
33. Identifies, selects and carries out process

5.0 Analysis
34. Distinguishes fact from opinion
35. Distinguishes fact from hypothesis
36. Distinguishes conclusion from statements which support it
37. Points out unstated assumption
38. Shows interaction or relation of elements
39. Points out particulars to justify conclusions
40. Checks hypotheses with given information
41. Distinguishes relevant from irrelevant statements
42. Detects error in thinking
43. Infers purpose, point of view, thoughts, feelings
44. Recognizes bias or propaganda

6.0 Synthesis (Creativity)
45. Reorganizes ideas, materials, processes
46. Produces unique communication, divergent idea
47. Produces a plan, proposed set of operations
48. Designs an apparatus
49. Designs a structure
50. Devises a scheme for classifying information
51. Formulates hypotheses, intelligent guesses
52. Makes deductions from abstract symbols, propositions
53. Draws inductive generalization from specifics

7.0 Evaluation
54. Evaluates something from evidence
55. Evaluates something from criteria
APPENDIX B

CLASSROOM OBSERVATION NOTES INSTRUMENT
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Teaching Aids Used

Instructor
APPENDIX C

INTEREST IN AND VALUE OF THE COURSE

TO THE STUDENT INSTRUMENT
Please indicate your academic rank by circling the most appropriate response.

Freshman    Sophomore    Junior    Senior    Graduate Student

Major area of study: ____________________________

Social Security Number: ________________________

1. Please identify the statement that best describes the reason you are enrolled in this course.

   A. I enrolled in this course because it is required in my major area of study.

   B. I enrolled in this course because it is recommended as a course supporting my major area of study.

   C. This course satisfies the agricultural elective requirements necessary for graduation in my major area of study.

You are asked to identify your level of agreement or disagreement with each of the following statements. For example, in the statement:

   Social interaction in the College of Agriculture has many rewards.

   Most Certainlty   Undecided   Most Certainlty    Agree
   Disagree         |             Agree
   1  2  3  4  5  6  7  (8)  9  10  11

A student that circles 8 agrees with the statement.

Please complete the following statements in a similar manner.

1. The material and concepts in this course are related specifically to my career objectives in agriculture.

   Most Certainlty   Undecided   Most Certainlty    Agree
   Disagree         |             Agree
   1  2  3  4  5  6  7  8   9  10  11
2. I am enrolled in this course because of the good reputation of the instructor.

Most
Certainly Undecided Most
Disagree | Agree
1 2 3 4 5 6 7 8 9 10 11

3. I am enrolled in this course because I heard it was very challenging.

Most
Certainly Undecided Most
Disagree | Agree
1 2 3 4 5 6 7 8 9 10 11

4. Even if this course was not required for graduation, I would enroll because I am interested in this area of study.

Most
Certainly Undecided Most
Disagree | Agree
1 2 3 4 5 6 7 8 9 10 11

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APPENDIX D

COVER LETTER DISTRIBUTED WITH STUDENT INSTRUMENTS
January 20, 1988

TO: Selected Students

We in the College of Agriculture are always interested in studying the teaching-learning process with the goal of improving students' education. I am currently directing such an investigation.

Your professor has agreed to participate and we need your assistance and cooperation as well. We hope you will agree to help us.

Will you please complete the attached instrument according to the instructions provided? Please return it to your professor by the date he gives you (it may be given in class or your professor may have you complete it at home).

Thanks for your help. Your involvement will contribute to the discovery of knowledge that can serve future generations of students in our College.

Sincerely,

L. H. Newcomb, Professor & Chair
Department of Agricultural Education

Enclosure
APPENDIX E

STUDENTS' PREVIOUS EXPERIENCE INSTRUMENT
Please circle the most appropriate response for each statement.

1. This was my first experience with the materials and concepts presented in this course. 
   
   YES  NO

2. I have studied similar material and concepts in other college courses.  
   
   YES  NO

3. This course builds upon materials and concepts from other college courses.  
   
   YES  NO

4. My high school courses were related to the material and concepts presented in this course.  
   
   YES  NO

5. I completed two or more years of vocational agriculture courses in high school with course material and concepts similar to this course.  
   
   YES  NO

6. In high school, I was actively involved in Future Farmers of America programs that related to the materials and concepts presented in this course.  
   
   YES  NO

7. I was involved in agricultural projects in my county 4-H programs for two or more years that related to materials and concepts experienced in this course.  
   
   YES  NO

8. I have two or more years of work experiences in agriculture specifically related to this course.  
   
   YES  NO

Thank you for your cooperation.
APPENDIX F

INSTRUCTOR'S COGNITIVE EXPECTATIONS FOR THE COURSE INSTRUMENT AND REFERENCE MATERIALS
INSTRUCTOR'S EXPECTATIONS
FOR PERCENTAGE OF THEIR INSTRUCTION AT EACH LEVEL OF COGNITION

Instructor Interviews

1. Looking back on your class which you taught winter quarter, what were your expectations (in percentages) for learning at each level of cognition?

   Remembering  ________  (FTCB-Knowledge)
   Processing  ________  (FTCB-Translation, Interpretation, Application and Analysis)
   Creating  ________  (FTCB-Synthesis)
   Evaluating  ________  (FTCB-Evaluation)

2. Of the percentage you identified in the category Processing, using this sheet as a guide (guide attached) could you estimate what percentage would most likely fall into each of these categories?

   Translation  ________
   Interpretation  ________
   Application  ________
   Analysis  ________
PROCESSING LEVEL OF COGNITION BREAKDOWN INTO FTCB CATEGORIES

Translation
- Restate in own words or briefer terms
- Gives concrete examples of an abstract idea
- Verbalizes from a graphic representation
- Translates verbalization into graphic form
- Translates figurative statements into literal statements or vice versa
- Translates foreign language to English or vice versa

Interpretation
- Gives reason (tells why)
- Shows similarities/differences
- Summarizes or concludes from observation of evidence
- Shows cause and effect relationship
- Gives analogy, simile, metaphor
- Performs a directed task or process

Application
- Applies previous learning to new situations
- Applies principle to new situation
- Applies abstract knowledge in a practical situation
- Identifies, selects and carries out process

Analysis
- Distinguishes fact from opinion
- Distinguishes fact from hypothesis
- Distinguishes conclusion from statements which support it
- Points out unstated assumption
- Shows interaction or relation of elements
- Points out particulars to justify conclusions
- Checks hypotheses with given information
- Distinguishes relevant from irrelevant statements
- Detects error in thinking
- Infers purpose, point of view, thoughts, feelings
- Recognizes bias or propaganda
COGNITIVE LEVELS OF LEARNING

A. Remembering
1. Involves the ability to memorize and recall:
   a. simple, concrete facts, definitions, dates, etc.
   b. means of classifying or categorizing these facts
   c. complex, abstract theories or generalizations
2. No understanding of the concepts or principles of the information is required.

B. Processing
1. Involves the use of known facts, principles, theories, etc.
2. Uses included in this level are:
   a. comprehension of the meaning and intent of the material
   b. application of understood information to new and unique situations
   c. analysis of the information or situation to increase understanding and facilitate problem solving

C. Creating
1. Involves the ability to combine pieces of information in a form that is new to the student.
2. Provides the opportunity for independent thinking, self expression.
3. Generally involves the development of some type of product:
   a. a communication that expresses the unique ideas, feelings, and experiences of the student.
   b. a plan or solution to a particular situation.
4. This product can be used to inform, describe, persuade, impress, or entertain.
D. Evaluating

1. Involves the ability to make a judgment or critical evaluation, for a given set of information, that is based on a standard or specific criteria.

2. The judgment/evaluation can be based on:
   a. internal evidence - assessing the accuracy, consistency, and logic of the material.
   b. external criteria - applying established criteria to judge or evaluate a particular situation or document.

3. The criteria used in the evaluation can be either from established standards or those determined by the student.
APPENDIX G

INSTRUCTOR'S PREVIOUS EXPERIENCE INSTRUMENT
Assessing The Instructor's Previous Experiences

A. Please indicate the total number of years of university teaching experience.
   _______ years

B. Please indicate the total number of quarters responsible for teaching this course or a course with similar materials or concepts. Include teaching at OSU and other institutions.
   _______ quarters/semesters

C. Please indicate the number of years of employment or experience outside teaching in the university setting related to the course content.
   _______ years

Please circle the most appropriate response for each statement.

1. During my undergraduate education I........
   A. had a course very similar to this course
   B. had a course somewhat similar to this course
   C. did not have a course similar to this course

2. During my graduate education I........
   A. had a course very similar to this course
   B. had a course somewhat similar to this course
   C. did not have a course similar to this course

3. During my graduate education I........
   A. had the opportunity to work as a teaching associate in a course very similar to this course
   B. had the opportunity to work as a teaching associate in a course somewhat similar to this course
   C. did not have the opportunity to work as a teaching associate in a course similar to this course

- - Go To The Next Page - -
4. I consider the material and concepts presented in this class as . . .
   A. my primary area of expertise
   B. a secondary area of expertise
   C. an area of limited expertise

5. Which statement best describes your involvement in research related to the materials and concepts presented in this course?
   A. I have been very involved in research related to the material and concepts presented in this course.
   B. I have had some involvement in research related to the material and concepts presented in this course.
   C. I have not been involved in research related to the materials and concepts presented in this course.

6. Which statement best describes your participation in the agricultural community on issues related to materials and concepts presented in this course?
   A. I have had the opportunity to work extensively in the agricultural community on issues related to materials and concepts presented in this course.
   B. I have had some experiences in the agricultural community on issues related to materials and concepts presented in this course.
   C. I have had limited involvement in the agricultural community on issues related to materials and concepts presented in this course.

Thank you for your cooperation!
LIST OF REFERENCES


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